The Pennsylvania State University
The Graduate School
College of the Liberal Arts

THIS IS MY TITLE

A Dissertation in
Psychology
by
Jason William Gullifer

Submitted in Partial Fulfillment
of the Requirements
for the Degree of

Doctor of Philosophy

August 2014

The dissertation of Jason William Gullifer was reviewed and approved* by the following:

Judith F. Kroll
Distinguished Professor of Psychology, Linguistics, and Women's Studies
Director, Center for Language Science
Thesis Co-Advisor

Paola E. Dussias
Professor of Spanish, Linguistics, and Psychology
Associate Director, Center for Language Science
Thesis Co-Advisor

Carol Miller
Associate Professor of Communication Sciences and Disorders

Janet Van Hell
Professor Psychology and Linguistics
Director, Linguistics Program

Brad Wyble
Assistant Professor of Psychology

Melvin M. Mark
Professor of Psychology
Department Head

*Signatures are on file in the Graduate School.

Abstract

Contents

List of Figures viii

List of Tables ix

List of Symbols x

Chapter 1
Introduction 1
1.1 Parallel activation at the lexical level . . . 4
1.2 Models of bilingual word recognition . . . 8
1.3 Constraints on language co-activation . . . 10
1.4 What about the syntax? . . . 14

Chapter 2
Roadmap 16
2.1 Participants . . . 19
2.2 Word naming tasks . . . 20
2.3 Cognitive and linguistic tasks . . . 23
2.4 Priming task . . . 26
2.5 Analyses . . . 30

Chapter 3
Out of Context 32
3.1 Introduction . . . 32
3.2 Experiment 1: Monolinguals . . . 33
3.2.1 Methods . . . 33
3.2.2 Results & Discussion . . . 35
3.3 Experiment 2: Bilinguals . . . 37
3.3.1 Methods . . . 37
3.3.2 Results & Discussion . . . 38

3.4 General Discussion . . . 40
3.5 Table 1: Lexical Characteristics . . . 43
3.6 Table 2: Monolingual cognate results after removal . . . 43
3.7 Table 3: Monolingual homograph results after removal . . . 43
3.8 Table 4: Bilingual cognate results . . . 44
3.9 Table 5: Bilingual homograph results . . . 44
3.10 Figure 1: Cognate results . . . 46
3.11 Figure 2: Homograph results . . . 46

Chapter 4
RSVP **47**
4.1 Introduction . . . 47
4.1.1 Evidence for parallel activation . . . 48
4.1.2 Are there constraints? . . . 51
4.1.3 Co-activation at the syntactic level . . . 54
4.1.4 Cross-language activation and syntax . . . 57
4.1.5 The present study . . . 58
4.2 Experiment 1: Bilinguals out of context . . . 62
4.2.1 Methods . . . 62
4.2.2 Results & Discussion . . . 65
4.3 Experiment 2: Bilingual in context . . . 67
4.3.1 Methods . . . 67
4.3.1.1 Participants . . . 68
4.3.1.2 Materials . . . 69
4.3.1.3 Procedure . . . 70
4.3.2 Results . . . 70
4.3.2.1 Cognate Analysis . . . 72
4.3.2.2 Homograph analysis . . . 73
4.3.2.3 Reanalysis of Experiments 1 and 2 . . . 74
4.3.2.3.1 Out of context reanalysis . . . 75
4.3.2.3.2 Cognate reanalysis in context . . . 76
4.3.2.3.3 Homograph reanalysis in context . . . 78
4.4 Discussion . . . 79
4.5 General Discussion . . . 80
4.5.1 Parallel activation and syntactic context . . . 81
4.5.2 Cognate effect as a frequency effect . . . 85
4.6 Conclusion . . . 87
4.7 RSVP Tables and Figures . . . 87
4.7.1 Table 1: Lexical Characteristics . . . 87
4.7.2 Table 2: Bilingual cognate results out of context . . . 87

4.7.3 Table 3: Bilingual homograph results out of context 87
4.7.4 Figure 1: Cognate results OOC 88
4.7.5 Figure 2: Homograph results OOC 88
4.7.6 Table 4: RSVP Participant Characteristics 88
4.7.7 Table 5: CLOZE probability 88
4.7.8 Table 6: In context Cognate mode output 88
4.7.9 Table 7: In context Homograph model output 91
4.7.10 Figure 3: In context Cognate model 91
4.7.11 Figure 4: In context Homograph model 91
4.7.12 Table 8: Cognate excluded OOC 91
4.7.13 Table 9: Homograph excluded OOC 91
4.7.14 Figure 5: Cognate excluded OOC 94
4.7.15 Figure 6: Homograph excluded OOC 94
4.7.16 Table 10: Cognate excluded in context 94
4.7.17 Table 11: Homograph excluded in context 94
4.7.18 Figure 7: Cognate excluded in context 97
4.7.19 Figure 8: Homograph excluded in context 97
4.7.20 Figure 9: Cognate excluded with exec control 97
4.7.21 Table 12: Cognate excluded model with exec control 97

Chapter 5
Priming **101**
5.1 Introduction 101
5.2 The present study 107
5.3 Methods 107
5.3.1 Participants 107
5.3.2 Materials 108
5.3.3 Procedures 109
5.4 Scoring and Analysis 110
5.5 Results 112
5.6 General Discussion 113
5.7 Conclusion 113
5.8 Priming Tables and Figures 113
5.8.1 Table 1: Priming Participant Characteristics 113
5.8.2 Table 2: Priming Descriptives 113
5.8.3 Table 3: Cross Tabulation: Actives and Passives 114
5.8.4 Table 4: Cross Tabulation: Datives 114
5.8.5 Table 5: Actives and Passives model 114
5.8.6 Table 5: Actives and Passives model high prof 114
5.8.7 Figure 1: Actives and Passives 114

5.8.8 Figure 2: Actives and Passives high 114
5.8.9 Table 6: Datives model 114
5.8.10 Table 6: Datives model high prof 114
5.8.11 Figure 3: Datives 117
5.8.12 Figure 4: Datives high 117

Chapter 6
Discussion and Conclusions **119**

Chapter 7
Appendix A: Lexical Stimuli **120**

Chapter 8
Appendix B: Sentential Stimuli **124**

Chapter 9
Appendix C: Priming Sentential Stimuli **125**

List of Figures

3.1 45

4.1 89
4.2 90
4.3 92
4.4 93
4.5 95
4.6 96
4.7 98
4.8 99

5.1 115
5.2 116
5.3 118

List of Tables

List of Symbols

α The first greek letter, p. **??**

α The first greek letter, p. **??**

α The first greek letter, but we should really add some more text, though we need it to go on two lines, p. **??**

α The first greek letter, p. **??**

α The first greek letter, p. **??**

α The first greek letter, p. **??**

α The first greek letter, p. **??**

α The first greek letter, p. **??**

Dedication

Chapter 1 Introduction

Introduction Bilinguals who are highly proficient in both languages seem to be able to operate in one of their languages independently without influence from other languages. With the exception of perhaps a slight accent or subtle differences in wording, the speech of a highly proficient bilingual may be indistinguishable from that of a monolingual speaker. All language users, monolingual, bilingual, multilingual, occasionally make speech errors, mixing up the order of words in a sentence, for example. Bilinguals however, very rarely slip up and use a word in the wrong language for the situation. These observations could be taken as evidence that bilinguals can functionally separate their two languages, perhaps representing the two languages in independent stores. Indeed, the narrative in the literature on child bilingual language acquisition is that children begin life with a merged language system and eventually learn to separate the two languages, and some early brain imaging evidence suggests that the languages may be represented in distinct areas. However, psycholinguistic research on adult bilinguals who are fluent in two languages has shown that the two languages do constantly interact. When a bilingual reads a word in one language, related features are co-activated in the unintended language, and when a bilingual prepares to speak a word, the other language translation equivalent is on the tip of their tongue. As such, models of the bilingual lexicon that have been proposed in the past decade posit integrated representational stores for the two languages. Likewise in the domain of syntax, bilinguals can be primed to use a syntactic structure even, if that structure was heard in a different language. This suggests that syntax is also shared across languages and on some level becomes co-activated. Models of bilingual syntactic representation also posit shared storage of syntactic structures. Yet, the question remains: if the two languages are co-activated and interact, how does a bilingual or multilingual finally select a word or structure in the intended language from the myriad of co-activated alternatives?

This dissertation addresses the question of how bilinguals select the language they intend to use at the lexical level and at the syntactic level. The hypothesis explored here is that features of a sentence that are distinct to one language (specifically, when syntactic constructions differ across the two language) allow bilinguals to functionally separate syntactic structures and predict the language of upcoming words in a sentence. This question is addressed through the novel combination of two distinct research paradigms: the confederate picture description task and the Rapid Serial Visual Presentation reading paradigm. The confederate picture description task measures cross-language priming (i.e., the propensity to repeat a syntactic construction, such as the active construction or the passive construction, that was used recently), providing an index of the functional separability of various syntactic constructions within a population of bilinguals. When structures are primed across languages, they are assumed to be represented in a common, language-general store. If they are not primed, they are assumed to be represented in a distinct, language-specific store. The results of previous confederate picture description studies conducted on bilinguals who speak a variety of language pairs indicate that structures which share word order across the two languages are represented in language-general stores and structures that do not share word order are represented in language-specific stores. In Experiments 1 and 2 of this dissertation, the implications of these findings are applied to the domain of word recognition during reading. Experiment 1 investigates bilingual word recognition in isolation. Spanish monolinguals and Spanish-English bilinguals read aloud words that were cognates or homographs between Spanish and English. If bilinguals co-activate the unintended language, then we should observe effects that are consistent with cross-language activation (i.e., cognate facilitation and homograph inhibition) for bilinguals but not monolinguals. In Experiment 2, two sets of sentences are constructed: (1) a set of sentences with syntactic structures that are inferred to be language-specific for Spanish-English bilinguals and (2) a set of sentences with syntactic structures that are inferred to be language-general for Spanish-English bilinguals. If bilinguals co-activate the unintended language during sentence reading, then the cognate and homograph effects should persist in the sentential conditions. However, if sentence context, or aspects of sentence context such as language-specific syntactic constructions, can trigger language-selective access, then the effects should be reduced in following these conditions. In Experiment 3, a confederate picture description study is conducted on a similar sample of Spanish-English bilinguals, providing independent evidence on whether the inferences of separate vs. shared syntax hold for this set of bilingual speakers.

To preview the findings, Experiment 1 shows that Spanish-English bilinguals activate the unintended language (here English, the L2) when they read words aloud in the L1. Co-activation was evidenced by significant facilitation for cognates relative to control words, but there was no homograph inhibition. In Experiment 2, the cognate facilitation and homograph inhibition effects were present but modulated by sentence construction. The cognate facilitation effect differed when comparing the two dative conditions: cognate facilitation was greater in the dative condition that shares word order with the English dative compared to the dative condition that does not share word order, but a follow-up analysis calls the stability of this interaction into question. The homograph effect also depended on syntactic construction: there was a facilitatory homograph effect in sentences with active and passive constructions, which share word order between Spanish and English, and an inhibitory effect in the dative constructions. The interaction was robust after the follow-up analysis. Finally, the results of Experiment 3, while preliminary, suggest that only sentences in the active and passive condition were able to be primed from Spanish to English. The dative structures, which differ in word order, showed no significant effect of priming. This suggests that for our sample of bilinguals, active and passive structures are represented in mental stores that are shared across language and that dative structures are represented in separate mental stores. This is the first demonstration, to our knowledge, of (1) a language-specific storage for syntactic structures in Spanish-English bilinguals and (2) that language-specific storage has consequences for the co-activation of the two languages during word recognition.

The dissertation is laid out as follows. In what remains of Chapter 1, I provide an overview of the evidence for parallel activation of two languages in bilinguals, focusing on the lexical level. I then discuss the extant research constraints to language co-activation, including whether aspects of sentence context affect co-activation. In Chapter 2, I provide an intellectual and methodical road-map to the four empirical investigations in Chapters 3, 4 and 5. Specifically, I review the literature on cross-language syntactic priming and argue that data from language usage can provide valuable insights into how syntactic structure is stored representationally. In Chapter 3, two experiments are reported to provide independent evidence for lexical co-activation during word naming, in which bilinguals name words outside of sentence context. In Chapter 4, I present the empirical results of an experiment in which I investigate whether syntactic constructions that are implicated as language-specific structures by previous syntactic priming research can reduce co-activation of the unintended language at the lexical level. In Chapter 5, I report the empirical results of a cross-language syntactic priming experiment in which I investigate whether word-order differences allow bilinguals to establish structures as language-specific. Finally in Chapter 6, I present the general discussion and conclusions, tying together the results of the four empirical studies.

1.1 Parallel activation at the lexical level

Parallel activation at the lexical level The strongest evidence for parallel activation of the two languages has been shown when bilinguals read single words that are ambiguous across their two languages, such as interlingual cognates and homographs. Cognates are words which share form and meaning across languages (e.g., `piano" in English and Spanish) while homographs overlap in form but conflict in meaning across languages (e.g.,`pan" which is a receptacle for cooking in English but a leavened food item in Spanish). If it were possible for a bilingual to access words selectively in a single language, then the presence of cross-language ambiguity should not influence processing in comparison to non-ambiguous words. However, contrary to this prediction, cognates typically elicit faster reaction times to read or name the word (i.e., cognate facilitation; e.g., Dijkstra et al., 1998; Van Hell & Dijkstra, 2002; Schwartz et al., 2007). Inter-lingual homographs typically elicit slower processing times (i.e., homograph inhibition; e.g., Beauvillain & Grainger, 1987; Dijkstra et al., 1998). In the past decade, cross-language co-activation has become a widely-accepted phenomenon in the field of bilingualism. Critically, monolingual of either language pair do not show differential effects towards interlingual cognates or homographs, suggesting that the effects witnessed in bilingual participants are due to their bilingualism and not to spurious effects related to uncontrolled properties of the stimuli.

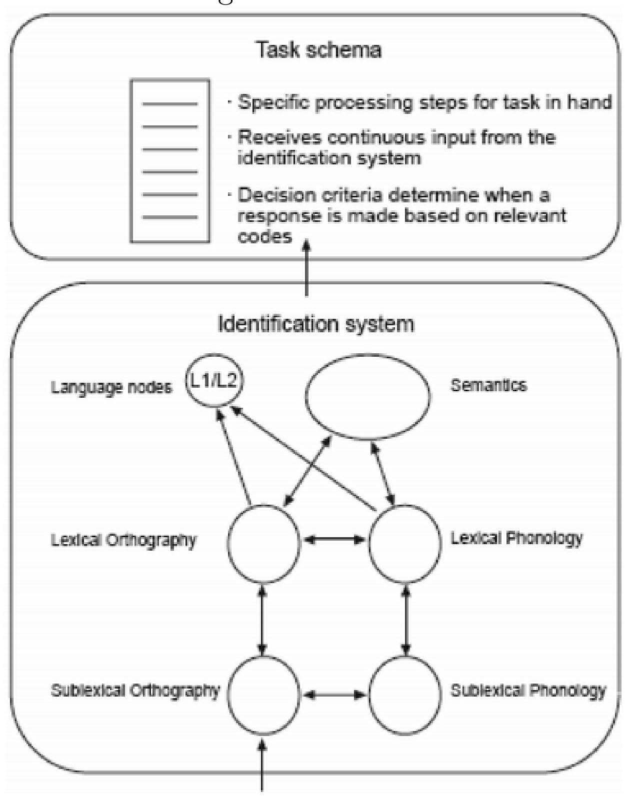
Evidence for language co-activation (or language non-selectivity) is observed across a broad range of tasks and contexts. Cognate facilitation and homograph inhibition are observed using a variety of dependent measures. Initial research was conducted with behavioral measures such as reaction time for lexical decision (Dijkstra et al., 2008; Van Hell & De Groot, 2008; Van Hell & Dijkstra, 2002), translation (Van Hell & De Groot, 2008; Sanchez-Casas, Davis, & Garcia-Albea, 1992), word association (Van Hell & Dijkstra, 2002), and word naming (e.g., Schwartz & Kroll, 2006; Schwartz et al., 2007). More recent studies find language co-activation in measures such as eye-tracking (Duyck et al., 2007; Libben & Titone, 2009; Titone et al., 2011; Van Assche et al., 2010; Van Assche et al., 2009) and event-related potentials (ERPs; Midgley, Holcomb, & Grainger, 2011). Behavioral measures tend to measure the aggregate result of processing. Hence a cognate effect in a lexical decision task provides no information about the point in the timecourse of processing at which both languages started to become activated. It could theoretically be the case that parallel activation occurs late in the process of word recognition, almost as if bilinguals translate words between their two languages, or both languages might become activated initially at the point at which orthography begins to be decoded. More time sensitive methods, such as ERPs and eye-tracking, indicate that parallel activation is not solely a late process. Both language alternatives become activated early in processing and remain activated during late stages of processing. For example, in eye tracking, cognate effects are observable in first fixation duration and gaze duration measures, assumed to reflect initial lexical access. They also show that both languages remain activated throughout the time-course of processing (e.g., Duyck et al., 2007; Libben & Titone, 2009; Van Assche et al., 2010; Van Assche et al., 2009) via cross-language effects in total reading time, a finding which could suggest that the intended language may never actually be selected categorically or that the selection is not observable without an even more sensitive measure. Non-selective access has been observed for language pairs such as Dutch and English, which share the same writing system (e.g., Dijkstra, 2005), in Chinese and English, which do not (Thierry & Wu, 2007), and in English and American Sign Language (e.g., Morford et al., 2011), one spoken and one signed language. Parallel activation is also not simply a side-effect of L2 processing. While the first or dominant language (L1) does strongly influence processing of the weaker L2, a bilingual's L2 or even L3 can become activated during L1 processing (e.g., Van Assche et al., 2009; Van Hell & Dijkstra, 2002). Overall, the degree of cross-language activation is relatively insensitive to the demands of the task at hand. Parallel activation is observed in blocked and mixed language contexts and across a range of different methods including naming latencies (e.g., Schwartz & Kroll, 2006; Schwartz, et al., 2007), eye-movement records (e.g., Duyck et al., 2007, Libben & Titone, 2009; Van Assche et al., 2009; Van Assche et al., 2010), lexical decision times (e.g., Dijkstra et al., 1998; Van Hell & De Groot, 2008; Van Hell & Dijkstra, 2002), and ERPs (e.g., Midgley et al., 2011).

Parallel activation is a graded phenomenon, not an all-or-nothing process. As in monolingual word recognition (Seidenberg & McClelland, 1989), the activation of any particular word for a bilingual is a continuous function of a distributed pattern of activation across multiple levels of mental representations, including the orthography, phonology, and semantics. Thus, the degree of cross-language overlap at each level factors in to the degree of observable cross-language co-activation. Cognate and homograph effects are larger when words share orthographic overlap or phonological overlap across the two languages. These effects are not categorical but continuous, such that greater overlap corresponds to a larger magnitude of cross-language co-activation(e.g., Duyck, Van Assche, Drieghe, & Hartsuiker, 2007; Schwartz, Kroll, & Diaz., 2007; Van Assche, Drieghe, Duyck, Welvaert, & Hartsuiker, 2010; Van Assche, Duyck, Hartsuiker, & Diependaele, 2009). Parallel activation of the semantics is evident in homograph recognition; the conflict in meaning across the two readings of an interlingual homograph produces a cost to processing. No studies to my knowledge have tested whether the degree of shared semantic overlap across languages influences the degree of co-activation. However, cognate effects in translation have been shown to depend upon semantic factors such as word concreteness (e.g., Van Hell & De Groot, 2008). In sum, bilingual word recognition is an interactive process dependent on graded activation among multiple levels of representation.

The main focus of work on parallel activation has been on the processing of cognates and homographs. However, there are at least two critiques to this approach. First, one can argue that the processing differences observed for words with cross-language overlap are simply the result of increased frequency of usage of word. For example, a Spanish-English bilingual will experience the cognate word "bus" twice as often as her monolingual counterpart, and this increased experience may lead to a processing advantage for that word in the bilingual's lexicon (see e.g. the weaker-links or frequency lag hypotheses, Gollan, Montoya, Cera, & Sandoval, 2008; Gollan, et al., 2011). Second, it is not clear from the study of cognate and homograph processing alone that non-selective access extends to processing of every word in the lexicon. While it is likely true that increased frequency of usage is partially responsible for the cognate and homograph effects, it does not completely rule out parallel activation of languages. Cognate and homograph effects depend on the degree of orthographic overlap (e.g., which can be calculated via the Van Orden or Levenshtein distance methods, Levenshtein, 1966; Van Orden, 1987) and phonological overlap (that can be elicited from participants making auditory judgments on sound overlap) of a word between the two. Smaller cross-language effects are observed for language-ambiguous words with a less orthographic or phonological overlap, and this relationship is linear (e.g., Dijkstra et al., 1999; Schwartz et al., 2007; Van Assche et al., 2010). A purely frequency-dependent hypothesis would not predict sensitivity to cross-language overlap within language-ambiguous words. Touching on the second critique, further evidence in favor of the parallel activation hypothesis is the observation of cross-language effects for stimuli that share no overt similarities between the two languages and in tasks that require no overt language processing (Chabal & Marian, 2013; Morford, Wilkinson, Villwock, Piñar, & Kroll, 2011; Thierry & Wu, 2007; Wu, Cristino, Leek, & Thierry, 2013). For example when proficient Chinese-English bilinguals and monolingual speaker of each language make semantic relatedness judgments on English words, both groups of speakers show semantic priming via a positive modulation of the N400 component for related words. However, only bilinguals show an additional modulation when the Chinese translation of the English words share characters and phonology, features that were never overtly present in the experiment (Thierry & Wu, 2007; Wu & Thierry, 2010). Likewise, deaf signers who read English activate the sign translation equivalents despite the fact that there is no phonological nor orthographic overlap between the two linguistic systems. Thus there is strong evidence for cross-language activation in spite of the frequency dependence and when stimuli other than cognates and homographs are used in experiments.

1.2 Models of bilingual word recognition

Models of bilingual word recognition Dijkstra2002 proposed the BIA+ model to account for cross-language interactions during bilingual word recognition (see also Dijkstra1998 for an earlier version of the BIA+ model). The BIA+ model, adapted from the Interactive Activation Model (**McClelland1981**), was designed to account for data from reading experiments conducted with bilingual participants. The model, shown in Figure 1, is divided into two separate levels: the task schema and the word identification system. The word identification system is responsible for handling only linguistic input while the task schema handles the demands of non-linguistic contexts.



The word identification system deals with linguistic input to the model. The BIA+ posits an integrated lexicon (i.e., the words of each language are integrated into one ŞdictionaryŤ) and shared semantics across the two languages. The word identification system is highly interactive. Upon ŞreadingŤ a word, nodes for phonological and orthographic representations at the lexical and sublexical levels become active. Activation then spreads within and between the lexical and sublexical levels causing potential candidates to become more highly activated than other words. The higher levels of the model (i.e., the semantics level and language nodes) receive activation from the lower levels. In the semantic level, concepts receiving enough activation spread this activation back down to the lower levels further reinforcing the activation of potential lexical candidates. The language nodes are responsible for identification of the language being read. A crucial assumption made by the model is that the higher level nodes may only receive bottom-up activation. Furthermore, the language nodes may not send activation back down to the lower levels. Thus, prior knowledge of the intended language will not increase activation to nodes at lower levels. That is, the language nodes cannot function as a language filter. Instead, the nodes must be sufficiently activated through experience with a linguistic input.

While the word identification system handles linguistic input, the task schema deals with non-linguistic contexts. The task schema is responsible for accomplishing the task at hand (e.g., lexical decision, naming, etc.) and determining when a response should be made. In order to help with this decision, this level of the model receives constant input from the word identification system. A critical assumption of the BIA+ model is that the task schema (and, thus, non-linguistic context) does not infiltrate the word recognition system. Evidence for this was shown by \textcite{Dijkstra2000} who demonstrated that the presence of stimuli and not expectations derived from instructions affected bilingual performance in a lexical decision task.

Given the assumptions of the BIA+ model it is easy to see how cross-language overlap will affect the recognition of words. Cognates, because of their close overlap in orthography, phonology, and meaning, will receive activation in both languages more quickly compared to words without similar overlap. Thus lexical decision or naming will be facilitated. On the other hand, when homographs are the input, the cross-language overlap with orthography and phonology may initially speed activation but the discrepancy in meaning will cause the system to have trouble identifying the language of the word thus slowing lexical decision or naming performance. Overall, the BIA+ predicts that a parallel access account with respect to language occurs in a bottom-up fashion. This parallel activity is not easily constrained by non-linguistic contexts.

The question now is how linguistic contexts influence word recognition. Because the BIA+ model was designed to account for word recognition outside of sentence contexts, it makes no explicit predictions regarding linguistic contexts. However, as we shall see in the following section, there are specific linguistic contexts that may allow bilinguals to recognize words in a language-selective manner.

1.3 Constraints on language co-activation

Constraints on language co-activation A major question in multilingual word recognition is whether a single language alternative can be selected from the myriad of activated words, and if so, what cues may aid in enabling a language selection. The recent research shows that language-selective access is difficult to achieve. Neither aspects of lexical form nor of the context of language usage provide a strong language cue that can reduce co-activation of the unintended language during bilingual word recognition.

Aspects of lexical form

One potential source for a language cue may be present in the cross-linguistic differences between two language pairs; languages often differ on many facets. Language specific characteristics can be quantified on many different levels of representation: phonological, orthographic, morphosyntactic, syntactic, pragmatic, etc. Languages may have different allowable phonemes (e.g., click languages), phoneme that are perceived as different in one language because they tend to mark a difference in meaning may be realized as the same in another language where they do not differentiate meaning. Languages exhibit different phonotactics where e.g., consonant clusters may be allowed in onset positon for some languages (e.g., tk in XXX but not in English). Language have different orthographic systems. They may share script, e.g. English, Spanish, and German share much of the same latin script, but there are differences in diacritics. Languages may share completely separate as in latin, Cyrillic, and Arabic. Morphosyntactically, some languages exhibit characteristics not seen in other languages. For example, many romance languages such as Spanish have a robust system of pronomical object clitics (or proclitics, e.g., Şle blah blahŤ) that does not exist in modern Germanic languages such as English or German. Syntactically, the study of word order has been very important in the field of linguistics, particularly with the advent of Chomsky's idea of universal, generative grammar in the late 1950s. Languages readily exhibit differing word orders, and much effort has been invested into unifying these differences. This includes language typologists who have focused on constituent order and differences across language. For example, Greenberg (1963) proposes a basic order typology from which he derives a set of linguistic universals: languages tend to have prepositions or postpositions, one of the six possible orderings of the subject, verb, and object, and adjectives that occur prenominally or postnominally. The position of qualifying adjectives in relation to nouns. (From a UG standpoint, maybe there are relatively few real differences in how language is structures across different languages).

Cognates, for example, often exhibit slight differences in their realization between two languages, despite their overall shared form. Cognates often have distinct phonology in each language (e.g., the cognates base and base in English and Spanish) and can also lack perfect orthographic overlap (e.g., the cognates ship and schip in English and Dutch). Likewise, cognate translations related by phonology may be written in entirely different scripts, as is the case between Hebrew and English or Chinese and English. In the most extreme case, one of the two languages in a pair may lack a system of writing entirely such as is the case for ASL-English bilinguals. Counterintuitively, these structural differences do appear not to function as a language cue. As mentioned earlier, Morford et al. (2011) found that ASL-English bilinguals were facilitated in judging that two English words were semantically related if the two words also shared similar hand-shape (i.e., phonological) forms in ASL, suggesting that ASL became activated during the processing of English words, a context where ASL was not perceptually relevant. While the form of the bilingual's two languages may influence processing, it does not eliminate non-selectivity entirely. More research is necessary before we can conclude that bilinguals do not exploit language specific features to allow language-specific lexical access.

Aspects of language context

A second potential cue may be present in aspects of the language context and in higher order linguistic representations such as the syntax or semantics in which words are typically embedded. Despite the presence of rich context in naturalistic language use, the early experimental evidence for non-selectivity came almost entirely from tasks in which words were presented in isolation (e.g., Dijkstra et al., 1998; Dijkstra et al., 1999; Schwartz et al., 2007; Van Hell & Dijkstra, 2002). An obvious question was whether sentence context itself would override the nonselectivity observed in isolated word recognition. Quite counterintuitively, recent research suggests that the mere presence of a sentence context alone seems to be ineffective in allowing a bilingual to select one language during comprehension. When bilinguals process language ambiguous words within a coherent sentence context, the effects of the language not in use remains, as if the words had been presented out of context. For example, Van Assche et al. (2009) reported cognate effects while Dutch-English bilinguals read sentences in their native language, Dutch. Although the sentences appeared in only one language and that language was their native and more dominant language, there was a persistent effect of English, the L2, on the processing of Dutch, the L1. Although effects tend to be more robust in the L2 which tends to be more vulnerable to the influence of the L1, the overall pattern of these findings have been replicated in a number of studies with different language pairs.

One aspect of sentence context that does appear to function to accomplish language selection is highly predictable semantic constraint. When a sentence is highly predictable in its interpretation, cross-language effects are diminished to the point where they are no longer observable. For example, Schwartz and Kroll (2006) asked Spanish-English bilinguals to read sentences in which cognates and non-cognate controls were embedded. One set of sentences were low constraint in that the critical target word, a cognate or control, was not predictable on the basis of the initial context. Another set of sentences was highly predicable. To illustrate, in a sentence like `When we entered the hall we saw a piano in the corner of the room" the cognate word`piano" is not predictable given the surrounding context, hence it has a low semantic constraint. When same cognate is placed in the sentence "Before playing, the composer wiped the keys of the piano at the beginning of the concert it becomes highly predictable given the preceding context. Schwartz and Kroll found that in low constraint sentences, there was cognate facilitation similar to out of context presentation. In contrast, following high semantic constraint, cognate facilitation was eliminated, suggesting that word recognition became language-selective. The results were virtually identical in both English and Spanish. Schwartz (2003) further found that high constraint sentences functioned to eliminate cross-language phonological modulation that had been observed in isolated word recognition (e.g., Schwartz et al., 2007). This type of interaction between semantic constraint and language co-activation has been documented in a handful of other studies (e.g., Chambers & Cooke, 2009; Libben & Titone, 2009; Titone et al., 2011; Van Hell & De Groot, 2008), although there is remaining debate about the presence and locus of the semantic constraint effects (e.g., see Van Assche et al., 2010).

Grammatical information also seem to function as a potential language cue. Sunderman and Kroll (2006) found that lexical form interference could be eliminated in a translation recognition task (i.e., decide whether two words are translations of one another) when the two words differed in their grammatical class. Likewise, Baten, Hofman, and Loeys (2010) demonstrated that word class interacted with the degree of language co-activation for words embedded in a sentence context. A facilitatory homograph effect was present when participants were required to make a lexical decision to target words, but only when the meaning of the homograph shared grammatical class with its translation. For example, when the Dutch-English homograph brief was used as an adjective in an English sentence (brief is a noun meaning letter in Dutch) no homograph interference was observed, suggesting that higher order grammatical properties such as word class can provide information that that can aid bilinguals in selecting the target language. In each of these examples, it is not clear whether the locus of selection occurs early or late in processing. Although more evidence overall suggests a late point of selection, consistent with the predictions of the BIA + model, identifying the precise locus at which selection will require that studies use methods such as eye tracking and ERPs that permit a sensitive analysis of the early time course of processing.

A critical question is whether the apparent language nonselectivity that is evident in bilingual word recognition will also be manifest when words are read in sentence context. Isolated word presentation may increase ambiguity, resulting in exaggerated processing for words that share cross-language overlap. In theory, the language of a sentence context should provide bilinguals with a cue to the target language that effectively reduces the activation of the language not in use. However, it appears that even when words are presented in unilingual sentence contexts, word recognition remains non-selective. When bilinguals are asked to name words in the context of sentences, naming latencies reveal patterns of cross-language activation consistent with out of context presentations (e.g., Schwartz & Kroll, 2006). Eye-movement records within context also indicate that language ambiguous words elicit differential fixation and gaze duration patterns, which are assumed to track the earliest stages of lexical access (e.g., Duyck et al., 2007; Libben & Titone, 2009; Van Assche et al., 2009; Van Assche et al., 2010). These findings are consistent with an interpretation of the BIA+ model in which word recognition proceeds without any influence from the presence of a sentence context.

Given persistent parallel activation of the two languages, a recent question has been whether there are any contextual factors which can function as a cue to allow bilinguals to selectively access, or "zoom in" to a single language alone (e.g., Elston-Güttler et al., 2005). To date, the only factor that appears to reduce lexical nonselectivity is semantic constraint. When a sentence contains a highly predictable lexical alternative, then the effects of cross language overlap are decreased or eliminated (e.g., Schwartz & Kroll, 2006; Libben & Titone, 2009; Van Hell & De Groot, 2008; but see Van Assche et al., 2010). Currently, BIA+ does not model the way in which the semantics of a sentence context interact with the non-selectivity of the system. The model could be modified to allow, for example, the semantics of a sentence to preactivate the language nodes, allowing for a faster language selection to occur. However, such an alteration might be drastic given that sentences which are low semantic constraint yet still coherent in their meaning still elicit parallel activation. Clearly, other factors to language selection must be identified before the BIA+ model is modified to account for the influence of linguistic context during word recognition. Curiously, a factor that has received little attention is grammatical structure. Languages differ syntactically and these differences lead to language-specific representations. The hypothesis in the proposed research is that cross-language syntactic differences may function to achieve language selection during word recognition.

1.4 What about the syntax?

What about the syntax? The question of whether cross-language syntactic differences influence word recognition was addressed by Gullifer et al. (2011). In that study, Spanish-English bilinguals read sentences in each of their languages and named a critical target word aloud. Target words were cognates (e.g., bus in English and Spanish) matched to unambiguous control words (e.g., hairspray-laca). Half of the Spanish sentences contained syntax structurally specific to Spanish. Syntactic specificity was manipulated in two ways: (a) the indirect object of a ditransitive verb was realized pleonastically with the proclitic le and its corresponding noun phrase; and (b) the grammatical subject of the object relative clause was not expressed overtly (e.g., Las monjas (a) le llevaron las mantas que (b)(pro) habían bordado a la directora del orfanato. [The nuns took the quilts that they had embroidered to the director of the orphanage.]) The English translations were controls in that the initial phrase of the sentence was not syntactically specific to either language. When all participants were included in the analyses, there was cognate facilitation that did not depend on the syntax of the sentence. Monolingual speakers of English and Spanish exhibited no cognate effects. However, data from a subset of the bilingual participants who were fastest to perform the naming task revealed the predicted interaction between sentence type and cognate status, suggesting that for these speakers, language-specific syntax eliminated the cognate effect. No independent measure of proficiency clearly modulated the effect. Taken together, the results suggested that bilinguals activate both languages while reading a unilingual sentence. If language-specific syntax did modulate nonselectivity, its effect was subtle. The results of Gullifer et al. raise the question of exactly what types of structures function as language specific. Descriptively, the presence of clitics and pro-drop are Spanish specific in comparison to English, but these (morpho)syntactic features may be too subtle to be exploited by bilinguals during processing. A more robust syntactic manipulation, for example, a structure that is assured to be represented differentially across languages, may function as such a cue that can allow bilinguals to select a language without influence from the unintended language. The question of how syntactic representations are represented and processed has been addressed in the work on cross-language syntactic priming. The presence or absence of syntactic priming has been taken as evidence for shared vs. separate syntactic representations across the two languages of a bilingual. The idea in the planned experiments is to first exploit syntactic priming as a method to differentiate language specific and language shared structures and then to assess the consequences of those structures for restricting lexical access to the language in use.

Chapter 2 Roadmap

Roadmap This dissertation addresses the question of how bilinguals select the language they intend to use at the lexical level and at the syntactic level. The hypothesis explored here is that features of a sentence that are distinct to one language (specifically, when syntactic constructions differ across the two language) allow bilinguals to functionally separate syntactic structures and predict the language of upcoming words in a sentence. This question is addressed through the novel combination of two distinct research paradigms: the confederate picture description task and the Rapid Serial Visual Presentation reading paradigm. The logic of this dissertation is to use the cross-language syntactic priming effect as a descriptive characterization of whether a structure is represented in a shared, language non-specific store or in separate language-specific stores. First, we selected two sets of structures, one set that should be language non-specific and another set that should be language-specific as characterized by previous findings on cross-language syntactic priming. Then, the consequences of this characterization for bilingual word recognition will be assessed in the rapid-serial visual presentation task. Finally, a confederate picture description study will confirm or disconfirm the characterization of the structures as language non-specific or language-specific.

The confederate picture description task measures cross-language priming (i.e., the propensity to repeat a syntactic construction, such as the active construction or the passive construction, that was used recently), providing an index of the functional separability of various syntactic constructions within a population of bilinguals. When structures are primed across languages, they are assumed to be represented in a common, language-general store. If they are not primed, they are assumed to be represented in a distinct, language-specific store. Cross-language syntactic priming is relatively robust for structures that overlap in word order, and the original evidence for this dependency comes from Loebell and Bock (2003). They showed that German (L1) Ű English (L2) bilinguals elicited cross-language priming for structures in the dative alternation (e.g., double object: The boy sent his pen pal a letter [Der Junge schickte seinem Breiffreund einen Brief]; prepositional dative: The boy sent a letter to his pen pal. [Der Junge schickte einen Brief an seinen Brieffreund]). While Loebell and Bock observed cross-language priming for dative structures between German and English (which overlap in their word order across languages), they observed no such priming for active and passive sentences (active: The janitor cleans the floors daily [Der Hausmeister reinigt die Böden täglich]; passive: The floors are cleaned daily by the janitor [Die Böden werden täglich von dem Hausmeister gereinigt [literally: ŚThe floors are daily by the janitor cleanedŠ]. They speculated that the lack of priming was due to the lack in word order overlap between German and English. In this alternation, the passive structure differs in word order across the two languages because the main verb of the German sentence ("gereinigt" the past participle of the verb to clean) comes at the end of the clause. In line with this hypothesis, the active-passive alternation has been shown to prime between other languages where the word order overlaps (e.g., Spanish and English; Hartsuiker et al., 2004).

Since Lobell and Bock, the cross-language syntactic priming effect has been replicated many times using a variety of tasks and syntactic structures. Priming has been found when the word order overlaps across languages: for example, in dative alternation in Dutch-English bilinguals (Schoonbaert et al, 2007), Swedish-English bilinguals (Kantola, & Van Gompel, 2011), and Greek-English bilinguals (Salamoura & Williams, 2007); the adjective-noun/relative clause alternation in Dutch and German (Bernolet, et al., 2007); as well as with the active/passive alternation in Spanish-English bilinguals (Hartsuiker, et al., 2004) and Polish-English bilinguals (Fleischer et al., 2012). A reduction in priming when the word order differs across languages has been shown the adjective-noun/relative clause alternation in German and English (relative clauses in German exhibit verb-final structure in contrast to English) does not elicit priming (Bernolet et al., 2007) and prepositional object dative constructions that involved word order variations between Greek and English (Salamoura & Williams, 2007).

On the basis of this previous literature, Spanish and English should have shared representations for actives and passive structures, due to the existence of word order overlap for these structures across the two languages. However, dative structures should not be completely shared across Spanish and English. While some prepositional object datives (specifically prepositional object datives in which the prepositional phrase comes after the indirect object noun phrase: NP-PP share word order in English and Spanish (e.g., Un hombre mostrando a una mujer su celular [A man shows to a woman his phone]), others do not. Spanish contains dative construction where the prepositional phrase precedes the indirect object noun phrase (i.e., PP-NP), and this construction is, for the most part, unavailable in English (e.g., Es un señor mostrándole lo que tiene en el celular a una señora [ItŠs a man showing what he has on the phone to a woman]). Additionally English contains the double object dative (e.g., A man is showing a woman his phone), a construction that does not exist in Spanish.

Experiments 1 and 2 investigate the consequences of the presence of active, passive, NP-PP dative, and PP-NP dative sentence constructions for bilingual word recognition. If bilinguals co-activate the unintended language during sentence reading, then the cognate and homograph effects (which measure cross-language activation) should persist in the sentential conditions of Experiment 2 compared to the out-of-context condition of Experiment 1. However, if language-specific syntactic constructions can trigger language-selective access, then the effects should be reduced in the conditions hypothesized to be language specific on the basis of previous syntactic priming studies (i.e., PP-NP dative sentences). Experiment 3, is a syntactic priming study that measures the propensity for priming in active, passive, and the two types of prepositional object dative constructions, providing independent descriptive evidence as nature of the representations for the structures chosen for Experiment 2. Language-specific structures that reduce co-activation of the unintended language (e.g., PP-NP dative sentences) would not be expected to show priming, whereas structures that freely allow for cross-language co-activation (e.g., active, passive, and NP-PP datives) should show significant priming.

The out-of-context word naming study (Experiment 1 in Chapter 3) and the in-context word naming study (Experiment 2 in Chapter 4) are in the process of being written-up together for publication. This publication (in progress) is represented by Chapter 4, and as such it contains repeated information from earlier chapters (condensed introductory material from Chapter 1 and data from the out-of-context study in Chapter 3). The cross-language syntactic priming study (Experiment 3) is reported in Chapter 5. Before continuing to the empirical investigations, an overview of the methods is reported here.

2.1 Participants

Participants Four groups of participants were recruited for the empirical investigations in this dissertation. One group of participants was a set of Spanish monolinguals from the University of Granada in Spain and the surrounding area. This group of participants had little knowledge of a second language. English proficiency was tested via an English verbal fluency task, and all included participants had a lower English verbal fluency than the lowest-producing English monolingual participants tested in an unrelated study. The group of Spanish monolinguals participated in the Spanish out-of-context word naming task to ensure that the lexical stimuli chosen for the word naming experiments were well matched on variables that influence word naming latencies.

The other three groups of participants were Spanish-English bilinguals. One group of Spanish-English bilinguals was recruited from the University of Texas, El Paso and the surrounding area; they participated in the out-of-context bilingual word naming study. Another group of Spanish-English bilinguals was recruited from the Pennsylvania State University and the surrounding area; they participated in the in-context word naming experiment. The final group of bilinguals was recruited from the University of Texas, El Paso and the surrounding area so that they could participate in the cross-language syntactic priming experiment. The participants in the three groups of Spanish-English bilinguals are highly proficient in English and Spanish. However, the bilinguals recruited from the El Paso area tend to be more balanced in the use of their two languages compared to the group of bilinguals from the State College area. This is likely related to the fact that there is a small, qualitative trend towards English dominance for the El Paso bilinguals compared to the Penn State bilinguals. However, the predicted impact of this trend on the results of the empirical studies is minimal.

The slight English dominance could result in greater English-on-Spanish effects for the out-of-context word naming study. This is not a problem, because one of the purposes of the out-of-context study is to ensure that the materials selected are sensitive to cross-language effects. However this does make an explicit comparison between the naming latencies in the out-of-context study to the in-context study difficult. What appears to be a smaller magnitude of cross-language effects due to sentence context could be due to the Spanish dominance of the speakers recruited from Penn State for that study. For the syntactic priming study, the English dominance of the participants should not influence the results. Priming tends to be significant and bi-directional as long as the speakers are highly proficient in the two languages (e.g., Bernolet et al., 2013).

2.2 Word naming tasks

Word naming tasks The word naming tasks were used to assess the degree of cross-language activation. Participants were presented with cognate and control words, and the time it took them to begin naming was recorded. The latencies for cognates and noncognates were compared to measure parallel activation. Two types of word naming tasks were used in the present set of experiments: out of context word naming, and word naming in sentence context. Before detailing each of these tasks, I review how the target words were selected.

Selection of target words The experimental items consisted of 240 Spanish words (see Appendix A). Forty words were critical cognate words between Spanish and English (e.g., cable) and 40 were lexically matched non-cognate control words (e.g., chispa in Spanish meaning spark in English). Forty words were critical homograph words between English and Spanish (e.g., pie in Spanish means foot in English) and 40 were lexically matched non-homograph control words. We matched each critical word to a control word on the basis of word length, two measures of lexical frequency (ALAMEDA: Alameda & Cuetos, 1995, and LEXESP: Sebastián-Gallés, Martí, Carreiras, & Cuetos, 2000), number of phonemes, and number of syllables in Spanish. We did not match the stimuli on these factors across Spanish and English. We matched the stimuli by-hand and with the help of the NIM search engine (Guasch, Boada, Ferré, & Sánchez-Casas, 2013). The entire set of lexical stimuli can be found in Appendix A.

We divided the lexical stimuli evenly into two sets of stimuli. In the later sentence-context experiment, we embedded each set of stimuli under different syntactic constructions (set 1: active and passive; set 2: dative; see Chapter 4). To assess whether lexical characteristics varied by construction (Active/Passive vs. Dative) or word type (cognate vs. Noncognate and homograph vs. Nonhomograph), we conducted two sets of between items ANOVAs (one set of cognate stimuli and another for homograph stimuli) with each of the lexical characteristics (word length, the two measures of frequency, number of syllables, and number of phonemes) as dependent variables. For the cognate stimuli, there were no significant differences for any of the five lexical characteristics (all Fs < 1, ps $>$ 0.05), indicating that the stimuli were well matched across conditions. For the homograph stimuli, there were no significant differences in word length, number of syllables, or number of phonemes (all Fs < 1.089, ps > 0.05). However, there were significant differences by Construction for the two frequency measures (Alameda: $F(1{,}76) = 5.868$, $p < 0.05$; LEXESP: $F(1{,}76) = 7.003$, $p < 0.05$), indicating that homographs and matched controls in the active and passive conditions were more frequent compared to those in the dative conditions, see Table 1 for the descriptives of lexical characteristics. The effect of word type and the interaction between word type for the two frequency measures with the homograph stimuli were not significant (Fs < 1, ps > 0.05). In future analyses, we included log word frequency as a co-variate to statistically control for the confound.

Out of context word naming Two word naming experiments assessed cross-language activation outside of sentence context. An English out of context experiment was administered to Spanish monolinguals (Experiment 1 in Chapter 3). This was done in order to ensure that any cognate and homograph effects found in the Spanish out of context study could truly be associated to parallel activation of Spanish and English, and not to lexical properties of the stimuli. Because English monolinguals have no knowledge of Spanish (or any other language), naming latencies for critical cognates and homographs should not differ from those of noncognates and nonhomographs. At the beginning of each trial, a fixation point was displayed until the participant pressed a key. The fixation point was followed by a Spanish target word. Upon the display of each word, participants named the target into a voice trigger microphone as quickly and as accurately as possible. We recorded the naming session to code naming accuracy following the task. Participants saw each of the cognates, homographs, and control items. They also saw 12 practice items at the beginning of the experiment. The items were pseudo-randomized prior to each session with the constraint that the participants should never see more than three critical trials in a row.

A Spanish out of context word naming task was administered to a group of Spanish-English bilinguals in order to assess the degree to which the target cognate and homograph stimuli were sensitive in eliciting parallel activation of English and Spanish (i.e., Experiment 2 in Chapter 3). The procedure for the Spanish out-of-context experiment was identical to that of the Spanish out of context experiment, except for the language of the stimuli.

Word naming was chosen because prior studies show that it is a sufficiently sensitive task for detecting parallel activation of two languages (**Schwartz2007**). Furthermore, overt naming, in comparison to a lexical decision task, ensures that participants activate the target word in the language of the task because they are required to speak in that language. Additionally, any modulation of the cross-language effects due to sentence context is particularly compelling because the other language has been deactivated in production as well as in comprehension. However, the downside is that for any null-interaction between word type and sentence construction, it is impossible to tell whether the unintended language was deactivated during comprehension and became re-activated during production or whether it was always co-activated throughout the time-course of processing.

Word naming in sentence context

The in context Rapid Serial Visual Presentation (RSVP) task allowed for the assessment of parallel activation while participants read sentences. In this instantiation of the RSVP task, participants were presented with a fixation cross at the beginning of each trial. After the participant pressed a key, a sentence was displayed word-by word at a fixed pace. When the target word, marked in red, appeared it remained on the screen until the participant spoke the word into the voice trigger microphone. At this point, the remainder of the sentence was displayed, word-by-word. Yes-no comprehension questions were created fora subset of the sentences to probe comprehension and to further distract participants from the main goal of the task. RTs to name the target word and measures of accuracy for both naming and comprehension questions were recorded. Thus, the dependent measures for the RSVP task are the same as the measures in the out of context word naming task.

We embedded the lexical stimuli within four sentence structures: actives, passives, prepositional object datives structures with NP-PP word order, and prepositional object dative structures with PP-NP word order. On the basis of previous syntactic priming literature, actives, passives, and possibly NP-PP datives can be considered Spanish-non-specific structures because they have been shown to exhibit cross-language syntactic priming for Spanish and English. Prepositional object structures with PP-NP dative can be considered Spanish-specific structures because they do not share linear word order across the two languages and should exhibit less robust cross-language syntactic priming in these languages. We divided the set of cognate materials (40 cognates and 40 matched controls) and the set of homographs materials (40 cognates and 40 matched controls) in half. Half of the critical-control pairs were embedded under the active and passive sentences while the other half were embedded under the prepositional object sentences. Thus each critical and control word appeared in two sentences (active and passive, or NP-PP and PP-NP), and we created two stimulus lists to counterbalance the stimuli so that no participant saw repetitions of any critical-control word pair. This resulted in a final sample of 320 sentences with 160 sentences per list (see Appendix B).

The RSVP task has been used successfully to demonstrate evidence for parallel activation in sentence context (**Schwartz2006**). While it is less naturalistic than the eye-tracking methodology, it accurately taps into the word-recognition process while at the same time providing a less complex dataset for analysis. Also, previous studies show that RSVP can yield results similar to eye-tracking (**Altarriba1996**). Furthermore, the dependent measure for RSVP is the same as the one used in the out of context norming experiment (i.e., time to begin naming the target), allowing for comparison between the in context and out of context results.

2.3 Cognitive and linguistic tasks

Cognitive tasks

Automated operation-span We administered the Automated Operation-Span task (**Unsworth2005**) to assess working memory capacity. In this version of the o-span task, participants remember letters in the order that they are presented while they simultaneously solve simple math equations. In the practice section of the task, participants first complete the letter recall portion of the task, then they complete the math portion of the task, and finally the practice doing both tasks together. In the letter practice, a letter appeared on the screen and participants remembered the letter and the order it was presented within the set of letters. During recall, participants saw a 4x3 matrix of letters, and they clicked each letter they remembered in the correct order. In the math portion of the experiment, participants saw a math equation (e.g., 2 X 2 + 1 = ?), and they had to solve the problem as quick as possible and click the mouse when they finished. On the next screen, they saw a digit and responded yes or no whether the digit was the solution to the equation. The math practice served to familiarize the participant with the math portion of the task as well as to calculate how long it would take each person to solve the math operations in the experimental version of the task. After the math practice, the program calculated each individualŠs mean time required to solve the equations, and participants were given this time (plus 2.5 SD) as a limit for the math portion of the experimental session for that individual. The participants completed 15 math operations in this practice session. In the final practice session, the participants performed both the letter recall and math portions together, a procedure identical to the experimental version of the task. just as they would do in the experimental version of the task. If the participants took too long to solve the math equation the trial was counted as an error that trial as an error. After participants completed all of the practice sessions, the participant began the experimental trials. These trials consisted of three sets of each set size, with the set sizes ranging from 3 to 7. Thus there was a total of 75 letters and 75 math problems. At the conclusion of the task, the program reports five scores to the experimenter: Ospan score, total number correct, math errors, speed errors, and accuracy errors. The OSpan score is the sum of all perfectly recalled sets, and this score was what we used as the working memory span for given participant.

AX continuous performance task (AXCPT) We administered a variation of the AX-CPT task, adapted from (**Ophir2009**; **Morales2013**). In this version of the AX-CPT task, five letters appeared on each trial, and eac letter remained on the screen for 300 milliseconds followed by an blank inter-trial interval of 1000 milliseconds. The five letters represented (in order): a cue (in red), three distractors (in white), and a probe (in red). The participant responded by pressing a "no" key on a button box for every probe and every distractor. However, they responded to the probe in a manner contingent to the relationship between the probe and the cue. If the cue was the letter "A" and the probe was the letter "X", the participants responded with a "yes" response (AX trials). If the cue was the letter “A” but the probe was any letter other than “X”, participants responded to the probe with a “no” response (AY trials). If the cue was any letter other than “A,” and the probe was an “X,” participants responded with a “no” response (BX trials). Finally, if the cue was any letter other than “A” and the probe was any letter other than “X,” participants responded with a “no” response (BY trials). Cue letters were randomly selected from all letters of the alphabet, save “X,” “Y”, and “K”; the former due to its identity as the target probe letter, and the latter two due to their visual similarity with the target probe letter. Similarly, the probe letters were randomly selected from all letters of the alphabet, save “A,” “Y,” and “K”; the former due to its identity as the target cue letter, and the latter two due, again, to their visual similarity with the target probe letter. The distractor letters were also randomly selected from all letters of the alphabet, except “A,” “K,” “X,” and “Y.” The task consisted of 100 trials of four trial types presented: AX trials (70%), BX trials (10%), AY trials (10%), and BY trials (10%).

Flanker Task We administered a Flanker task (**Emmorey2008**) to assess executive function. Participants saw displays of chevrons, diamonds, and Xs. In each block, participants had to respond as quickly and accurately as possible to the direction of the highlighted chevron. Control blocks consisted the presentation a single chevron pointing left or right. In the incongruent blocks, the target chevron was flanked by black chevrons pointing in the same direction as the target (congruent trials) or in the opposite direction as the target (incongruent trials). Go/no-go blocks consisted of trials with either black diamonds or black Xs flanking the target chevron, and participants withheld their response when the chevron was was flanked by black Xs (no-go trials) and respond otherwise. In flanker trials (i.e., during non-control blocks) the red chevron could appear in either the second, third, or fourth position in the five-item sequence, pointing either left or right. In addition to these blocks, there were two mixed blocks consisting of congruent, incongruent, go, and no-go trials intermixed in a random but fixed presentation. The Flanker task began and ended with control trial blocks (consisting of 12 control trials), and two mixed blocks in the middle of the task (consisting of 36 trials each, 9 trials per condition). The congruent/incongruent and go/no-go blocks were presented between the control block and the mixed blocks, and again in reverse order between the mixed blocks and the final control block. The order of the congruent/ incongruent and go/no-go blocks was counterbalanced between participants.

Linguistic tasks

Spanish and English picture naming tasks We administered English and Spanish picture naming tasks designed after (**Gollan2008**) to assess the relative proficiency of each language. Each language block included a set of high-frequency and low-frequency pictures, and the presentation was blocked by language. On any given trial, the participant would see a fixation cross until they participant pressed a key to initiate the trial, followed by a blank screen (displayed for 350 ms), followed by a black and white line drawing. The drawing remained on the screen until a voice-key was activated by the voice trigger. The participants named pictures as quickly as possible in the instructed language without making mistakes. Within each language, the pictures were pseudorandomly mixed, such that no more than three pictures of a given frequency category (i.e., high or low frequency) appeared consecutively.

Grammar tasks In order to assess language proficiency in both English and Spanish, bilinguals performed portions of two grammar tests: the Michigan English Language Institute College English Test (MELICET) and the Diplomas de Español como Lengua Extranjera (DELE). Each portion contained 50 questions. Each test covered grammatical aspects such as verb conjugation and preposition choice. All questions were multiple choice. While the grammar tests will not provide a comparison of the relative proficiency of each language, they can be used to compare groups of speakers within languages, in a similar manner as the picture naming task will be used. Thus, more proficient speakers of either language should score more highly, on average, compared to speakers who are less proficient in that language. We have used these tasks successfully to this end in previous studies (**Gullifer2013**).

2.4 Priming task

Confederate picture description task[Cross-language syntactic priming Syntactic priming is the phenomenon whereby the appearance of a certain syntactic structure facilitates the subsequent production or processing of that structure. Classically, syntactic priming is observed when monolingual participants read a prime sentence (e.g., active: `The lightning struck the house" or passive:`The house was struck by lightning”) and are asked to describe a picture of a novel event (e.g., a man eating an apple). Participants are more likely to describe the picture using the passive voice when the preceding sentence primes the passive voice (Bock, 1986). Since Bock, syntactic priming has been used as a tool to investigate how syntax is processed (see Pickering & Ferreira, 2008, for a review). Work on syntactic priming in bilinguals has demonstrated that the syntactic representations of two languages may utilize partially overlapping representations (Schoonbaert et al., 2007) with representational overlap depending on shared word order across languages. Priming is relatively robust for structures that overlap in word order. For example, Loebell and Bock (2003) showed that German (L1) Ű English (L2) bilinguals elicited cross-language priming for structures in the dative alternation which overlap perfectly in their word order (e.g., double object: The boy sent his pen pal a letter [Der Junge schickte seinem Breiffreund einen Brief]; prepositional dative: The boy sent a letter to his pen pal. [Der Junge schickte einen Brief an seinen Brieffreund]). Similar findings have been shown for the dative alternation in Dutch-English bilinguals (Schoonbaert et al, 2007), Swedish-English bilinguals (Kantola, & Van Gompel, 2011), and Greek-English bilinguals (Salamoura & Williams, 2007); the adjective-noun/relative clause alternation in Dutch and German (Bernolet, et al., 2007); as well as with the active/passive alternation in Spanish-English bilinguals (Hartsuiker, et al., 2004) and Polish-English bilinguals (Fleischer et al., 2012). These results suggest that bilingual syntactic representations overlap when word order is shared across the two languages.

Structures that contain word order differences across languages are less likely to show cross-language syntactic priming. Loebell and Bock (2003) observed no syntactic priming across German and English for structures in the active/passive alternation (active: The janitor cleans the floors daily. [Der Hausmeister reinigt die Boeden taeglich.]; passive: The floors are cleaned daily by the janitor. [Die Boeden werden taeglich von dem Hausmeister gereinigt.]). In this alternation, the passive structure differs in word order across the two languages because the main verb of the German sentence ("gereinigt" the past participle of the verb to clean) comes at the end of the clause. Likewise, the adjective-noun/relative clause alternation in German and English (relative clauses in German exhibit verb-final structure in contrast to English) does not elicit priming (Bernolet et al., 2007). Salamoura and Williams (2007) found that prepositional object dative constructions that involved word order variations between Greek and English elicited no cross-language syntactic priming. There are cases in which priming is observable across languages despite the presence of word order differences. Desmet and Declercq (2006) found that relative clause attachment sites (e.g., NP1 vs. NP2 attachment) can be primed across Dutch and English despite Dutch a verb-final structure within Dutch relative clauses which differs from that of English relative clauses. Shin and Christianson (2009) showed that priming occurs for the dative alternation between Korean and English despite differing word orders of Korean and English (Korean has SOV word order while English has SVO word order). Weber and Indefrey (2009) reported that passives could be primed between German and English despite word order differences between the constructions. Fleischer et al. (2012) found the Polish active OVS structure primed use of the English passive in Polish-English bilinguals. In one sense, this result suggests that priming can occur despite word order differences between languages because English does not have OVS word order in active sentences. However, the results stress the importance of linear word order because participants were primed to produce a construction (the English passive) in which the linear order of thematic roles overlapped across languages (the passive and OVS both place stress on the grammatical patient by fronting it). Clearly, the distinction between shared and separate syntactic representations as dictated by the presence or absence of word order differences is not clear-cut. However, the presence of discrepancies in the results of experiments utilizing structures with word order differences across languages suggests that the degree of representational overlap is reduced when word order is not shared.]

[An alternative explanation for the discrepancy in the studies presented above regarding priming and word order differences is that the results are confounded with the type of task being used. Studies that find an asymmetry in priming between overlapping and non-overlapping word orders tend to use the classical picture priming paradigm in which confederate speakers present participants with prime sentences before the participants describe a scene (e.g., Bernolet et al., 2007; Loebell & Bock, 2003) or other production oriented experiments (e.g., Salamoura & Williams, 2007). In contrast, the studies finding evidence for cross-language syntactic priming despite word order differences have used a wider range of tasks including sentence recall and self-paced reading (SPR). There may therefore be differential sensitivity across tasks to detect cross language priming for structures without word order overlap. Comprehension tasks, such as self-paced reading, tend to be less sensitive to the detection of syntactic priming (e.g., Ledoux et al., 2007; Thothathiri & Snedeker, 2008) and typically require lexical repetition to obtain priming. In the present study we assess cross-language priming in both production and comprehension and include ERPs to identify syntactic priming that occurs during comprehension but that may not be observable in behavioral tasks (e.g., Ledoux, et al., 2007; Tooley et al., 2009).] **Selection of materials** There were two sets of 144 pictures. One set was the naive participantŠs description set. It contained 64 experimental pictures and 80 filler pictures. 32 of the experimental pictures depicted scenes that could be described with either an active description or a passive description, and the other half depicted scenes that could be depicted with dative descriptions. The filler sentences depicted scenes that could be described with intransitive descriptions. Care was taken to avoid the depiction of cognates and homographs whenever possible. All of the pictures were photographs or digitally altered scenes consisting of photographed objects.

The location and animacy of the agents and patients in a description picture influences the baseline number of passive productions (e.g., Bock, 1986; Hartsuiker & Kolk, 1998a). Thus, we controlled the images to bias the production of passive sentences: the agent of the picture was always inanimate, and in the majority of the pictures was depicted on the right side of the picture (24/32; one agent was on the left and in 7 it was ambiguous or in the center of the picture). This is the standard procedure in studies on syntactic priming (e.g., Hartsuiker et al., 2004). For the dative pictures, the location of the agent and recipient were split roughly in half. Fifteen of the dative pictures depicted the agent of the left, 15 depicted the agent on the right, and two were ambiguous or featured the agent in the center of the picture.

The other set of pictures was the confederateŠs description set (i.e. the participantŠs verification set). It included the same proportion of pictures as the participantŠs description set (32 active/passive, 32 dative, and 80 filler pictures) The animacy and location of the objects for the confederateŠs description set varied. This set of pictures was paired with a set of sentential stimuli that made up the confederateŠs description script. The sentential stimuli included 64 active sentences, 64 passive sentences, and 80 filler sentences. The experimental sentential stimuli were divided into two groups, and the filler sentences remained the same for each group. Cognate status and homograph status was controlled within construction (active and passive, or dative): one quarter of the sentences in each sentential condition contained cognates, another quarter contained non-cognate matched control words, another quarter contained homograph words, and the final quarter contained non-homograph control words. For the active and passive sentences, the target word filled either the thematic role of the agent or the theme. If a target was an agent in one group it would be the theme in the other group. For the dative sentences, the target word filled either the thematic role of the theme or the recipient and the targets were similarly counterbalanced. Half of the pictures matched the semantic content of the sentence and half of the pictures did not. The participantŠs description pictures were randomly assigned to the confederateŠs description set at the run time of the experiment.

Procedure For the picture description task, the participant and a confederate sat in front of separate laptop computer running E-Prime software. The confederate and the participant took turns describing pictures to one another. The stated goal was for the describer should provide quick and accurate description of the picture they saw on the monitor and for the listener to quickly decide (by making a yes-no response on the keyboard) whether the picture they saw on their computer screen matched the spoken description of the other participant. The experimenter told the naive participant to always speak in Spanish the confederate to always speak in English. While the naive participant generated descriptions for their pictures, the confederate pretended to describe pictures to the participant, but in fact read the scripted sentences. The experimenter digitally recorded the session so that the responses could be transcribed later.

2.5 Analyses

Analyses Reaction time data were modeled using linear mixed effects regression (LMER) analysis with model comparison. LMER has several benefits over traditional Analysis of Variance (ANOVA). First, LMER models are more explicit than ANOVA because they model trial-level data, as opposed to aggregated mean reaction time data, allowing the experimenter to include trial- and item-level factors in one analysis along with participant-level factors. Second, LMER allows for incorporation of random effects by participant and by item (random intercepts: the extent to which participants and items vary on the dependent variable, and random slopes: the extent to which effects of interest vary by participant and by item), obviating the need for two separate ANOVAS, one by participants (F1) and one by items (F2). Finally, LMER is robust to unbalanced designs, such as the present experiment in which words were hierarchically embedded under different syntactic structures.

In[Some of this might want to stay in the ŞpaperŤ and some could also be moved or copied to the roadmap chapter] LMER, statistical significance can be assessed by using a model comparison approach. The performance of any single LMER model can be assessed with a likelihood ratio, an expression of the likelihood that a particular set of data would be observed given the model. When comparing two nested models (where one model contains a subset of terms compared to the other), the difference in the deviance (related to the likelihood: –2 * log-likelihood) between the two models is chi-square distributed. The two models being compared will differ in the degrees of freedom. Knowing the difference in deviance and difference in degrees of freedom allows the experimenter to conduct a chi-square test to assess whether the two models are significantly different from the resulting p-value. In other words, two models can be compared to assess whether the inclusion of an effect (or interaction) results in an observable difference large enough to warrant the spending of degrees of freedom. When a final model has been constructed, significance of the slopes (betas) can be determined via the normal approximation, which is not anti-conservative given an adequate sample of participants (Barr et al., 2013).

Chapter 3 Out of Context

Out-of-context norming studies

3.1 Introduction

Previous studies find evidence for nonselectivity by showing that bilinguals, but not monolinguals, recognize cognates faster than matched control words and homographs slower than control words. Cognate facilitation occurs as a result of the lexical form and semantic overlap across the two languages. Homograph inhibition primarily occurs as the result of the lack of semantic overlap between the homograph and itŠs distractor word in the unintended language.

There are two main goals of the first two experiments. The first goal is to replicate previous studies showing that bilinguals access both languages non-selectively when words are presented in isolation and that monolinguals do not show similar effects. A successful replication will ensure that the stimuli are capable of eliciting parallel activation, so that they can later be used to investigate bilingual word recognition in sentence contexts. The second goal is to provide a baseline measure for the size of cognate and homograph effects for the sets of cognate and homograph as they are divided in study on naming words in sentence context. A comparison between the magnitude of the effects within sentence context to the magnitude of the effects outside sentence context will allow for a precise assessment of the effect of sentence context on bilingual word recognition.

To this end, we matched a set of cognates to a set of non-cognate controls, and a set of homographs to a set of non-homograph controls. We divided the two sets of stimuli in half so that we could embed one set inside active and passive sentences and the other set inside dative sentences. Native Spanish speaking participants who were highly proficient in English as a second language read aloud the target words in isolation. Based on previous results, we predicted cognates in this experiment to be named faster than control words, and homographs to be slower compared to nonhomograph control words. If the stimuli were well matched after being divided into the two sets of constructions, then there should be no significant differences in the magnitude of the effects across the two constructions. We Şdummy codedŤ the target words as pertaining to the active and passive set or the dative set. In these first two experiments there should be no effect of sentence context (active and passive vs. dative) for well-matched sets of words because no sentence context was present.

3.2 Experiment 1: Monolinguals

Experiment 1: Monolinguals out-of-context

3.2.1 Methods

Methods

Participants

Thirty Spanish monolinguals from the University of Granada and the surrounding area participated in the word naming experiment. All participants gave informed consent, and the procedures had the approval of the Institutional Review Boards of the Pennsylvania State University and the University of Granada. Participants received Ă10 per hour for their participation in the experiment. All participants considered themselves as monolingual in Spanish (i.e., they had minimal knowledge of a second language). We administered an English verbal fluency task to assess the objective English fluency of the Spanish monolinguals. In the verbal fluency task, participants named as many exemplars of a given category as they could in 30 seconds. The task included 4 categories (animals, vegetables, fruits, and body parts). We compared participant performance to that of English monolinguals who named categories in their native language. We rejected Spanish monolinguals who performed better than the worst English monolinguals from the word naming analysis. The English monolinguals ranged from 7–18 exemplars per category, and we removed three Spanish monolinguals who produced greater than 7 exemplars per category and one Spanish monolingual who had missing verbal fluency data. The remaining 26 Spanish monolinguals ranged in production from 3–7 exemplars per category (M = 5.16, SD = 1.34), suggesting that they knew very little English.

Materials

The experimental items consisted of 240 Spanish words (see Appendix A). Forty words were critical cognate words between Spanish and English (e.g., cable) and 40 were lexically matched non-cognate control words (e.g., chispa in Spanish meaning spark in English). Forty words were critical homograph words between English and Spanish (e.g., pie in Spanish means foot in English) and 40 were lexically matched non-homograph control words. We matched each critical word to a control word on the basis of word length, two measures of lexical frequency (ALAMEDA: Alameda & Cuetos, 1995, and LEXESP: Sebastián-Gallés, Martí, Carreiras, & Cuetos, 2000), number of phonemes, and number of syllables in Spanish. We did not match the stimuli on these factors across Spanish and English. We matched the stimuli by-hand and with the help of the NIM search engine (Guasch, Boada, Ferré, & Sánchez-Casas, 2013). The entire set of lexical stimuli can be found in Appendix A.

We divided the lexical stimuli evenly into two sets of stimuli. In the later sentence-context experiment, we embedded each set of stimuli under different syntactic constructions (set 1: active and passive; set 2: dative; see Chapter 4). To assess whether lexical characteristics varied by construction (Active/Passive vs. Dative) or word type (cognate vs. Noncognate and homograph vs. Nonhomograph), we conducted two sets of between items ANOVAs (one set of cognate stimuli and another for homograph stimuli) with each of the lexical characteristics (word length, the two measures of frequency, number of syllables, and number of phonemes) as dependent variables. For the cognate stimuli, there were no significant differences for any of the five lexical characteristics (all Fs < 1, ps $>$ 0.05), indicating that the stimuli were well matched across conditions. For the homograph stimuli, there were no significant differences in word length, number of syllables, or number of phonemes (all Fs < 1.089, ps > 0.05). However, there were significant differences by Construction for the two frequency measures (Alameda: $F(1,76) = 5.868$, $p < 0.05$; LEXESP: $F(1,76) = 7.003$, $p < 0.05$), indicating that homographs and matched controls in the active and passive conditions were more frequent compared to those in the dative conditions, see Table 1 for the descriptives of lexical characteristics. The effect of word type and the interaction between word type for the two frequency measures with the homograph stimuli were not significant (Fs < 1, ps > 0.05). In future analyses, we included log word frequency as a co-variate to statistically control for the confound.

Procedure

Upon arrival to the lab, participants read and completed an informed consent form. Participants then sat at a computer and began a set of experiments, starting with the out of context word naming task. Following the word naming experiment, participants completed a verbal fluency task to assess English fluency. At the end of the session, participants received Ă5 as compensation for their time. The experimental session lasted approximately 30 minutes.

In the word naming task, participants received verbal and written instructions on how to proceed through the task. A fixation cross (Ş+Ť) appeared before each word, and participants pressed the space bar to bring up a Spanish word. They then named the word as quickly and accurately as possible in Spanish as soon as it appeared. A voice-key trigger recorded the latency to begin naming, and the entire session was auditorily recorded so naming accuracy could be coded later. Ten Spanish practice words preceded the experimental session to familiarize the participant with the task and to allow the experimenter to adjust the microphone sensitivity. During this time, the experimenter was present to answer any questions the participant might have. Following the practice section, the experimenter left the room.

3.2.2 Results & Discussion

Results & Discussion Undergraduate research assistants who spoke English and Spanish coded the accuracy of the word naming data. We excluded rials in which an incorrect word was named or in which the production would add variability to reaction times (RTs; e.g., hesitation before naming the target word) from the RT analysis. We cleaned the RT data using a procedure for the removal of absolute and relative outliers. First, considering only correctly named trials, we excluded RTs above 1500 ms and below 150 ms. We determined the absolute cutoffs via visual inspection of a density plot. Next, on the resulting subset of data, we excluded RTs if they fell outside of a 2.5 SD range around the mean naming latency for each participant. The cleaning procedure resulted in the removal of 5.7% of correct trials. The mean comprehension question accuracy was 96%.

We modeled reaction time data using linear mixed effects regression (LMER) analysis with model comparison. Before modeling, the dependent variable, RT to begin naming, was log-transformed. Numeric independent factors were all centered, and variables with a non-normal distribution were log-transformed (e.g., word frequency). First, we built a control model by including variables that significantly affected log RT. We included control variables which were significant in model comparisons against a baseline (null model), and which explained independent portions of the variance (as determined via successive model comparison) in the final analysis. The control factors that were significant were centered and log-transformed word frequency, centered word length (in characters), and a composite score of picture naming performance (summed z-scores of inverse reaction time and accuracy on the picture naming task).

On top of the control model, we added the effects of interest. The primary effects of interest were two categorical variable. The first variable was the four-level word type factor (cognate, cognate control, homograph, homograph control). Because the sets of cognates and controls and homographs and controls are not comparable (they were not matched to each other), two separate models were constructed to examine the cognate effect (cognate vs. noncognate) and the homograph effect (homograph vs. Nonhomograph). Also of interest was the two-level categorical variable representing which construction the set of cognate and homograph stimuli would be embedded in the sentence context word naming experiment (actives and passives or NP-PP and PP-NP datives). We sum-coded all categorical effects. We included random intercepts by participant and by item in all models. For the final models, we included random slopes for centered and logged word frequency, centered word length, word type, construction, and the interaction between word type and construction. The homograph model did not converge with the full random-effects structure until we removed the slope for the interaction between word type and construction. We did not add random slopes by target word, as all factors were manipulated between items.

For the cognate data,there was a significant effect of centered log frequency

(SS = –0.018, SE = 0.004, t = –3.755, $p < 0.001$) such that an increase in word frequency related to a decrease in log RT. There were no significant effects of centered word length, centered log frequency, word type, or construction(ts < 1.96, ps > 0.05). For the homograph data, there was an effect of centered word length (SS = –0.010, SE = 0.004, t = 2.441, $p < 0.05$). There was no effect of centered log frequency, word type, nor of construction (ts < 1.96, ps > 0.05). However, the interaction between word type and construction was approaching significance (SS = –0.047, SE = 0.025, t = 1.854, p = 0.064), suggesting that there could be an inhibitory homograph effect for the set of homographs selected for active and passive sentences in the sentence context study.

To remove potential lexical confounds, we computed item-specific cognate and homograph effects by averaging naming latencies for each critical word and for each matched control word across participants. We computed ninety-five percent confidence intervals for the mean difference between each critical-control pair, and we excluded any pair for which the confidence interval did not include 0 (indicative of a significant difference). This procedure resulted in the removal of three cognate-noncognate pairs and seven homograph-nonhomograph. Following the removal procedure, there was an effect of centered log frequency in the cognate model (SS = –0.002, SE = 0.003, t = –3.400, $p < 0.001$), and no other effects were significant (ts < 1.96, ps > 0.05). For the homograph model, there no significant effects (ts < 1.96, ps > 0.05). See Tables 2 and 3 for the fixed effects from the cognate and homograph models after item exclusion.

Following the removal procedure, there was no evidence that monolinguals showed a cognate effect nor a homograph effect and no evidence for any effects or interactions with the structure condition, indicating that the experimental stimuli were relatively well controlled on factors that influence naming latencies.

3.3 Experiment 2: Bilinguals

Experiment 2: Spanish-English bilinguals out-of-context

3.3.1 Methods

Methods

Participants

Thirty-eight Spanish-English bilinguals participated in the out-of-context norming study.. The participants were recruited from the University of Texas, El Paso and the El Paso area. All participants gave informed consent, and the procedures had the approval of the Institutional Review Boards of the Pennsylvania State University and the University of Texas, El Paso. Participants were paid $10 per hour for their participation in the experiment. Participants were recruited if they considered themselves bilingual between English and Spanish. Participants completed language history questionnaires to assess subjective language proficiency. Three participants had missing data on the language history questionnaire, resulting in a final sample of 35 participants. Overall, the participants from the final sample were proficient speakers of Spanish and English and the sample was balanced in their ratings of English and Spanish ($MSpanish = 8.80$; $MEnglish = 8.70$; $t(34) = 0.394$, $p > 0.05$).

Materials

The lexical stimuli are identical to those in Experiment 1.

Procedure

The word naming procedure is identical to that of Experiment 1. The general procedure was similar, except that following the word naming task, participants completed an additional set of tasks for a different experiment that included a verbal fluency task in English and Spanish, an operation span task, a Spanish picture naming task.

3.3.2 Results & Discussion

Results & **Discussion[**Go through the items and find out if thereŠs something about them that are impacting the lack of homograph effect]

Undergraduate research assistants who spoke English and Spanish coded the accuracy of the word naming data. We excluded rials in which an incorrect word was named or in which the production would add variability to reaction times (RTs; e.g., hesitation before naming the target word) from the RT analysis. We cleaned the RT data using a procedure for the removal of absolute and relative outliers. First, considering only correctly named trials, we excluded RTs above 2500 ms and below 250 ms. We determined the absolute cutoffs via visual inspection of a density plot. Next, on the resulting subset of data, we excluded RTs if they fell outside of a 2.5 SD range around the mean naming latency for each participant. The cleaning procedure resulted in the removal of 4.5% of correct trials. The mean comprehension question accuracy was 91%.

We modeled reaction time data using linear mixed effects regression (LMER) analysis with model comparison. Before modeling, the dependent variable, RT to begin naming, was log-transformed. Numeric independent factors were all centered, and variables with a non-normal distribution were log-transformed (e.g., word frequency). First, we built a control model by including variables that significantly affected log RT. We included control variables which were significant in model comparisons against a baseline (null model), and which explained independent portions of the variance (as determined via successive model comparison) in the final analysis. The control factors that were significant were centered and log-transformed word frequency, centered word length (in characters), and a composite score of picture naming performance (summed z-scores of inverse reaction time and accuracy on the picture naming task).

On top of the control model, we added the effects of interest. The primary effects of interest were two categorical variable. The first variable was the four-level word type factor (cognate, cognate control, homograph, homograph control). Because the sets of cognates and controls and homographs and controls are not comparable (they were not matched to each other), two separate models were constructed to examine the cognate effect (cognate vs. noncognate) and the homograph effect (homograph vs. Nonhomograph). Also of interest was the two-level categorical variable representing which construction the set of cognate and homograph stimuli would be embedded in the sentence context word naming experiment (actives and passives or NP-PP and PP-NP datives). We sum-coded all categorical effects. We included random intercepts by participant and by item in all models. For the final models, we included random slopes for centered and logged word frequency, centered word length, word type, construction, and the interaction between word type and construction. We did not add random slopes by target word, as all factors were manipulated between items.

For the cognate data, there was a significant effect of centered log-transformed word frequency (SS = –0.024, SE = 0.006, t = –4.330, $p < 0.001$), indicating that an increase in word frequency related to a decrease in log RT. There was also an effect of centered word length (SS = 0.025, SE = 0.005, t = 5.177, p < 0.001), indicating that an increase in word length related to an increase in log RT. There was significant effect of the cognate contrast (SS = –0.052, SE = 0.013, t = –3.983, p < 0.001), indicating that cognates were named more quickly compared to non-cognate controls. There was no significant effect of the construction contrast nor an interaction between the cognate and construction contrasts (ts < 1.96, ps > 0.05).

For the homograph data, there was a significant effect of centered log-transformed frequency (SS = –0.024, SE = 0.009, t = –2.790, p < 0.01). There was no significant effect of centered word length (SS = 0.009, SE = 0.006, t = 1.441, p = 0.15). There were no significant effects for the homograph contrast, the construction contrast, nor the interaction between the two (ts < 1.96, ps > 0.05). See Tables 3 and 4 for the fixed effects from the cognate and homograph models.

The Spanish-English bilinguals recruited for this study showed significant cognate facilitation effect. This cognate effect was similar for the set of words that are embedded in the active and passive sentences compared to those embedded in the dative sentences in the sentence-context word naming study. These results are in line with many previous out-of-context word recognition and word naming studies finding that bilinguals activate co-active both languages despite performing a unilingual task. There was no evidence of a homograph inhibition effect for the bilinguals. Previous studies have shown that homograph effects are more sensitive to aspects of context, such as stimulus list composition. For example, Dijkstra, Van Jaarsveld, and Ten Brinke (1998) failed to observe homograph inhibition in lexical decision unless they included filler items that were in the unintended language. In this experiment, there were no items in the unintended language. A potential interpretation of the results is that bilinguals were functioning in a language selective manner, as measured by the homograph effect.

3.4 General Discussion

General Discussion

To review, there were two goals of this pair of out-of-context word naming experiments. The first goal was show that bilinguals access both languages non-selectively when words are presented in isolation and that monolinguals do not show similar effects. The second goal was to provide a baseline measure for the size of cognate and homograph effects for the sets of cognate and homograph as they are divided in study on naming words in sentence context.

The two out-of context studies reported here suggest that this sample of Spanish-English bilinguals co-activated English when they read in their native language, Spanish. This co-activation was observable through significant cognate facilitation effect for the two sets of cognate stimuli. Monolinguals did not show a cognate effect, suggesting that the set of cognates was well-matched to the set of cognate-control items. These results are in line with many previous out-of-context word recognition and word naming studies finding that bilinguals activate co-active both languages despite performing a unilingual task. However, there was no evidence for co-activation of English from the homograph stimuli. Previous studies have shown that homograph effects are more sensitive to aspects of context, such as stimulus list composition. For example, Dijkstra, Van Jaarsveld, and Ten Brinke (1998) failed to observe homograph inhibition in lexical decision unless they included filler items that were in the unintended language. In this experiment, there were no items in the unintended language and it was a mostly monolingual task.

A potential interpretation of the results is that bilinguals were functioning in a mostly language-selective manner throughout the task, only activating the unintended language when cognate words were being processed. A language-selective account would predict no influence of homograph status or cognate status on word naming latency. No homograph effect was observed here in line with a language-selective account, but there was a significant cognate effect, which has traditionally been taken as evidence for cross-language activation. Cognates, with overlap in form and meaning across the two languages, may then provide a strong trigger to co-activate the unintended language while the homographs (and by extension control words) did not as they contain language-specific representations at the level of the semantics. An alternative account of the cognate effect is that it reflects not cross-language activation, but a difference in frequency across languages for cognates relative to control words. Because cognates share form and meaning, they may be represented only once in the lexicon. This special storage would result in a cross-language ambiguity and increased frequency of occurrence compared to non-cognate control words. If this interpretation of the cognate effect were correct, then participants may have been functioning in a completely language-selective way through this word naming task, and this interpretation of the results would call into question the extensiveness of cross-language activation during language comprehension, because it is only observable under certain conditions such as when the task is highly ambiguous between the two languages.

Another potential interpretation of the results is that both languages are activated in parallel, but that the locus of language selection is not fixed at a certain level of representation or at a certain point in the timecourse of word recognition.. During recognition of cognates, the co-activation of the two languages would be persistent through late stages of lexical access due to the overlap in lexical form and semantics, and this overlap facilitates processing processing at each level of representation. For homographs on the other hand, co-activation at the level of the lexical form results in facilitation, but then the competition at the level of the semantics must be resolved resulting in a slow-down in processing. The combination of facilitation and inhibition in this setting results in a null effect of homographs compared to controls. If the relevance of the unintended language had been boosted in some way (e.g., through the inclusion of fillers items in the unintended language), it would take longer to resolve the competition at the level of the semantics, resulting in an effect that surfaces as inhibitory for homographs relative to controls.

One way to adjudicate between these two potential interpretations is by the inclusion of additional layers of context. If context can trigger or suppress the relevance of the unintended language in some way, then effects that measure language co-activation should change in magnitude. Effects unrelated to co-activation would be predicted to stay of the same magnitude. This is the primary goal of the following experiment, where the same target words are embedded in meaningful sentence contexts. Some of the sentence contexts contain syntactic constructions that only occur in Spanish (potentially reducing the relevance of English), while others contain constructions that can occur in either Spanish or English.

Related to the second goal of this set of experiments, the results reported here show that the two sets of homograph and cognate words (the set of cognates and homograph to be embedded under active and passive sentences and the set to be embedded under dative construction) were relatively well matched. After removal of critical-control word pairs that showed a significant effect, the results of the monolingual study found no cognate effect or homograph effect, and no interactions with the construction dummy variable. These word pairs will also be removed from the data in the sentence context study in the next chapter to ensure that any significant effects for bilingual speakers are due to the overlap of the critical word with the unintended language and not confounded lexical properties.

3.5 Table 1: Lexical Characteristics

Construction Word Type Length Frequency: ALAMEDA Frequency: LEXESP Number of Syllables Number of Phonemes Active/Passive Cognate 7.05 58.65 34.374 3.05 7 Active/Passive Noncognate 7.05 51.85 23.4135 2.9 6.8 Active/Passive Homograph 5.1 142.75 49.2521 2.15 5.1 Active/Passive Nonhomograph 5.2 135.65 48.36435 2.3 4.9 Dative Cognate 7.15 65.85 32.6775 3 7.05 Dative Noncognate 6.85 69.2 27.4275 2.85 6.5 Dative Homograph 5.4 55.8 21.8343 2.45 5.55 Dative Nonhomograph 5.45 53 21.54915 2.45 5.3

The set of homographs and controls in the active and passive conditions were more frequent compared to the set in the dative conditions.

3.6 Table 2: Monolingual cognate results after removal

Estimate Std..Error t.value p.z Sig. (Intercept) 6.25 0.03 247.30 0.00 * clFrequency_1 –0.02 0.00 –3.40 0.00 * cLength 0.00 0.00 –0.14 0.89

WordType1 –0.01 0.01 –0.68 0.50

ConstructionSuper1 0.00 0.01 0.48 0.63

WordType1:ConstructionSuper1 0.00 0.02 0.03 0.97

3.7 Table 3: Monolingual homograph results after removal

Estimate Std..Error t.value p.z Sig. (Intercept) 6.27 0.03 248.74 0.00 * clFrequency_1 0.00 0.01 0.31 0.76

cLength 0.01 0.00 1.88 0.06

WordType1 0.01 0.01 0.87 0.38

ConstructionSuper1 0.00 0.01 0.33 0.74

WordType1:ConstructionSuper1 0.02 0.02 0.96 0.34

3.8 Table 4: Bilingual cognate results

Estimate Std..Error t.value p.z Sig. (Intercept) 6.41 0.032 203.18 0 * clFrequency_1 –0.024 0.006 –4.33 0 * cLength 0.025 0.005 5.177 0 * WordType1 –0.052 0.013 –3.983 0 * ConstructionSuper1 –0.003 0.013 –0.204 0.838

WordType1:ConstructionSuper1 0.028 0.025 1.119 0.263

3.9 Table 5: Bilingual homograph results

Estimate Std..Error t.value p.z Sig. (Intercept) 6.388 0.029 219.476 0 * clFrequency_1 –0.024 0.009 –2.79 0.005 * cLength 0.009 0.006 1.441 0.15

WordType1 0.019 0.018 1.022 0.307

ConstructionSuper1 0.018 0.018 1 0.317

WordType1:ConstructionSuper1 –0.026 0.036 –0.728 0.467

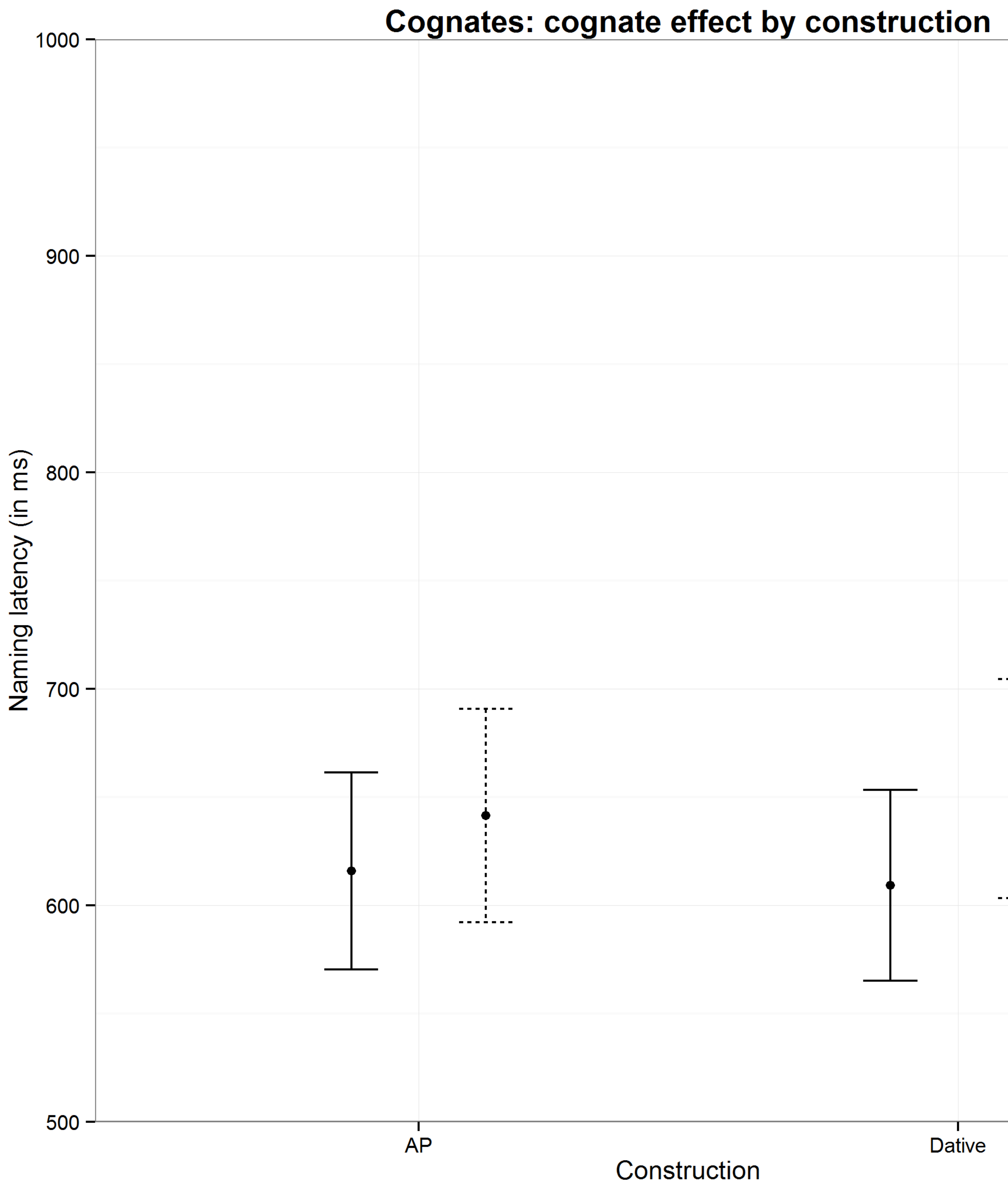
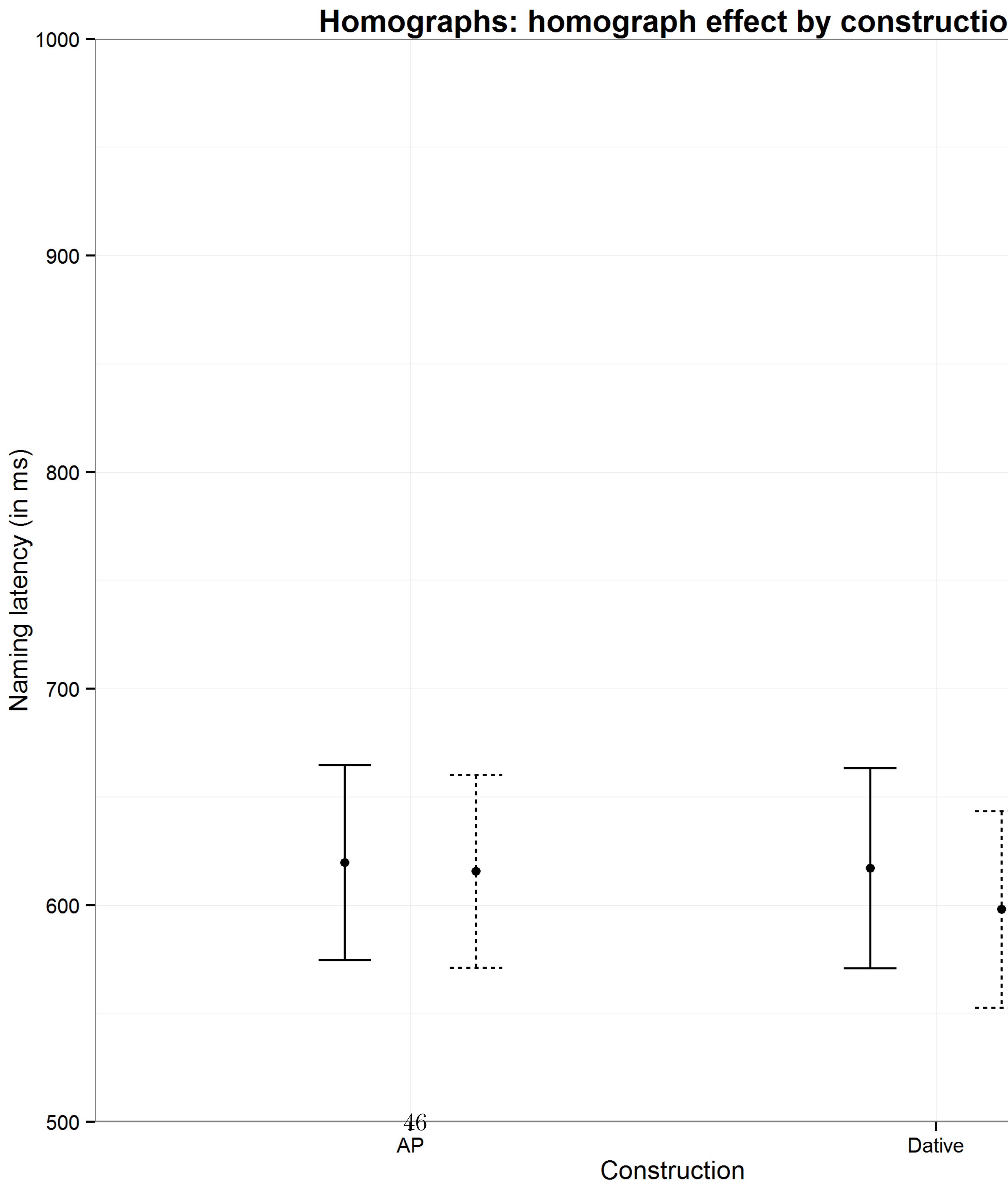

Cognates: cognate effect by construction
1000
900
800
700
600
500
Naming latency (in ms)
AP
Dative
Construction

Figure 3.1.

3.10 Figure 1: Cognate results

3.11 Figure 2: Homograph results



Chapter 4 RSVP

What about the syntax? Bilingual word recognition in sentence context

4.1 Introduction

In the past two decades we have learned that bilinguals co-activate lexical alternatives in both languages despite the intention to use a single language in production or during comprehension (De Groot & Nas, 1991; list 100 others). Although bilinguals exploit co-activation in discourse to code-switch, or move fluidly between languages even mid-sentence, they must also control co-activation to avoid speaking in the unintended language at an inopportune moment. Cognitive mechanisms have been proposed to account for bilingual language control, with a distinct focus on language production. The mechanisms include inhibition of the unintended language and attention to the intended language. Another potential locus for language selection is at the level of the linguistic input: features of words (e.g., language-specific orthography or phonology), of the environment (i.e., the requirement to only use one language), or of the sentence context could provide bilinguals with a means to select the intended language, particularly if they provide language-specific information. The search for linguistic cues has turned up relatively little in this respect. One feature of the input that has been ignored is the syntax. At the syntactic level, bilinguals also co-activate both languages, but this co-activation appears to depend on the presence of word-order overlap. Given that word order of syntactic constructions can differ extensively across languages it is surprising that no published studies have investigated this obvious feature as a mechanism of language control. This study is one of the first, to our knowledge, to investigate the question of whether language-specific structures at the syntactic level can influence co-activation at the lexical level.

4.1.1 Evidence for parallel activation

Evidence for parallel activation Parallel activation of the two languages is observed most reliably during the processing of words that are related in lexical form in both languages (e.g., cognates: the word "piano" in English and Spanish or interlingual homographs: "pie" in Spanish means foot, not the baked-good). Bilinguals, but not monolinguals, show differential processing patterns within-language for these form-related words compared to lexically-matched unrelated words (non-cognates or non-homographs), suggesting that the lexical representations of both languages are activated for the use of a single language alone (e.g., Dijkstra, 2005). Often, cognate words are processed more quickly compared to non-cognate control words due to the complete (or near-complete) overlap in lexical form and meaning across languages. Homographs are typically processed more slowly compared to non-homograph control words because while they share lexical form, they do not share semantics leading to a competitor effect. While the majority of evidence for parallel activation draws from the processing of words that are overtly related in form between the two languages (and hence may be ambiguous between the two languages), bilinguals are also sensitive to form similarities that are not overtly present in the input. Bilinguals making semantic relatedness judgments on pairs of words are influenced by whether the translations of the word pairs have lexical form repetitions even though those form repetitions are never explicitly presented, suggesting that bilinguals have ŞunconsciousŤ access to the form of the unintended language (e.g., Thierry and colleagues; Morford and colleagues). The absence of such effects in monolingual speakers indicates that the differential processing is due to bilingualism and not to uncontrolled lexical variation. Parallel language activation occurs from the earliest stages of lexical access (e.g., orthographic activation), and the two languages remain activated into late states of activation (e.g., semantic activation and semantic integration of a word within a sentence).

Parallel language activation is a pervasive phenomenon, and is a hallmark of bilingual language processing. Co-activation occurs for bilinguals regardless of the typological distance between the language pairs they speak: effects indicative of co-activation are found in typologically distinct languages like English and Japanese, English and Chinese, or English and American Sign Language and in typological more similar languages like Dutch and English or Spanish and English. Co-activation is not task-dependent, and it has been observed using an array of behavioral measures, eye-tracking measures, and electrophysiological measures. Language co-activation is bi-directional with regard to language, and it occurs for bilinguals who are highly proficient speakers of each language. The dominant language (often the native language, or L1) is co-activated during comprehension of the weaker language (often the second language, or L2), but the weaker language also becomes activated during comprehension of the dominant language, indicating that the phenomenon is not due to low proficiency in or shallow processing of a second language. However, proficiency does play a role in determining the magnitude of co-activation.

The degree of co-activation during reading appears to be continuously modulated by individual differences including language proficiency and executive control ability (Titone et al., 2011; Pivneva et al., 2014). During L2 reading, increasing L2 proficiency is associated with reduced cognate facilitation effects, at early and late stages of lexical access suggesting that for the most highly proficient bilinguals the target language may be accessed before the L2 can become activated due to speeded lexical access even in a situation where co-activation would be beneficial to processing (in the case of cognates, which share complete overlap between the two languages; Pivneva et al., 2014). During L1 reading, bilinguals who have an early L2 age of acquisition (AoA, and likely higher L2 proficiency) show larger cognate effects compared to bilinguals who acquire the two languages later in life (Titone et al., 2011). Greater executive control abilities are associated with reduced homograph interference only at early stages of lexical access, suggesting that when there is competition between the two languages, it can be overcome by cognitive control (Pivneva et al., 2014). Indeed, cognitive control has long been implicated as a mechanism used by bilinguals to select the intended language during language production.

Despite the pervasive co-activation of the two languages, lexical switching from one language to the other is costly, and the cost surfaces regardless of whether bilinguals switch the language of production (MacNamara et al., 1968; Meuter and Allport, 1999; Costa and Santesteban, 2004; Costa et al., 2006; Gollan and Ferreira,

2009) or switch languages during lexical comprehension tasks (e.g., Grainger and Beauvillain, 1987; Thomas and Allport, 2000; Von Studnitz and Green, 2002). The presence of switch costs despite initial parallel language activation suggests that bilinguals eventually come to resolve cross-language co-activation and select the intended language. If this were not the case and the two languages remained forever active, then the observation of a switch cost would be quite counterintuitive. An important question is how and when the co-activation is finally resolved.

There are two theoretical classes of bilingual lexical selection, and while both classes assume that the two languages become co-activated in parallel, but they differ on how co-activation is resolved. Language non-selective theories posit that after the unintended language becomes co-activated, bilinguals apply an inhibitory control mechanism to suppress the unintended language. In contrast, language-selective theories posit that bilinguals use a selective attention mechanism to guide lexical access, pre-activating words in the intended language and effectively ignoring co-activated words in the unintended language (Costa et al., 1999; Finkbeiner et al., 2006; La Heij, 2005). Hybrid theories posit that at lower levels of proficiency, inhibition is the primary means of lexical selection, but as a bilingual becomes increasingly experienced in L2 use, the need to inhibit the L1 during L2 use decreases and speakers instead rely on selective attention to the L2. If lexical access is truly non-selective, then effects indicative of parallel activation should always be observable during the earliest stages of word recognition, before inhibition is applied to suppress the unintended language and encourage selection of the intended language (i.e., late selection). In contrast, if language-selective theories of lexical access are correct, bilinguals should be able to exploit language-specific cues present in the input and employ them in a top-down manner to pre-activate the intended language and reduce or eliminate the effects of parallel activation (e.g., cognate or homograph effects) even at early stages of word recognition (i.e., early selection).

The dominant model of bilingual word recognition is the Bilingual Interactive Activation Plus (BIA+) model (Dijkstra and Van Heuven, 2002). BIA+ is a non-selective model that proposes a late account of language selection. The model assumes that words in the two languages are stored in an integrated lexicon, resulting in co-activation of lexical and sublexical representations of the two languages. The model further assumes that task demands (e.g., language of the task) do not influence the earliest stages of word recognition; they are applied only after lexical candidates are activated and passed from the word recognition module to the task schema module. The role of language-specific cues is not implemented BIA+, however its late selection mechanism predicts that any cues that function to distinguish different language alternatives would affect selection only at a late stage of recognition, after the activation of both languages has occurred. The evidence from bilingual word recognition is compelling in supporting a non-selective, late-selection theory of word recognition.

4.1.2 Are there constraints?

Language selection: Are there constraints on parallel activation? There are a number of ways in which parallel activation could be constrained or cued to result in language-selective access. Bilinguals could exploit the context of language usage to predict the language of upcoming words. For example, some contexts dictate the usage of a single language (e.g., instructions dictating the use of English in a language experiment, usage of a language in a mostly monolingual environment, or sentences are often written using a single language) while other contexts dictate the usage of multiple languages (e.g., in a bilingual language experiment, while speaking with multilingual friends, or during the comprehension of code-switched sentences). Bilinguals could also notice and exploit any of the numerous cross-linguistic differences between the two languages they speak to predict the language of upcoming words. For example at the lexical level, two languages often differ in their orthography (graphemes may exist in one language, but not the other), in their phonetics/phonology (phonemes may exist in one language but not the other), or in how they categorize items based on semantic features (e.g., Chinese prioritizes shape when categorizing drinking vessels while English prioritizes material). At the (morpho)syntactic level, languages may differ in their basic word order typology (e.g., SVO languages vs. VSO), in their usage of certain grammatical constructions to convey an idea, or in the realization of the word order for any given construction. Many of these contexts are present at the same time during natural language usage, yet the extant literature has only scratched the surface to examine their systematic contributions.

Overall, there are relatively few cues that function to eliminate parallel activation during word recognition. Those cues that have been uncovered seem to function only at relatively late stages of lexical access, in line with non-selective, late accounts of language selection. Language co-activation occurs regardless of the contextual constraint of the environment or task at hand. While a monolingual environment might strongly require the use of one language and not, bilinguals have been shown to activate both languages when only one language is necessary or expected (Van Hell & Dijkstra). Furthermore, the magnitude of co-activation is surprisingly similar regardless of whether presentation of the languages is rapidly mixed or blocked by language (Gullifer et al., 2013). Early studies on non-selective access involved the presentation of isolated words, devoid of meaningful context, however later studies showed much the same results for words embedded in unilingual sentences (e.g., Duyck et al., 2007; Libben & Titone, 2009; Schwartz & Kroll, 2006). Most of the studies examining (and consequently failing to find) an influence context on cross-language activation have used cognate facilitation as the metric for co-activation. There is some evidence that the context of language usage can influence homograph inhibition. For example, access to the L1 meaning of a homograph has been shown to rely on pre-activation of the L1 through a priming task (e.g., watching a movie in L1 before commencing the experiment) and it has been shown to decrease over the course of the experiment as participants zoom-in to the second language (Elston-Guttler and colleagues). Relatedly, homograph inhibition effects have also been shown to rely on the inclusion of distractor items in the unintended language (Dijkstra, et al., 1998). Similarly, the extant research on language-specific cues have also found little evidence for an interaction with cross-language activation. However, in these same contexts the cognate effect appears to be relatively robust, raising the question of how effective each of the measures are in providing a metric for cross-language activation.

Relatively fewer studies have investigated the role of language-specific properties of the input on co-activation during bilingual word recognition. In auditory word recognition, it has been shown the accentedness of speech, which could in theory provide a sublexical about the language membership of upcoming words, does not influence the magnitude of co-activation as measured by the homograph effect (e.g., Lagrou, Hartsuiker, & Duyck, 2011). The co-activation of unintended language is evident during the recognition of a word despite the presence of language-specific orthography (e.g., Van Assche, Duyck, Hartsuiker, & Diependaele, 2009).

While language specific lexical form may reduce the magnitude of the co-activation effect, it does not eliminate it altogether. Crucially, non-selective access has been shown for bilinguals who speak language pairs that do not share any of the same orthography (such as Chinese and English; Thierry & Wu, 2007) and for bilinguals who lack a writing system in one language entirely (e.g., Morford et al., 2011). Together, these results show that many potential language cues, at least at the lexical and sublexical level, are insufficient to bias processing to that language alone.

The only factor that has been shown to reduce the activation of the language not in use is a strongly biased semantic context in combination with a unilingual sentence context. When sentences are semantically constrained such that upcoming words are highly predictable, those upcoming words are processed more quickly. Additionally for a bilingual speaker, the processing of language ambiguous words such as cognates or homographs becomes more similar to that of control words (e.g., Libben & Titone, 2009; Schwartz & Kroll, 2006; Van Hell & De Groot, 2008; but see Van Assche, Drieghe, Duyck, Welvaert, & Hartsuiker, 2010). Not all studies find a reduction of cross-language effects in high constraint sentences even when there is a clear facilitatory effect of semantic constraint (e.g., Van Assche et al.). The effect depends on factors such as AoA and proficiency. Generally, when these participant variables favor cross-language activation (e.g., a lower proficiency in the intended language for L2 processing or an early L2 AoA for L1 processing), bilinguals appear to use semantic constraints to reduce activation of the unintended language. However, if participant variables instead favor less cross-language activation (e.g., a higher proficiency when the intended language is the L2 or a late L2 AoA for L1 processin), there can be no interaction between semantic constraint and cross-language activation, suggesting that for these bilinguals there is a different locus of language selection. For example, Titone et al. (2011) gave English-French bilinguals an L1 reading task with the intent to measure L2 to L1 cognate facilitation. They found that bilinguals who learned French relatively late in life were able to use a high semantic constraint to reduce cognate facilitation. Bilinguals who acquired French early in life did not use the semantic context to reduce co-activation of the unintended language in the same way, but they showed smaller cognate effects overall compared to the late bilinguals. Thus, the early bilinguals employed a different mechanism for reducing cross-language influence compared to the late bilinguals, who relied on the semantic context to reduce co-activation.[Expand this so the reader can figure it outĚ needs to be reworded..]

[The point is that different measures of nonselecitivty tell different storiesĚ. The attempting of seeing how the system closes down has not been done for each of these meausres..] Similarly, Pivneva et al. (2014) find that semantic constraint reduces cognate facilitation during L2 reading only for bilinguals who had lower proficiency in L2. Bilinguals with higher L2 proficiency were less likely to show cognate activation overall, and hence did not need to make use of the semantic context. They also found that when the activation levels of the unintended language were boosted via the inclusion of filler items in the non-target language, cross-language effects were increased to the point that the semantic constraint effect was no longer able to overcome co-activation. Crucially eye-tracking studies show that when the semantic constraint effect does reduce co-activation the reduction occurs only at late stages of processing, in line with a late account of language selection (e.g., Libben & Titone, 2009).

4.1.3 Co-activation at the syntactic level

Co-activation at the level of the syntax The main focus of studies on bilingual co-activation has been at the lexical level. Yet, co-activation has been observed at other levels as well. At the level of the syntax, bilinguals activate structures in a language non-selective manner. Unlike the case of lexical co-activation, syntactic co-activation has constraints, and these constraints appear to have consequences for lexical choice. Cross-language syntactic priming is the primary evidence for syntactic co-activation in bilinguals. Syntactic priming is the phenomenon whereby the appearance of a certain syntactic structure (e.g., a passive structure; ŞThe house was struck by lightningŤ) facilitates the subsequent production or processing of that structure. Classically, syntactic priming is observed when monolingual participants hear a prime sentence (e.g., a passive structure: ŞThe church was struck by lightningŤ) and are asked to describe a picture of a novel event (e.g., a bottle being stuck by a bullet). In their descriptions, participants are more likely to describe a picture using the passive voice when the preceding sentence contains a passive prime (Bock, 1986). Work on syntactic priming in bilinguals has demonstrated that syntactic choice can be primed across languages (i.e., cross-language syntactic priming). In these cases where priming is observable, it suggests that bilinguals have shared representational storage for syntactic structures, and that they access these structure in a language non-selective manner.

The cross-language syntactic priming effect (and thus non-selective access of the syntax) appears to have constraints, depending at least partially on shared linear word across languages. Priming is relatively robust for structures that overlap in word order. For example, Loebell and Bock (2003) showed that German (L1) Ű English (L2) bilinguals elicited cross-language priming for structures in the dative alternation which overlap perfectly in their word order (e.g., double object: The boy sent his pen pal a letter [Der Junge schickte seinem Breiffreund einen Brief]; prepositional dative: The boy sent a letter to his pen pal. [Der Junge schickte einen Brief an seinen Brieffreund]). Similar findings have been shown for the dative alternation in Dutch-English bilinguals (Schoonbaert et al, 2007), Swedish-English bilinguals (Kantola, & Van Gompel, 2011), and Greek-English bilinguals (Salamoura & Williams, 2007); the adjective-noun/relative clause alternation in Dutch and German (Bernolet, et al., 2007); as well as with the active/passive alternation in Spanish-English bilinguals (Hartsuiker, et al., 2004) and Polish-English bilinguals (Fleischer et al., 2012). When structures do not share linear word order across languages priming is less likely to occur. Loebell and Bock (2003) observed no syntactic priming across German and English for structures in the active/passive alternation (active: The janitor cleans the floors daily. [Der Hausmeister reinigt die Boeden taeglich.]; passive: The floors are cleaned daily by the janitor. [Die Boeden werden taeglich von dem Hausmeister gereinigt.]). In this alternation, the passive structure exhibits different word order across German and English, due to the position of the main verb. Similar results word-order dependent results have been shown with the adjective-noun/relative clause alternation in German and English (Bernolet et al., 2007), and the prepositional object dative constructions in Greek and English (Salamoura and Williams, 2007). The word order dependence is not clear cut; there are cases in which priming is observable across languages despite the presence of word order differences: priming of NP attachment in Dutch and English despite Dutch verb-final structure, the dative alternation in Korean and English despite differing word orders (Korean: SOV; English: has SVO; Shin and Christianson, 2009); passive in German and English (Weber and Indefrey, 2009); the English passive structure by the Polish active OVS structure (Fleischer et al., 2012). In one sense, the observation of any priming despite word order differences suggests that all structures maybe be shared across languages despite word order difference. However, the presence of discrepancies across a wide range of experiments when word order is not shared suggests that the degree of representational overlap may be reduced when word order is not shared.

There have been relatively few cross-language syntactic priming experiments with Spanish-English bilinguals. Hartsuiker and colleagues[Make sure to add all the years, and complete references and stuff.] show cross-language priming from Spanish to English for active and passive structures, which share word order between Spanish and English. Similarly, Cooperson, in an unpublished dissertation, showed bi-directional priming for the passive construction between Spanish and English. Meijer and Foxtree tested priming of prepositional object datives from Spanish to English. Recollection of English target sentences with a double object dative construction (NP-NP) were more likely to be recalled using a prepositional object dative construction (NP-PP) when a preceding Spanish prime was presented with a prepositional object dative (NP-PP), even when the prime construction did not contain the same thematic role (i.e., dative propositional phrases, locatives, and instruments all primed dative prepositional phrases). While prepositional object datives may optionally differ in word order between Spanish and English (Spanish allows PP-NP constructions), the only condition tested here was with the prime containing NP-PP, a word order that is shared between both languages. They did not find priming between single and double negation from English to Spanish (shared word order, but double negation is marked in usage). They find priming of direct object pronoun order from English to Spanish. English allows verb-DOP word order but not DOP-verb order where Spanish allows both. Spanish sentences with DOP-verb order were recalled as verb-DOP following an English verb-DOP construction. Perhaps clitics donŠt matter?

In summary, the past two decades of psycholinguistic research have given rise to a number of studies examining cross-language activation and the factors which could theoretically modulate it. Cross-language activation at the lexical level is robust. An emerging literature suggests that lexical co-activation depends on speaker internal factors such as language proficiency, age of acquisition, and executive control. However, it does not appear to depend on many external factors (contextual and sentential factors), when it does it often interacts in a complex way with speaker internal factors. In contrast, cross-language activation at the level of the syntax has been show to depend strongly on speaker external factors, including on linear word order overlap of the primed constructions. The question of interest here is whether constraints that function at the syntactic level can influence lexical selection during word recognition and production, and whether this factor interacts with speaker internal factors such as language proficiency. Evidence for the claim that syntax may influence word recognition comes from the study of naturalistic code-switching. Code-switching is a phenomenon where some bilinguals will intermix their two languages when speaking with other, similar types of bilinguals. Code-switching can occur mid-sentence (i.e., intrasentential switching). Crucially, the choice point of where to switch is governed by word order constraints. Speakers are less likely to switch languages at a point in a sentence where the word order is not equivalent between the two languages, and often this type of switch is considered ungrammatical. Given the notorious variation in word order across languages (even within the same language family) and the implication that syntactic variation influences lexical choice, it is surprising no studies within the ample body of literature developed in the last decade-and-a-half have investigated whether syntax can function as a cue for bilinguals to selectively access a language during word recognition.

4.1.4 Cross-language activation and syntax

Syntactic effects of lexical co-activation The question of whether cross-language syntactic differences influence word recognition was addressed in preliminary work by Gullifer et al. (2011). In that study, Spanish-English bilinguals read sentences in each of their languages and named a critical target word aloud. Target words were cognates (e.g., bus in English and Spanish) matched to unambiguous control words (e.g., laca [hairspray]). Half of the Spanish sentences contained syntax structurally specific to Spanish. Syntactic specificity was manipulated in two ways: (a) the indirect object of a ditransitive verb was realized pleonastically with the proclitic ŞleŤ and its corresponding noun phrase; and (b) the grammatical subject of the object relative clause was not expressed overtly (e.g., Las monjas (a) le llevaron las mantas que (b)(pro) habían bordado a la directora del orfanato. [The nuns took the quilts that they had embroidered to the director of the orphanage.])

The English translations were controls in that the initial phrase of the sentence was not syntactically specific to either language. When all participants were included in the analyses, there was cognate facilitation that did not depend on the syntax of the sentence. Monolingual speakers of English and Spanish exhibited no cognate effects. However, data from a subset of the bilingual participants who were fastest to perform the naming task revealed the predicted interaction between sentence type and cognate status, suggesting that for these speakers, language-specific syntax eliminated the cognate effect. No independent measure of proficiency clearly modulated the effect. Taken together, the results suggested that bilinguals activate both languages while reading a unilingual sentence. If language-specific syntax did modulate nonselectivity, its effect was subtle.

The results of Gullifer et al. raise the question of exactly what types of structures function as language specific. Descriptively, the presence of clitics and pro-drop are Spanish-specific in comparison to English, but these (morpho)syntactic features may be too subtle to be exploited by bilinguals during processing. A more robust syntactic manipulation, for example, a structure that is assured to be represented differentially across languages, may function as such a cue that can allow bilinguals to select a language without influence from the unintended language. The question of how syntactic representations are represented and processed has been addressed in the work on cross-language syntactic priming. The presence or absence of syntactic priming has been taken as evidence for shared vs. separate syntactic representations across the two languages of a bilingual.

4.1.5 The present study

The present study The goal of the present study is to combines observations from work on cross-language syntactic priming to identify a structure that should be considered language-specific between English and Spanish, and determine whether such a language-specific structure could allow Spanish-English bilinguals to selectively access the target language. One feature that appears to contribute to whether a structure is stored in a language specific way is linear word order. When word order of a structure is not shared across languages, cross-language priming tends to be weak, suggesting that two structures are language-specific. When word order is shared, cross-language priming is strong, suggesting that the structures are language non-specific. Significant cross-language syntactic priming from Spanish to English has been shown for passive structures in comparison to active structures, indicating that these structures are non-specific. No study has explicitly identified a set of structures which fail to prime between Spanish and English because of a difference in word order, however there are differences in how dative sentences are structured between English and Spanish. While both languages allow for NP-PP structuring of prepositional object datives and this structure has been shown to prime between Spanish and English, only Spanish freely allows a PP-NP prepositional object dative. Thus the PP-NP dative structure is predicted to be represented in a language specific manner, and may allow for language-selective access of Spanish during word recognition.

Two experiments are reported here. In the first experiment, a group of Spanish-English bilinguals read four sets of target words aloud while the latency to begin naming was recorded. Two sets consisted of cognates (which share lexical form and meaning across the two languages) and matched controls; one set will be embedded in the active and passive sentences in the second experiment while another set will be embedded in the dative sentences. The other two sets consisted of homographs (which share lexical form but not meaning across the two languages) and matched controls; again, one set will be embedded in the active and passive sentences in the second experiment while another set will be embedded in the dative sentences. If bilinguals activate both languages then, cognates in this experiment should be named faster than non-cognate control words, and homographs should be named slower compared to non-homograph control words. If the stimuli were well matched after being divided into the two sets of constructions, then there should be no significant differences in the magnitude of the effects across the two constructions.

In the second experiment, we embedded one set of target words in active and passive sentences and another set in dative sentences. A new group of Spanish-English bilinguals read sentences word-by-word and named the target words embedded in the middle of each sentence while the latency to begin naming was recorded. The language of the sentences was always Spanish, the L1 of the sampled participants, and the sentences contained syntactic structures that were predicted on the basis of syntactic priming literature to be syntactically specific to Spanish (datives), or non-specific to Spanish and English (actives and passives). If bilinguals activate both languages, then significant cognate facilitation and homograph inhibition should arise. If the presence of language-specific syntax allows bilingual readers to access the target language selectively, then cognate and homograph effects should be reduced or eliminated following structural information that is not shared between the two languages (specifically, in PP-NP dative constructions and perhaps in the NP-PP dative condition), resulting in an interaction between syntactic structure and word status. It is also possible that participantsŠ abilities to use the syntactic information predictively depends on the fluency in native language or in the second language, resulting in an interaction between syntactic structure, word status, and the fluency. In contrast, the BIA+ model makes the prediction that the the magnitude of cognate facilitation reflects bottom-up processes that are unaffected by the syntactic context in which word recognition occurs.

We modeled the reaction time data from both experiments using linear mixed effects regression (LMER) analysis with model comparison. LMER has several benefits over traditional Analysis of Variance (ANOVA). First, LMER models are more explicit than ANOVA because they model trial-level data, as opposed to aggregated mean reaction time data, allowing the experimenter to include trial- and item-level factors in one analysis along with participant-level factors. Second, LMER allows for incorporation of random effects by participant and by item (random intercepts: the extent to which participants and items vary on the dependent variable, and random slopes: the extent to which effects of interest vary by participant and by item), obviating the need for two separate ANOVAS, one by participants (F1) and one by items (F2). Finally, LMER is robust to unbalanced designs, such as the present experiment in which words are hierarchically embedded under different syntactic structures.

In[Some of this might want to stay in the ŞpaperŤ and some could also be moved or copied to the roadmap chapter] LMER, statistical significance can be assessed by using a model comparison approach. The performance of any single LMER model can be assessed with a likelihood ratio, an expression of the likelihood that a particular set of data would be observed given the model. When comparing two nested models (where one model contains a subset of terms compared to the other), the difference in the deviance (related to the likelihood: –2 * log-likelihood) between the two models is chi-square distributed. The two models being compared will differ in the degrees of freedom. Knowing the difference in deviance and difference in degrees of freedom allows the experimenter to conduct a chi-square test to assess whether the two models are significantly different from the resulting p-value. In other words, two models can be compared to assess whether the inclusion of an effect (or interaction) results in an observable difference large enough to warrant the spending of degrees of freedom. When a final model has been constructed, significance of the slopes (betas) can be determined via the normal approximation, which is not anti-conservative given an adequate sample of participants (Barr et al., 2013).

To anticipate the findings, the results of the first, out-of-context experiment indicated that bilinguals activated both languages through a significant cognate effect. However, the homograph effect was not significant. There were no effects of construction or interaction between construction and word type in the out-of-context experiment, indicating that the two sets of cognates and the two sets of homographs were well matched. In the second experiment, there was a small but significant interaction between word type and construction for both the cognates and the homographs. In the second experiment, there was a cognate facilitation effect, the magnitude of which had an inverse relationship with L1 fluency. The cognate facilitation effect differed when comparing the two dative conditions: PP-NP vs NP-PP: cognate facilitation was greater in NP-PP datives. However, this interaction was eliminated (but was trending) when we analyzed a subset of words which showed a cognate effect in the out-of-context study, indicating that the effect was possibly the result of lexical confounds and not the syntactic manipulation. The homograph effect also depended on syntactic construction. There was a facilitatory homograph effect in the active and passive constructions and an inhibitory effect in the dative constructions. The interaction was still significant when we conducted the more stringent analysis, including only homographs that showed an out-of-context effect.

In a set of post-hoc analyses, we used model comparison to test for interactions between individual differences in executive function and language fluency and the predicted interaction between construction and word type. When the complete set of data was included, there were no higher order interactions between these variables. However, when we included only target words that showed a significant cognate or homograph effect in the out-of-context task, we found that participantsŠ ability to exercise pro-active control was strongly related to the magnitude of the cognate effect, suggesting that participants with stronger proactive control over their two languages were able to reduce influence form the unintended language, when that influence might facilitate them. There were no such interactions for the homograph stimuli.

Taken together, the results indicate that aspects of syntactic context, language fluency, and cognitive control exert a measurable influencef the degree of language co-activation during bilingual word recognition. This stands in contrast to predictions made by the BIA+ model of word recognition (BIA+; Dijkstra & Van Heuven, 2002), namely that the degree of language co-activation is independent to these factors.

4.2 Experiment 1: Bilinguals out of context

Experiment 1: Spanish-English bilinguals out-of-context

4.2.1 Methods

Methods

Participants

Thirty-eight Spanish-English bilinguals from the University of Texas, El Paso and the El Paso area participated in the out-of-context norming study. All participants gave informed consent, and the procedures had the approval of the Institutional Review Boards of the Pennsylvania State University and the University of Texas, El Paso. Participants received $10 per hour for their participation in the experiment. Participants considered themselves bilingual between English and Spanish. We administered a language history questionnaires to assess subjective language proficiency. Three participants had missing data on the language history questionnaire, resulting in a final sample of 35 participants. Overall, the participants from the final sample were proficient speakers of Spanish and English and the sample was balanced in their ratings of English and Spanish (MSpanish = 8.80; MEnglish = 8.70; $t(34) = 0.394$, $p > 0.05$).

Materials

The experimental items consisted of 240 Spanish words (see Appendix A). Forty words were critical cognate words between Spanish and English (e.g., cable) and 40 were lexically matched non-cognate control words (e.g., chispa in Spanish meaning spark in English). Forty words were critical homograph words between English and Spanish (e.g., pie in Spanish means foot in English) and 40 were lexically matched non-homograph control words. We matched each critical word to a control word on the basis of word length, two measures of lexical frequency (ALAMEDA: Alameda & Cuetos, 1995, and LEXESP: Sebastián-Gallés, Martí, Carreiras, & Cuetos, 2000), number of phonemes, and number of syllables in Spanish. We did not m match the stimuli for these factors across Spanish and English. We matched stimuli by-hand and with the help of the NIM search engine (Guasch, Boada, Ferré, & Sánchez-Casas, 2013). The entire set of lexical stimuli can be found in Appendix A.

We divided the lexical stimuli evenly into two sets of stimuli. In the second experiment, we embedded each set of stimuli under different syntactic constructions (set 1: active and passive; set 2: dative). To assess whether lexical characteristics varied by construction (Active/Passive vs. Dative) or word type (cognate vs. Noncognate and homograph vs. Nonhomograph), we conducted two sets of between items ANOVAs (one set of cognate stimuli and another for homograph stimuli) with each of the lexical characteristics (word length, the two measures of frequency, number of syllables, and number of phonemes) as dependent variables. For the cognate stimuli, there were no significant differences for any of the five lexical characteristics (all Fs < 1, ps > 0.05), indicating that the stimuli were well matched across conditions. For the homograph stimuli, there were no significant differences in word length, number of syllables, or number of phonemes (all Fs < 1.089, ps > 0.05). However, there were significant differences by Construction for the two frequency measures (Alameda: $F(1,76) = 5.868$, $p < 0.05$; LEXESP: $F(1,76) = 7.003$, $p < 0.05$), indicating that homographs and matched controls in the active and passive conditions were more frequent compared to those in the dative conditions, see Table 1 for the descriptives of lexical characteristics. The effect of word type and the interaction between word type for the two frequency measures with the homograph stimuli were not significant (Fs < 1, ps > 0.05). In future analyses, we included log word frequency as a co-variate to statistically control for the confound.

Monolingual out-of-context control experiment

To ensure that any potential cognate facilitation effect observed during the experiment could not be attributed to lexical properties of the stimuli, a Spanish monolingual control group named the target words in isolation. A final sample of twenty-six Spanish monolinguals from the University of Granada and the surrounding area are included in the dataset. They all reported minimal knowledge of a second language. We modeled reaction time data using linear mixed effects regression (LMER) analysis with model comparison. The procedure is outlined in the results section below. For the cognate data,there was a significant effect of centered log-transformed word frequency (SS = –0.018, SE = 0.004, t = –3.755, p < 0.001) such that an increase in word frequency related to a decrease in log RT. There were no significant effects of centered word length, centered log frequency, word type, or construction(ts < 1.96, ps > 0.05). For the homograph data, there was an effect of centered word length (SS = –0.010, SE = 0.004, t = 2.441, p < 0.05). There was no effect of centered log-transformed word frequency, word type, nor of construction (ts < 1.96, ps > 0.05). However, the interaction between word type and construction was approaching significance (SS = –0.047, SE = 0.025, t = 1.854, p = 0.064), suggesting that there could be an inhibitory homograph effect for the set of homographs selected for active and passive sentences in the sentence context study.

To remove potential lexical confounds, we computed item-specific cognate and homograph effects by averaging naming latencies for each critical word and for each matched control word across participants, and computed ninety-five percent confidence intervals for the mean difference between each critical-control pair. We excluded any word pair for which the confidence interval did not include 0 (indicative of a significant difference) from further analysis. This procedure resulted in the removal of three cognate-noncognate pairs and seven homograph-nonhomograph. Following the removal procedure, there was an effect of centered log-transformed word frequency in the cognate model (SS = –0.002, SE = 0.003, t = –3.400, p < 0.001), and no other effects were significant (ts < 1.96, ps > 0.05). For the homograph model, there no significant effects (ts < 1.96, ps > 0.05). See Tables 2 and 3 for the fixed effects from the cognate and homograph models after item exclusion. Following the removal procedure, there was no evidence that monolinguals showed a cognate effect nor a homograph effect and no evidence for any effects or interactions with the structure condition, indicating that the experimental stimuli were relatively well controlled on factors that influence naming latencies.

Procedure

Upon arrival to the lab, participants read and completed an informed consent form. Participants then sat at a computer and began the set of experiments, starting with the out of context word naming task. Following the word naming experiment, participants completed a verbal fluency task to assess English fluency. At the end of the session, participants received Ă5 as compensation for their time. The experimental session lasted approximately 30 minutes.

In the word naming task, participants received verbal and written instructions on how to proceed through the task. A fixation cross (Ş+Ť) appeared before each word, and participants pressed the space bar at each fixation point to bring up a Spanish word. They named the word as quickly and accurately as possible in Spanish as soon as it appeared. A voice-key trigger recorded the latency to begin naming, and a digital audio recorder recorded the entire the session for later coding of naming accuracy. Ten Spanish practice words preceded the experimental session to familiarize the participant with the task and to allow the experimenter to adjust the microphone sensitivity. During this time, the experimenter was present to answer any questions the participant might have. Following the practice section, the experimenter left the room.

Following the word naming task, participants completed an additional set of tasks for a different experiment that included a verbal fluency task in English and Spanish, an operation span task, a Spanish picture naming task.

4.2.2 Results & Discussion

Results & **Discussion[**Go through the items and find out if thereŠs something about them that are impacting the lack of homograph effect]

Undergraduate research assistants who spoke English and Spanish coded the accuracy of the word naming data. We excluded rials in which an incorrect word was named or in which the production would add variability to reaction times (RTs; e.g., hesitation before naming the target word) from the RT analysis. We cleaned the RT data using a procedure for the removal of absolute and relative outliers. First, considering only correctly named trials, we excluded RTs above 2500 ms and below 250 ms. We determined the absolute cutoffs via visual inspection of a density plot. Next, on the resulting subset of data, we excluded RTs if they fell outside of a 2.5 SD range around the mean naming latency for each participant. The cleaning procedure resulted in the removal of 4.5% of correct trials. The mean comprehension question accuracy was 91%.

Before modeling, we log-transformed the dependent variable, RT to begin naming. We centered all numeric independent variables, and we log-transformed variables with a non-normal distribution (e.g., word frequency). We constructed a control model by including variables that significantly affected log RT. We included control variables which were significant in model comparisons against a baseline (null model), and which explained independent portions of the variance (as determined via successive model comparison) in the final analysis. The control factors that were significant included centered and log-transformed word frequency, centered word length (in characters), and a composite score of picture naming performance (summed z-scores of inverse reaction time and accuracy on the picture naming task). These effects made up the control model. On top of the control model, the effects of interest were added. The primary effects of interest were two categorical variable. The first variable was the four-level word type factor (cognate, cognate control, homograph, homograph control). Because the sets of cognates and controls and homographs and controls are not comparable (they are not matched to each other), we constructed two separate models to examine the cognate effect (cognate vs. noncognate) and the homograph effect (homograph vs. Nonhomograph) independently. Also of interest was the two-level categorical variable representing which construction the set of cognate and homograph stimuli would be embedded in the sentence context word naming experiment (actives and passives or NP-PP and PP-NP datives). We used sum coding for each effect contrast. We included random intercepts by participant and by item in all models and, random slopes for centered and logged word frequency, centered word length, word type, construction, and the interaction between word type and construction by participant and in the final models. We did not add random slopes by target word, as all factors were manipulated between items.

For the cognate data, there was a significant effect of centered log-transformed word frequency (SS = –0.024, SE = 0.006, t = –4.330, $p < 0.001$), indicating that an increase in word frequency related to a decrease in log RT. There was also an effect of centered word length (SS = 0.025, SE = 0.005, t = 5.177, $p < 0.001$), indicating that an increase in word length related to an increase in log RT. There was significant effect of the cognate contrast (SS = –0.052, SE = 0.013, t = –3.983, $p < 0.001$), indicating that cognates were named more quickly compared to non-cognate controls. There was no significant effect of the construction contrast nor an interaction between the cognate and construction contrasts (ts < 1.96, ps > 0.05). See Table 2 for the fixed effects from the cognate model.

For the homograph data, there was a significant effect of centered log-transformed frequency (SS = –0.024, SE = 0.009, t = –2.790, $p < 0.01$). There was no significant effect of centered word length ($t < 1.96$, $p > 0.05$). There were no significant effects for the homograph contrast, the construction contrast, nor the interaction between the two (ts < 1.96, ps > 0.05). See Table 3 for the fixed effects from the homograph model.

The Spanish-English bilinguals recruited for this study showed significant cognate facilitation effect. This cognate effect was similar for the set of words that are embedded in the active and passive sentences compared to those embedded in the dative sentences in the sentence-context word naming study. These results are in line with many previous out-of-context word recognition and word naming studies finding that bilinguals activate co-active both languages despite performing a unilingual task. There was no evidence of a homograph inhibition effect for the bilinguals. Previous studies have shown that homograph effects are more sensitive to aspects of context, such as stimulus list composition. For example, Dijkstra, Van Jaarsveld, and Ten Brinke (1998) failed to observe homograph inhibition in lexical decision unless they included filler items that were in the unintended language. In this experiment, there were no items in the unintended language. A potential interpretation of the results is that bilinguals were functioning in a language selective manner, as measured by the homograph effect.

4.3 Experiment 2: Bilingual in context

Experiment 2: Spanish-English bilinguals in-of-context

4.3.1 Methods

Methods

4.3.1.1 Participants

Participants Forty-two Spanish-English bilinguals participated in the RSVP experiment (the final sample included 29 participants after data cleaning; see below). The participants were members of the Pennsylvania State University or the State College area communities. All participants gave informed consent, and the procedures had the approval of the Institutional Review Board of the Pennsylvania State University. Participants received $10 per hour for their participation in the experiment. We recruited participants if they considered themselves bilingual between English and Spanish, and this recruitment procedure resulted in a heterogeneous sample of Spanish-English bilinguals with a variety of language experiences. Participants completed a language history questionnaires to assess subjective language proficiency. Additionally, a picture naming task with sections in Spanish and English, and portions of English and Spanish grammar tests (Michigan English Language Institute College English Test and the Diploma de Español como lengua extranjera) assessed objective language proficiency. Finally, an Operation-Span task (i.e., Automatic O-Span; Unsworth et al., 2005) and a Flanker Task (e.g., Bunge, et al., 2002; Emmorey et al., 2008) assessed working memory and cognitive control.

The recruited sample included a heterogeneous population of Spanish-English bilinguals. Some participants were born in the United States others emigrated from Spanish-speaking countries. Some participants were heritage speakers of Spanish and others knew a third language. In order to obtain a more homogeneous sample, we excluded participants from the analysis using the following procedure. We excluded participants who reported using a language other than Spanish or English (or both) at home (N=2). We also excluded participants who scored below 75% accuracy on word naming and answering comprehension questions for the main task (N=7). We determined the cutoff of 75% by visual inspection of histograms for word naming accuracy and comprehension question accuracy; 75% was the point at which a second mode in the distribution began. Finally, we excluded participants from the analysis if they did not have complete data on the administered tasks (N=4) included in the final model. This resulted in a final sample of 29 participants.

Overall, the participants from the final sample were highly proficient speakers of Spanish and English and the sample showed trends toward Spanish dominance.

Twenty-one participants reported using only Spanish in the home, and eight reported using both English and Spanish in the home. Participants rated themselves more highly in Spanish than in English (MSpanish = 9.51; MEnglish = 8.47; t(28) = 3.796, $p < 0.001$), and they were more accurate in the Spanish picture naming task compared to the English task (MSpanish = 0.91; MEnglish = 0.84; t(28) = 2.462, $p < 0.05$). There were no significant differences in picture naming speed (MSpanish = 1011.86; MEnglish = 1067.83; t(28) = 1.670, p = 0.10) or in performance on the grammar tasks (MSpanish = 38.24; MEnglish = 38.52; t(22) = 0.270, p = 0.79). The set of participant characteristics for the final sample of participants is shown in Table 4.

4.3.1.2 Materials

Materials The lexical stimuli were identical to those in Experiment 1.

We chose four structures to embed the Spanish lexical stimuli within: actives, passives, prepositional object datives structures with NP-PP word order, and prepositional object dative structures with PP-NP word order. On the basis of previous syntactic priming literature, actives, passives, and possibly NP-PP datives can be considered Spanish-non-specific structures because they have been shown to exhibit cross-language syntactic priming for Spanish and English. Prepositional object structures with PP-NP dative can be considered Spanish-specific structures because they do not share linear word order across the two languages and should exhibit less robust cross-language syntactic priming in these languages. We divided the set of cognate materials (40 cognates and 40 matched controls) and the set of homographs materials (40 cognates and 40 matched controls) in half. Half of the critical-control pairs were embedded under the active and passive sentences while the other half were embedded under the prepositional object sentences. Thus each critical and control word appeared in two sentences (active and passive, or NP-PP and PP-NP), and we created two stimulus lists to counterbalance the stimuli so that no participant saw repetitions of any critical-control word pair. This resulted in a final sample of 320 sentences with 160 sentences per list (see Appendix B).

Critical words never occurred in sentence-final position, to avoid potential sentence wrap up effects. The sentences were written with the intention to keep semantic constraint low to avoid introducing potentially confounding effects due to a highly probably target word (e.g., Schwartz and Kroll, 2006). A sentence completion study confirmed that, overall the sentences had a low semantic constraint (CLOZE probability M = 0.05, range: 0.00 - 0.72), and the semantic constraint did not differ between conditions (see Table 5; all Fs < 4, ps > 0.05). Care was taken to ensure that none of the words in the filler sentences overlapped with critical target words of the experimental sentences. Yes-no comprehension questions were created for each of the filler sentences and for half of the critical sentences (50% yes, 50% no) to probe comprehension and to further distract participants from the main goal of the task.

4.3.1.3 Procedure

Procedure The experiment lasted for two one-hour long experimental sessions that were carried out over two days. At the beginning of each session, participants gave informed consent. During the first session, they completed a language history questionnaire to gauge their language background (including subjective measures of proficiency). Participants were then seated at a computer where they began the sentence task. Sentences were presented using RSVP such that participants read sentences silently word-by-word (300 ms per word) until they encountered a target word, which was displayed in red. They were instructed to name the target word aloud quickly and accurately. Following the main task, the participants completed a test of Spanish grammar (DELE), a picture naming experiment in Spanish, and then a picture naming experiment in English. The tasks were ordered to minimize switching between the two languages, and particularly to minimize switching from English (L2) to Spanish (L1). Participants were invited back for a follow-up study during which they completed the battery of cognitive tasks (Operation Span, AX-CPT, and Flanker) and a test of English grammar (MELICET).[IŠm probably going to have to explain more about these side-tasks, given that some of them are significant predictors in the analysis.]

4.3.2 Results

Results

Undergraduate research assistants who spoke English and Spanish coded the accuracy of the word naming data. We excluded rials in which an incorrect word was named or in which the production would add variability to reaction times (RTs;

e.g., hesitation before naming the target word) from the RT analysis. We cleaned the RT data using a procedure for the removal of absolute and relative outliers. First, considering only correctly named trials, we excluded RTs above 2500 ms and below 250 ms. We determined the absolute cutoffs via visual inspection of a density plot. Next, on the resulting subset of data, we excluded RTs if they fell outside of a 2.5 SD range around the mean naming latency for each participant. The cleaning procedure resulted in the removal of 6.5% of correct trials. The mean comprehension question accuracy was 88%.

Data transformations and control models were constructed following the procedure from Experiment 1. The significant control factors were centered and log-transformed word frequency, centered word length (in characters), and a composite score of picture naming performance (summed z-scores of inverse reaction time and accuracy on the picture naming task). These effects made up the control model. On top of the control model, we added the a-priori effects of interest. The primary effects of interest were two categorical variables: sentence construction (active, passive, NP-PP dative, and PP-NP dative) and word type (cognate, cognate control, homograph, homograph control), and their interaction. Because the sets of cognates and controls and homographs and controls are not comparable (they were not matched to each other), we constructed two separate models to examine the cognate effect (cognate vs. noncognate) and the homograph effect (homograph vs. Nonhomograph) independently. We used sum coding was used for for each word-type contrast. The categorical variable for sentence construction was contrast coded to yield three orthogonal comparisons: active sentences, NP-PP dative sentences, and PP-NP dative sentences compared to passive sentences; NP-PP datives and PP-NP datives compared to active sentences; and PP-NP dative compared to NP-PP datives.

After we constructed the effects-of-interest models, we tested for interactions between individual difference variables of executive control and language fluency and the effects of interest. Previous studies have shown that variables tracking language fluency interact with the magnitude of the cognate effect and variables tracking executive function interact with the homograph effect. Significance was tested via removal of the interaction terms during model comparison.

For the random effects structure of the final models (the a priori models and the individual differences models), Şkeep it maximalŤ by including random intercepts for participants and items and by adding random slopes for all between-participant variables by item and all between-item variables by participant. If a model failed to converge random slopes were removed; at a minimum random slopes for word type, construction, and the interaction between construction and word type were added by participant, and a random slope (and correlations with the intercept) for the Spanish naming composite was added by target word.

4.3.2.1 Cognate Analysis

The results of the cognate model are as follows. There was an effect of Spanish picture naming composite, such that an increase in the composite (related to increased fluency in Spanish) related to a decrease in log RT (SS = –0.084, SE = 0.023,* t* = –3.682, $p < 0.001$). There was an effect of centered log word frequency, such that an increase in frequency related to a decrease in log RT (SS = –0.013, SE = 0.004, t = –2.984, $p < 0.01$). There was an effect of centered word length, such that an increase in number of characters related to an increase in log RT (SS = 0.013, SE = 0.003, t = 4.739, p < 0.001). There was an effect for the contrast between passive and all other structures, such that words named in passive sentences were named more quickly compared to active sentences (SS = –0.011, SE = 0.003, t = –4.317, $p < 0.001$). There was no effect of the contrast between the two dative structures and active structure nor for the contrast between the two dative structures ($t < 1$, p, > 0.05). There was an effect for the cognate contrast such that, cognates were named more quickly compared to non-cognate controls (SS = 0.055, SE = 0.016, t = 3.482, $p < 0.001$). The cognate contrast interacted with Spanish picture naming composite, such that the magnitude of the cognate effect decreased with an increase in the composite (related to increasing Spanish fluency; SS = –0.034, SE = 0.010, t = –3.419, $p < 0.001$). The cognate contrast also interacted with the contrast between the two dative structures, indicating that the cognate effect was larger in dative sentences with NP-PP word order compared to sentences with PP-NP word order (SS = –0.024, SE = 0.012, t = –2.044, $p <$ 0.05). The cognate contrast did not interact with any other sentence construction contrast (ts < 1, ps > 0.05) There was no evidence for the addition of a three way interaction between Spanish composite, cognate contrast, and sentence structure in the model (?2 (6) = 7.245, p = 0.29). See Table 6 for the fixed effects from the cognate model.

To explore possible interactions between cognitive control, language fluency, and language co-activation, we tested for higher-order interactions between cognitive control variables (AXCPT ratio of proactive control, OSpan z-score, and the Flanker effect z-score) and the cognate and construction contrasts, and between the Spanish picture naming composite and cognate and the construction contrasts. We evaluated significance for the interactions by model comparison to less complex models. This procedure resulted in the removal of 5 participants who did not have complete data on the tasks. There was no evidence for higher order interactions between executive control variables, the cognate contrast, and sentence construction (p > 0.05 on all ?2 tests of model comparison).

4.3.2.2 Homograph analysis

The results of the homograph model are as follows. There was an effect of Spanish picture naming composite, such that an increase in the composite (related to increased fluency in Spanish) related to a decrease in log RT (SS = –0.058, SE = 0.023,* t* = –2.450, $p < 0.05$). There was an effect of centered log word frequency, such that an increase in frequency related to a decrease in log RT (SS = –0.026, SE = 0.005, t = –4.567, $p < 0.001$). There no significant effect of centered word length ($t < 1$, $p > 0.05$). There was an effect for the contrast between passive and all other structures, such that words named in passive sentences were named more quickly compared to active sentences (SS = –0.012, SE = 0.004, t = –3.099, $p < 0.01$). There was no effect of the contrast between the two dative structures and active structure nor for the contrast between the two dative structures ($t < 1$, $p > 0.05$). There was no effect for the homograph contrast, and no interaction between Spanish naming composite and the homograph contrast (ts < 1, ps > 0.05). However, the homograph contrast contrast interacted with the contrast between the active structure and the two dative structures, indicating that there was significant homograph inhibition in the dative structures (SS = –0.025, SE = 0.010, t = 2.40., $p < 0.05$). The homograph contrast did not interact with any other sentence construction contrast (ts < 1, ps > 0.05). There was no evidence for the addition of a three way interaction between Spanish composite, homograph contrast, and sentence structure in the model (?2 (6) = 9.312, p = 0.156). See Table 7 for the fixed effects from the homograph model.

To explore possible interactions between cognitive control, language fluency, and language co-activation, we tested for higher-order interactions between cognitive control variables (AXCPT ratio of proactive control, OSpan z-score, and the Flanker effect z-score) and the homograph and construction contrasts, and between the Spanish picture naming composite and homograph and the construction contrasts. We evaluated significance for the interactions by model comparison to less complex models. This procedure resulted in the removal of 5 participants who did not have complete data on the tasks. There was no evidence for higher order interactions between executive control variables, the homograph contrast, and sentence construction ($p > 0.05$ on all ?2 tests of model comparison).

4.3.2.3 Reanalysis of Experiments 1 and 2

Reanalysis of Experiments 1 and 2

Experiment 1 showed significant cognate facilitation but no homograph inhibition outside of sentence context. In Experiment 2, the cognate facilitation and homograph inhibition effects were present and modulated by sentence construction. A potential explanation of this modulation is that there were lexical confounds across the construction conditions that were not detected by the out-of-context analysis. This could be the case particularly for the homograph stimuli given a curious lack of homograph inhibition effect out-of-context. While it is temping to explain the lack of homograph inhibition in Experiment 1 as due to the monolingual, Spanish nature of the task (i.e., there were no English distractor words to induce activation of English), the were cognate words that did activate the unintended language, the participants were balanced in the use of their two languages but living or working in an English dominant environment, and the participants spoke English with the experimenter before proceeding with the word naming portion of the study. Thus, the homographs should have produced inhibitory effects but may have have contained stimuli with unintended lexical confounds, increasing variability and masking an effect.

To ensure that the apparent interactions between word type (particularly homograph effects) and construction were not due to lexical effects across the two sets of items (e.g., ŞinefficientŤ cognate or homograph items present to a greater degree in the dative condition), we conduced a conditional reanalysis of the data in the first two experiments. We subsetted the data from Experiments 1 and 2 to include on those critical-control word pairs which showed the predicted cognate facilitation or homograph inhibition effect in the out of context task in Experiment 1. To this end, we calculated mean naming latencies for each critical - control word pair. We considered any cognate-control pair with a mean difference less than 0 as showing cognate facilitation, and any homograph-control pair with a mean difference greater than 0 as showing homograph inhibition. We excluded and any item pairs that did not fit into either of these conditions from the reanalysis. Thus, the reanalysis of Experiments 1 and 2 included only items that were shown to elicit cognate and homograph effects outside of sentence context. This process resulted in the removal of 11 cognate-control word pairs (5 from active and passive, and 6 from dative conditions) and 11 homograph-control word pairs (7 from active and passive, and 6 from dative conditions), about 25% of the observations from the cognate model and 27% from the homograph model.

4.3.2.3.1 Out of context reanalysis Reanalysis of Experiment 1: Spanish-English bilinguals out-of-context

The models from Experiment 1 were recomputed after calculating and removing item-specific cognate and homograph effects. For the cognate data, there was a significant effect of centered log-transformed word frequency (SS = –0.022, SE = 0.006, t = –3.746, $p < 0.001$), indicating that an increase in word frequency related to a decrease in log RT. There was also an effect of centered word length (SS = 0.022, SE = 0.004, t = 6.210, $p < 0.001$), indicating that an increase in word length related to an increase in log RT. There was significant effect of the cognate contrast (SS = –0.084, SE = 0.015, t = –5.491, $p < 0.001$), indicating that cognates were named more quickly compared to non-cognate controls. There was no significant effect of the construction contrast, ($t < 1$, ps > 0.05). The interaction between the cognate contrast and the construction contrast approached significance (SS = 0.048, SE = 0.028, t = 1.710, p = 0.08), indicating that if anything, the cognate effect in the dative condition was larger than the cognate effect in the active and passive condition. See Table 8 for the fixed effects from the cognate model.

For the homograph data, there was a significant effect of centered log-transformed frequency (SS = –0.047, SE = 0.009, t = –5.161, $p < 0.001$). There was no significant effect of centered word length ($t < 1$, $p > 0.05$). There was a significant effect of the homograph contrast (SS = 0.072, SE = 0.020, t = 3.714, $p <$ 0.001), indicating that homograph were named more slowly than controls. Neither the construction contrast nor the interaction between construction and word type were significant (ts < 1.96, ps > 0.05). See Table 9 for the fixed effects from the homograph model.

4.3.2.3.2 Cognate reanalysis in context Reanalysis of Experiment 2: Spanish-English bilinguals out-of-context The models from Experiment 2 were recomputed after calculating and removing item-specific cognate and homograph effects from Experiment 1. The results of the cognate model are as follows. There was an effect of Spanish picture naming composite, such that an increase in the composite (related to increased fluency in Spanish) related to a decrease in log RT (SS = –0.093, SE = 0.023,* t* = –3.997, $p < 0.001$). There was an effect of centered log word frequency, such that an increase in frequency related to a decrease in log RT (SS = –0.012, SE = 0.005, t = –2.459, $p < 0.05$). There was an effect of centered word length, such that an increase in number of characters related to an increase in log RT (SS = 0.014, SE = 0.003, t = 4.875, p < 0.001). There was an effect for the contrast between passive and all other structures, such that words named in passive sentences were named more quickly compared to active sentences (SS = –0.011, SE = 0.003, t = –3.796, $p < 0.001$). There was no effect of the contrast between the two dative structures and active structure nor for the contrast between the two dative structures ($t < 1$, p, > 0.05). There was an effect for the cognate contrast such that, cognates were named more quickly compared to non-cognate controls (SS = 0.079, SE = 0.019, t = 4.202, $p < 0.001$). The cognate contrast interacted with Spanish picture naming composite, such that the magnitude of the cognate effect decreased with an increase in the composite (related to increasing Spanish fluency; SS = –0.047, SE = 0.012, t = –3.948, $p <$ 0.001). The cognate contrast did not interact with any of the construction contrasts (ts < 1, ps > 0.05). There was no evidence for the addition of a three way interaction between Spanish composite, cognate contrast, and sentence structure in the model (?2 (6) = 6.791, p = 0.34). See Table 10 for the fixed effects from the cognate model.

To explore possible interactions between cognitive control, language fluency, and language co-activation, we tested for higher-order interactions between cognitive control variables (AXCPT ratio of proactive control, OSpan z-score, and the Flanker effect z-score) and the cognate and construction contrasts, and between the Spanish picture naming composite and cognate and the construction contrasts. We evaluated significance for the interactions by model comparison to less complex models. This procedure resulted in the removal of 5 participants who did not have complete data on the tasks. There was a significant three-way interaction between z-scored OSpan score, the cognate contrasts, and the construction contrasts (?2 (3) = 12.139, p < 0.01). There was no three-way interaction between AXCPT reaction time ratio, the construction contrasts, and the cognate contrast; nor was there a two-way interaction between AXCPT ratio and the construction contrasts (ps > 0.05). There was, however, a significant interaction between the AXCPT ratio and the cognate contrast (?2 (1) = 3.922, p < 0.05). There was a significant three-way interaction between the Spanish picture naming composite, the construction contrasts, and the cognate contrast (?2 (3) = 9.996, p < 0.05). For the final model, random slopes by item were added for the centered AXCPT ratio and the o-span score.

In this new model. There was an effect of Spanish picture naming composite, such that an increase in the composite (related to increased fluency in Spanish) related to a decrease in log RT (SS = –0.087, SE = 0.030,* t* = –2.870, p < 0.01). There was an effect of centered log word frequency, such that an increase in frequency related to a decrease in log RT (SS = –0.014, SE = 0.006, t = –2.437, p < 0.05). There was an effect of centered word length, such that an increase in number of characters related to an increase in log RT (SS = 0.017, SE = 0.004, t = 4.668, p < 0.001). There was no main effect of the AXCPT ratio measure nor of the z-score OSpan measure (ts < 1.96, ps > 0.05). There was an effect for the contrast between passive and all other structures, such that words named in passive sentences were named more quickly compared to active sentences (SS = –0.012, SE = 0.005, t = –2.548, p < 0.05). There was no effect of the contrast between the two dative structures and active structure nor for the contrast between the two dative structures (t < 1.96, p, > 0.05). There was an effect for the cognate contrast such that, cognates were named more quickly compared to non-cognate controls (SS = 0.071, SE = 0.020, t = 3.571, p < 0.001). The cognate contrast interacted the AXCPT ratio measure (SS = –0.032, SE = 0.011, t = –2.898, p < 0.01), indicating that a higher ratio score (reflective of greater pro-active cognitive control) related to a smaller cognate effect. The cognate contrast interacted with Spanish picture naming composite, such that the magnitude of the cognate effect decreased with an increase in the composite (related to increasing Spanish fluency; SS = –0.041, SE = 0.012, t = –3.328, $p < 0.01$). The cognate contrast interacted with the contrast between the passive sentences and all other sentences, indicating that the cognate effect was smaller in the passive sentences (SS = –0.022, SE = 0.010, t = –2.200, $p < 0.05$). The other construction contrasts did not interact with the cognate contrast (ts < 1, ps > 0.05). The cognate contrast interacted with the z-score OSpan measure ($SS = 0.033$, $SE = 0.012$, $t = 2.759$, $p < 0.01$), indicating that cognate effects were facilitatory for participants with high span but inhibitory for participants with low span. None of the construction contrasts interacted with the Spanish picture naming composite nor did they interact with the z-score OSpan measure (ts < 1.96, ps > 0.05). However, there was a three-way interaction between the contrast of the two dative structures, the cognate contrast, and the z-score Ospan measure ($SS = 0.034$, $SE = 0.017$, $t = 2.036$, $p < 0.05$), indicating that the crossover interaction was not present in the NP-PP dative sentences as compared with the PP-NP dative sentences . Also there was a three-way interaction between the the contrast for passive structures compared to all other structures, the cognate contrast, and the Spanish picture naming composite ($SS = 0.016$, $SE = 0.007$, $t = 2.419$, $p < 0.05$), indicating that with higher fluency the cognate effect was reduced for all structures besides the passive.

4.3.2.3.3 Homograph reanalysis in context The results of the homograph model are as follows. There was an effect of Spanish picture naming composite, such that an increase in the composite (related to increased fluency in Spanish) related to a decrease in log RT (SS = –0.060, SE = 0.024,* t* = –2.508, $p <$ 0.05). There was an effect of centered log word frequency, such that an increase in frequency related to a decrease in log RT (SS = –0.031, SE = 0.006, t = –4.946, $p <$ 0.001). There no significant effect of centered word length ($t < 1$, $p > 0.05$). There was an effect for the contrast between passive and all other structures, such that words named in passive sentences were named more quickly compared to active sentences (SS = –0.017, SE = 0.005, t = –3.438, $p < 0.01$). There was no effect of the contrast between the two dative structures and active structure nor for the contrast between the two dative structures ($t < 1.96$, $p > 0.05$). There was no effect for the homograph contrast, and no interaction between Spanish naming composite and the homograph contrast (ts < 1.96, ps > 0.05). However, the homograph contrast contrast interacted with the contrast between the active structure and the two dative structures, indicating that there was significant homograph inhibition in the dative structures (SS = –0.028, SE = 0.013, t = 2.215, $p < 0.05$). The homograph contrast did not interact with any other sentence construction contrast (ts < 1, ps > 0.05). The addition of an interaction term between construction and Spanish picture naming composite was significant via model comparison (?2 (3) = 16.032, p < 0.01), but the three-way interaction between construction, word type, and Spanish picture naming composite was not significant (?2 (3) = 3.549, p = 0.31). The contrast between the passive and all other structures interacted with the Spanish picture naming composite (SS = 0.007, SE = 0.003, t = 2.160, $p < 0.05$), indicating that the speed-up for passive sentences became less dramatic with increased language fluency. The contrast between the two dative structures interacted with Spanish picture naming composite (SS = 0.019, SE = 0.008, t = 2.264, $p < 0.05$), indicating that a processing disadvantage arose for PP-NP structures at lower levels of proficiency. See Table 11 for the fixed effects from the homograph model.

To explore possible interactions between cognitive control, language fluency, and language co-activation, we tested for higher-order interactions between cognitive control variables (AXCPT ratio of proactive control, OSpan z-score, and the Flanker effect z-score) and the homograph and construction contrasts, and between the Spanish picture naming composite and homograph and the construction contrasts. We evaluated significance for the interactions by model comparison to less complex models. This procedure resulted in the removal of 5 participants who did not have complete data on the tasks. There was no evidence for higher order interactions between executive control variables, the cognate contrast, and sentence construction (p > 0.05 on all ?2 tests of model comparison).

4.4 Discussion

Discussion

The Spanish-English bilinguals recruited for this study showed evidence for the co-activation of English for Spanish target words embedded in Spanish sentence contexts. There was significant cognate facilitation in active sentences, passive sentences, and NP-PP dative sentences. These sentences all share word order between English and Spanish, and by this metric can be quantified as having language non-specific syntax. A separate group of bilinguals who named the same words out of context, also showed significant cognate facilitation effects.

There was also evidence that the magnitude of co-activation differed depending on the syntactic construction used in the sentence. The nature of the interaction was different for cognates and homographs.

4.5 General Discussion

General Discussion This study tested whether sentences that are hypothesized to contain Spanish-specific syntax can reduce co-activation of English in a visual word recognition task for a sample of highly proficient Spanish-English bilinguals. Cognate facilitation was observed during the production of words embedded in Spanish sentences. There was no significant homograph effect in this experiment. Critically, neither the degree of cognate facilitation nor the degree of homograph inhibition depended on the syntactic structure of the sentence in which the targets were embedded. However, the magnitude of cognate facilitation (but not the homograph effect) did depend on individual differences in Spanish fluency as measured by a Spanish picture naming task. Taken together, these results suggest that bilinguals co-activated their L2 (English) while reading and naming words in their L1 (Spanish). The presence of syntactic structures with word order that is allowable in Spanish but not English did not appear to function as a language cue that could restrict lexical activation to Spanish alone. However, the degree of co-activation did depend on individual fluency in the L1: participants who had greater L1 fluency experienced less co-activation of English. Despite the co-activation of the second language, participants had no overt trouble speaking their native language. Is this indicative of a cognitive control mechanism? Here we found no evidence that the degree of parallel activation was related to any of the measures in the cognitive control battery. The results reported here are partially consistent with the BIA+ model of word recognition, which posits a late account of language selection.

4.5.1 Parallel activation and syntactic context

Parallel activation and the factors that modulate it

*Could be an underestimation of the effect given that this is language productionĚ future studies should do eyetracking

Cognate facilitation is in line with many previous studies showing that bilinguals activate both languages when reading in one language alone, even when bilinguals read in the presence of context. Unilingual sentence sentence contexts and tasks have been shown to be insufficient to restrict lexical activation to a single language (), even when a direct comparison is made with mixed-language tasks (e.g., Gullifer et al., 2013). This is perhaps surprising. Throughout the course of an experiment entirely in one language a reader could theoretically accumulate evidence supporting the single-language requirement,and add it to their model of the situation to minimize influence of the unintended language. However, there was no evidence for this in the data. Both languages were co-activated in parallel, and remained that way throughout the course of the task. Trial number was neither a significant control variable nor did it interact with word type in the analysis. The lack of homograph inhibition for a unilingual task is also consistent with prior studies showing that homograph effects are dependent on a variety of factors such stimulus list composition and context of language usage. The results reported here extend the findings of previous studies in several ways by examining the factors which modulate cross-language co-activation, including the syntactic construction of the sentence and individual differences in language fluency.

While many previous studies have investigated the role of potential language cues, e.g., language specific lexical form, aspects of contextual constraint, aspects of environmental constrain, aspects of task constraint, and semantic context, it is curious that no published studies investigated the role of syntax, a feature that differ wildly across languages, especially in realization the realization of the surface for, i.e., the linear word order within a sentence. Many of these previous studies report no interaction between cross-language effects and the so-called language cues. The results reported here are consistent with the studies finding no interaction between cross-language activation and context. If language-specific syntax (either by itself or in conjunction with the presence of unilingual sentence contexts) could function as a language cue, the magnitude of cross-language effects should be reduced or eliminated in constructions where word order is not shared between English and Spanish, namely within the dative condition. Here, there was no evidence that the syntactic form of the sentence impacted cross-language effects. The magnitude of cognate facilitation was the same in active constructions, passive constructions, and NP-PP dative constructions which all share word order in English and Spanish. Critically, there was also cognate facilitation of the same magnitude in dative constructions with PP-NP word order, a word order that is not licit in most circumstances in American English. These results are in line with unpublished findings from Gullifer et al., (2013), who found that language-specific morphosyntactic features (the combined presence of pro-clitics and use of pro-drop in Spanish sentences) did not impact non-selectivity as measured by the cognate effect. While in both studies the interaction between cross-language effects and syntactic construction is a null finding, the magnitude of cognate facilitation was robust in the two studies. The convergence between the findings or lack thereof in the two studies, each with distinct materials and operationalizations of language-specific syntax, begins to indicate that aspects of the syntax do not influence aspects of word recognition.

The results reported here conflict with word recognition studies showing that context can modulate activation of the unintended language. The primary factor that has been shown to be significant in modulating co-activation of the unintended languages is a strongly biased semantic context. When monolingual participants read a sentence, they generate predictions about upcoming words in that sentence. The predictions are particularly strong when a sentences is highly biased in its meaning. In highly biased sentences, the processing of upcoming words is speeded when they fit into the semantic frame and costly when they do not. For bilingual speakers, these predictions may also include information about the language membership of upcoming words, and this information in turn affects lexical processing. In addition to the general processing advantage for words that fit into a highly biased semantic frame, bilinguals experience a magnitude reduction for effects that are indicative of cross-language activation. The results here, along with those of Gullifer (2013), suggest that language-specific syntax does not function in a similar manner to that biased of semantic context. Several options exist for the lack of interaction between syntactic context and cross-language activation.

One option is syntactic manipulations simply do not influence word recognition time. Indeed, there was no effect on naming latency when comparing words named under the active condition, the NP-PP dative condition, and the PP-NP dative condition. Similarly in Gullifer (2013), there was no main effect including language-specific morphosyntax on overall word naming latencies. It should be noted that in the present study, participants were generally faster to name words in the passive condition compared to all other conditions. so the syntactic manipulation was not wholly ineffective. A second option for the failure of language-specific syntax to interact with co-activation is that language-specific syntax, as we have been conceptualizing it, does not exist. The impetus for calling the dative structures language-specific in the present study was the observation in some early cross-language syntactic priming research that structures which do not share word order across two languages are less likely to show the cross-language syntactic priming, an effect that has been attributed to shared storage of syntax across different languages. However, emerging work on cross-language syntactic priming, particularly in the realm of reading comprehension, indicates that cross-language syntactic priming can be achieved even when the word order is not shared between the two languages. This suggests that bilinguals may have completely shared structural representations for structures despite a lack of shared linear word order. If this were true, then no structure would be considered language-specific, and hence no structure should interact with cross-language co-activation. Interestingly, this point would be predicted by proponents of Universal Grammar, who hypothesize that the underlying representation of syntax are the same across languages and that surface differences are the result of a set of parameters (that may differ across languages) acting on the underlying representation. Quite independently from work on cross-language syntactic priming, recent formulations of bilingualism from a Universal Grammar perspective include hypotheses of shared syntax for bilinguals (Universal Bilingualism; Roeper, in press). A final option offered here, and one that will be expanded upon is the idea that if there is a so-called language-specific syntax, then its usefulness to influence word recognition may be limited.

A limited influence of syntax during word recognition is predicted by some popular models of lexical and language representation, particularly those that include some form of modularization. The BIA+ model posits a modularization of the word recognition system from other aspects of context (except the semantics which is implemented in the word recognition module). Language selection is hypothesized to occur outside of the word recognition system after candidates for selection have become activated during word recognition. Thus, the model predicts a null influence of syntactic context (found here), but could allow for an influence of semantic context (as shown by previous studies). These findings are also in line with the declarative/procedural model (e.g., Ullman, 2001). In this model there is a functional and neuroanatomic distinction between declarative and procedural knowledge that is assumed to influence language representation and processing. Lexical knowledge is assumed to be declarative in nature, that is knowledge related to facts (semantic knowledge) and events (episodic knowledge). The declarative system is viewed as a non-information-encapsulated system, such that declarative knowledge is freely accessible to other systems. In contrast, syntactic knowledge is assumed to be procedural in nature (at least for early learners of an L2, for late-learners it is assumed to be declarative; Ullman, 2006[http://journals.cambridge.org/abstract_S1366728901000220]), that is knowledge related to the established motor and cognitive ŞhabitsŤ. The procedural system is viewed as being information-encapsulated. Cast in the light of the declarative-procedural model during L1 lexical activation, information related to the syntactic structure of the sentence is not freely accessible, and hence it would not be predicted to influence lexical-level processing (found here). On the other hand, declarative knowledge about the highly biased meaning of a sentence context would be able to influence lexical (declarative) processing (as shown by previous studies).

While the modular interpretations of the results are tantalizing, the authors are not completely convinced that a modular interpretation is best. There are findings in the study of bilingualism that suggest syntactic knowledge is not completely encapsulated from other knowledge during language processing, even for highly proficient bilinguals who would represent the syntaxes of the two languages procedurally. For example, lexical choice during intrasententially code-switched utterances is driven by the degree of syntactic overlap. Intra-sentential code-switching, a phenomenon in which the two languages are mixed mid-sentence, occurs for bilinguals who are highly fluent in the two languages who presumably have procedural storage of syntax in the two languages. Thus in some circumstances, it appears that speakers have access to syntactic knowledge during lexical activation and selection, suggesting that this type of procedural knowledge is not completely encapsulated. Relatedly, work from cross-language syntactic priming suggests that many syntactic structures have the ability to prime across language, and as such exhibit a common storage between the two languages. If the declarative/procedural model is correct, only early L2 learners would be able to demonstrate evidence for cross-language syntactic priming, but this is not the case. Finally, the declarative/procedural model also makes a counter-intuitive prediction that could be the focus of a future study. Because the model assumes that syntactic knowledge is stored declaratively for speakers who are not early learners of a second language (or at least late-learners at extremely high levels of proficiency), it is precisely this sample of bilinguals reading in their second language who could be predicted to utilize declarative syntactic knowledge to reduce co-activating of the unintended language during word recognition.

In the results reported here, there was a dependence of cognate facilitation on fluency in the language of the task, as measured by the Spanish picture naming composite. Here the language of the task was the native language of the participants, Spanish. This finding is consistent with those of Titone and colleagues who showed that cognate facilitation is dependent on the proficiency in the L2 when L2 was the language of the task. A straightforward interpretation of these results is that with increased language fluency, participants are better able to pre-activate the meaning of a word in the intended language, reducing the influence of the unintended language. However, there is an alternative hypothesis regarding that cognate effect that fits equally well with the data reported here.

4.5.2 Cognate effect as a frequency effect

A possible alternative account for the observed pattern of results is that the cognate effect does not reflect language co-activation but is rather a relative frequency effect.[ ] Because cognate share orthography, phonology, and meaning across two languages, a bilingual who speaks those two language necessarily will use these words more often compared to a monolingual speaker in either language. A well-known effect in the lexical processing literature (and one reported in the regression analyses here) is that words with higher frequency of usage will be processed, recalled, and named more quickly compared to words with lower frequency of usage. Thus, the bilingual cognate facilitation effect may be reflective of this increased frequency of usage. According to the frequency hypothesis, however, only cognates with identical orthography across the two languages experience increased usage. Thus only identical cognates should experience cognate facilitation. However, contrary to this hypothesis, the magnitude of cognate facilitation has been shown to be related to the precise degree of orthographic overlap across the two languages. Words with greater orthographic overlap (including non-identical cognates) are processed faster compared to words with less overlap. This is indicative that the cognate facilitation effect is at least partially due to cross-language overlap.

Still, the findings reported here and by Titone and colleagues are compatible with an account of cognate facilitation as a frequency effect. If cognate facilitation is truly a measure of language co-activation of the unintended language, then one would predict that the proficiency in the unintended language relate to the magnitude of cognate facilitation. A bilingual with a high proficiency in the unintended language should show the strongest cross-language effect, whereas a bilingual who is very weak in the unintended language should show little to no effect. However, neither here nor in the data of Titone and colleagues was this this case. Cognate facilitation was related to fluency in the language of the task at hand as opposed to fluency of the unintended language. Furthermore, data emerging from our lab suggests that native language cognate effects can occur very early in the learning of an L2. Second language learners who were enrolled in the first few semester of Spanish, showed evidence of processing English words that were cognates with Spanish differently compared to noncognate control words. This is a finding that is consistent with a frequency interpretation of the cognate effect, and is less consistent with a parallel activation interpretation. Finally, in the data reported here, both cognate status and word frequency In the present results, there was a similar interaction with L1 fluency for the cognate effect and for the word frequency effect. The similarity between the two effect suggests that the cognate effect may be more related to an increased frequency of usage across the two languages than to parallel activation of the unintended language. (Though qualitatively, the two interaction graphs look a bit different; two distinct frequency effects?, also in the modelĚ if the effects werenŠt independent it wouldnŠt be significant to include both of them in the same model).

If itŠs true that the cognate effect is a frequency effect and not a parallel activation effect, then itŠs not surprising that there is no interaction with language-specific syntaxĚ itŠs unrelated to the activation of the two languages.

4.6 Conclusion

Conclusions Implications. Work on syntactic priming: maybe all structures are shared. As fluency in the intended language (L1 or L2) increases cross language effects decrease; less of a chance for contextual factors to come into play. As fluency decreases, perhaps syntactic structures are also decreases.

4.7 RSVP Tables and Figures

4.7.1 Table 1: Lexical Characteristics

Construction Word Type Length Frequency: ALAMEDA Frequency: LEXESP Number of Syllables Number of Phonemes Active/Passive Cognate 7.05 58.65 34.374 3.05 7 Active/Passive Noncognate 7.05 51.85 23.4135 2.9 6.8 Active/Passive Homograph 5.1 142.75 49.2521 2.15 5.1 Active/Passive Nonhomograph 5.2 135.65 48.36435 2.3 4.9 Dative Cognate 7.15 65.85 32.6775 3 7.05 Dative Noncognate 6.85 69.2 27.4275 2.85 6.5 Dative Homograph 5.4 55.8 21.8343 2.45 5.55 Dative Nonhomograph 5.45 53 21.54915 2.45 5.3

The set of homographs and controls in the active and passive conditions were more frequent compared to the set in the dative conditions.

4.7.2 Table 2: Bilingual cognate results out of context

Estimate Std..Error t.value p.z Sig. (Intercept) 6.41 0.032 203.18 0 * clFrequency_1 –0.024 0.006 –4.33 0 * cLength 0.025 0.005 5.177 0 * WordType1 –0.052 0.013 –3.983 0 * ConstructionSuper1 –0.003 0.013 –0.204 0.838

WordType1:ConstructionSuper1 0.028 0.025 1.119 0.263

4.7.3 Table 3: Bilingual homograph results out of context

Estimate Std..Error t.value p.z Sig. (Intercept) 6.388 0.029 219.476 0 * clFrequency_1 –0.024 0.009 –2.79 0.005 * cLength 0.009 0.006 1.441 0.15

WordType1 0.019 0.018 1.022 0.307