NORTHWESTERN UNIVERSITY

The Effect of Phonological Structure on Visual Word Access in Bilinguals and Monolinguals

A DISSERTATION

SUBMITTED TO THE GRADUATE SCHOOL
IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS

for the degree

Doctor of Philosophy

Field of Linguistics/WCAS

By

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EVANSTON, ILLINOIS

December 2006

ABSTRACT:

The Effect of Phonological Structure on Visual Word Access in Monolinguals and Bilinguals

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This dissertation examines how phonological and orthographic differences between languages affect visual word access by studying children and adult Spanish/English bilinguals and monolinguals. The first two experiments examined if visual word access varies cross-linguistically by studying Spanish/English adult bilinguals, priming two syllable CVCV words both within (Experiment 1) and across (Experiment 2) syllable boundaries in the two languages. Spanish readers accessed more first syllables based on within syllable primes compared to English readers. In contrast, syllable based primes helped English readers recognize more words than in Spanish, suggesting that experienced English readers activate a larger unit in the initial stages of word recognition. Primes spanning the syllable boundary affected readers of both languages in similar ways. In this priming context, primes that did not span the syllable boundary helped Spanish readers recognize more syllables, while English readers identified more words, further confirming the importance of the syllable in Spanish and suggesting a larger unit in English. Overall, the experiments provide evidence that readers use different units in accessing words in the two languages.

Two additional experiments examined if visual word access varies in the two languages according to bilingual status and developmental status by priming two syllable CVCV words with bilingual children (Experiment 3) and monolingual children (Experiment 4). Bilingual readers accessed similar units in both languages, differing only in identifying more CVC units in English –as did English monolingual readers. Monolingual Spanish readers accessed more words based on all prime types, while bilinguals accessed more words based on only one prime type. Directly comparing monolinguals to bilinguals showed differences only in Spanish, with greater bilingual access of CV and CVC units and greater monolingual access of words. Overall, the experiments provide evidence that visual word access uses different units in the two languages. The results also suggest that developing bilingual readers do not adapt the process of visual word access between languages and that they may need more time to develop complete phonological representations for both scripts.

Acknowledgements:

Advisors:
Dr. James Booth, Communication Sciences and Disorders
Dr. Matt Goldrick, Linguistics
Dr. Janet Pierrehumbert, Linguistics

Partially supported by a Graduate Research Grant from the University Research Grants Committee at Northwestern University

Sincere gratitude to the following individuals and organizations for supporting this research by allowing the experiments to be conducted:

Inter-American Magnet School
Scott Ahlman, Assistant Principal

Sawyer School
Gerald Gliege, Principal
Nelly Robles, Assistant Principal
Mary Ann Fischer, Teacher

Secundaria UPAEP
Lic. Maria Teresa Torreblanca Rios
Lic. Juan de Dios Peña Ortega, Teacher

Chicago Waldorf School
Carol Triggiano, Teacher

Community Consolidated School District 93
Stratford Middle School
Hank Gmitro, Superintendent
Tammy Prentiss, Principal
Paula Hennessey, Teacher

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CHAPTER ONE

Introduction and Background

The nature of a language's phonology and the relationship of that phonology to the script on the page affect visual word recognition. A number of different phonological factors may impact the process of lexical access when reading. Some of the key phonological factors that may impact lexical activation include the structure of syllables and words (Alvarez, Carreiras, and Taft, 2001; Domínguez, de Vega, and Cuetos, 1997), the clarity of syllables in the language (Cutler, Mehler, Norris and Seguí, 1986), the rhythm of the language (Cutler and Norris, 1988; Sebastian-Galles, Dupoux, Seguí, and Mehler, 1992), and the absence or presence of lexical stress (Harris, 1983; Lavar, 1994; Sánchez-Casas, 1996). In addition, factors concerning the relation of a language to the script that represents it that affect visual word access include the degree of correspondence between phonemes and graphemes (Ziegler, Stone, & Jacobs, 1997; Katz and Frost, 1992), and the relative size of the orthographic unit needed for lexical access (Ziegler and Goswami, 2005).

Crosslinguistic research, examining languages that vary in some these phonological and script factors, is essential to increasing our understanding of reading and how it is affected by and uses phonology and orthography. Additionally, studying reading cross-linguistically in bilinguals can help us understand whether they pursue different strategies in both languages and if exposure to different writing systems affects lexical access in one of the languages. The goal of the current research is to examine phonological processing in early visual word access by focusing on English and Spanish. This research goal will allow a better understanding of the nature of reading, allowing the development of appropriate teaching strategies to help second language learners, a topic of great importance in this age of increasing globalization.

Accordingly, in this first chapter we will first examine some of the most important phonological differences between English and Spanish that may affect lexical access in the two languages. Next we will turn to considering issues relating to the effect of bilingual status on readers. Then we will consider some questions about how reading changes developmentally as young readers become experienced. Finally, we will conclude discussing our research goals for the series of experiments reported below in Chapters Two and Three.

Phonological Issues

Previous research investigating visual word access of multisyllabic words has suggested that English and Spanish may differ in their use of the syllable as a unit of lexical access, with all evidence pointing to the syllable playing a key role in Spanish and with evidence for the syllable being somewhat more mixed in English.

Current phonological theory, backed by linguistic evidence, advocates the prosodic approach, in which phonological representations are depicted as multi-layered hierarchical structures (Blevins, 1995; Jensen, 2000; Nespor and Vogel, 1986; Selkirk, 1982). Based on phonological evidence, the theory posits strictly layered prosodic categories (with those that apply to words outlined in (1)). One or more units of each category may be contained in the next higher unit (Jensen, 2000).

(1) *Prosodic hierarchy:*
Prosodic Word (ω)
Foot (F)
Syllable (σ)
Mora (m)
Segment

A legitimate problem in researching reading is whether visual word access proceeds via the same representational structures as speech, which would entail a conversion of orthographic representations into phonological ones. Obviously, written text can be converted into phonological codes since it can be read aloud, but the questions are if conversion occurs automatically, at what stage in the process, or if the use of phonological codes can vary. For example, much debate has centered on how much readers take a holistic or whole word approach to reading, if they break the script down into constituent parts while reading, or if the unit of analysis varies according to reading skill (Coltheart, Curtis, Atkins, and Haller, 1993; Coltheart, Rastle, Perry, Langdon, and Ziegler, 2001; Plaut, McClelland, Seidenberg, and Patterson, 1996).

While some researchers have adopted the position that reading automatically makes use of phonological processes (e.g. Perfetti, Zhang, and Berent, 1992), few reading researchers have started from the theoretical perspective of investigating if reading exploits pre-existing phonological representations. Most researchers who have explicitly adopted the prosodic approach to phonology to study visual word access have investigated the segmental level, (e.g. Berent, Bouissa and Tuller, 2001), while Ashby and Rayner (2004) examined the syllabic level. The goal of the present research is to further study the syllabic level, by comparing visual word access cross-linguistically to see if languages vary in their use of syllables during reading or if some other prosodic level may be implicated in early word recognition processes.

Prior research findings suggest that Spanish and English differ in their use of syllables in lexical access during reading, perhaps following from Spanish being a syllable timed language, with relatively equal syllable weight and clearly defined syllable structure (Sánchez-Casas, 1996; Harris, 1983; Carreires, Alvarez, and de Vega, 1993), while English is a stressed timed language, with alternation between strong and weak syllables and less well defined syllables (Kahn, 1976; Rubach, 1996; Selkirk, 1982; Jensen, 2000).

As previously mentioned, prior research findings suggest that Spanish and English differ in their use of syllables in lexical access during reading. In Spanish, a large consensus of empirical results support the syllable as a key unit of visual lexical access. Empirical results consistently demonstrate that highly frequent syllables have an inhibitory effect on lexical decision times (Álvarez, Carreiras, and de Vega, 2000; Álvarez, Carreiras, and Taft, 2001; Álvarez, Carreiras, and Perea, 2004; Álvarez, de Vega, and Carreiras, 1998; Carreiras, et al., 1993; Carreiras and Perea, 2002; Domínguez, de Vega, and Cuetos, 1993; Perea and Carreiras, 1998), and naming times (Carreiras et al., 1993; Domínguez et al., 1993; Perea and Carreiras, 1998).

This inhibitory effect of high frequency syllables on lexical decision and naming tasks is most easily explained by assuming a model of lexical activation containing a syllabic level of processing, where syllables activate potential candidates or lexical nodes. High frequency syllables activate a larger cohort of potential candidates (having a larger syllabic neighborhood) and competition among the many candidates results in the inhibitory effect. However, subsequent research has modified this analysis, specifying that inhibition is caused mainly by the number of higher frequency words that share the same first syllable instead of the number of syllabic neighbors alone (Perea and Carreiras, 1998), meaning that inhibitory effects are always larger for low frequency words (Álvarez et al., 2000; Álvarez et al., 1998; Carreiras et al., 1993; Perea and Carreiras, 1998) –an interpretation that is wholly compatible with an activational model positing a syllable level.

Follow-up research indicated that while more frequent words presented as syllable primes had an inhibitory effect on target identification, non-word primes had a facilitatory effect, and masked partial identity primes that corresponded to the syllable boundary speeded response time on a lexical decision task in comparison to those that did not, clear evidence that the syllable is a key sub-lexical unit in visual word access in Spanish (Carreiras and Parea, 2002). For example, in their fourth experiment, Carreiras and Parea (2002) used a partial identity priming task with lexical decision to probe the importance of the syllable boundary in Spanish. The targets were six letter words with either CV•CV• CV or CVC•CVC structure. The primes either corresponded to the first syllable of the word or did not (eg. *pa****-PA•SI•VO* vs. *pas***-PA•SI•VO* and *pa****-PAS•TOR* vs. *pas***-PAS•TOR*). Comparing primes that corresponded to the syllable boundary to those that did not, CV• CV•CV words were responded to faster when preceded by CV primes than by CVC primes and CVC•CVC words had quicker response times when preceded by CVC primes than by CV primes, thereby demonstrating the role of the syllable in lexical access in Spanish.

Studies have demonstrated that the empirical syllable frequency effects cannot result from such potentially confounding factors as bigram frequency (Carreiras et al., 1993), orthographic neighborhood density/neighborhood frequency (Perea and Carrieras, 1998), and stress placement (Álvarez et al., 2002). More recently, experimental results using non-word primes that have the same phonological form but a different orthographic form as a target (i.e. *bi.rel-VI.RUS*) suggest that the syllable priming effect is phonological in nature and not orthographic (Álvarez et al., 2004). In fact, all results lead to the conclusion that the syllable based priming effect is real and that the syllable truly is an important unit of lexical access in Spanish.

In contrast to Spanish, evidence for the appropriate unit of visual word access is somewhat mixed in English. Some syllable based structures such as Vocalic Center Groups (where consonants are grouped around vowels to form pronounceable units) (Spoehr and Smith, 1973) and subsyllabic components of onset and rime (Bowey, 1990; Treiman, 1986; Treiman and Chafetz, 1987) have received empirical support as units of lexical access. In contrast, studies using short-term memory techniques have found that subjects are not consistent in their syllabification judgments of English words, with stress, vowel quality (tense vs. lax), and the sonority of the consonant affecting syllabification (Treiman and Danis, 1988a; Treiman and Danis, 1988b; Treiman, Straub, and Lavery, 1994). Syllabification that varies according to context could be interpreted as meaning that syllables are a less reliable source of information, meaning that readers would rely on them less in word access.

In a study using an illusory conjunctions technique, Prinzmetal and associates concluded that syllables were a perceptual unit in reading based on subjects generally reporting the color of a target letter as being the same as that of the syllable in which it was a part, even when the color was different (Prinzmetal and Millis-Wright, 1984; Prinzmetal, Treiman, and Rho, 1986). Seidenberg (1987) challenged Prinzmetal's findings of syllable based processing, claiming that the results were instead due to orthographic factors. Specifically, the illusion of syllable-based perception arose from bigram troughs, where the low co-occurrence of orthographic letters that span syllables supplied a signal to readers of a syllable boundary. In turn, Rapp (1992) challenged the bigram trough hypothesis, using the same task as Prinzmetal et al. (1986) with stimuli controlled for bigram frequency and demonstrating sensitivity to syllabic structure.

In addition, naming experiments examining syllables as units of visual access have produced inconsistent results. For example, Jared and Seidenberg (1990) studied the effects of word frequency, spelling consistency, and number of syllables on the speed of naming multisyllabic words where they presented words as either wholes or broken into syllables. They concluded that readers do not always segment or decompose words into syllables. Several of their research findings suggest that readers were not breaking words into subunits for lexical access: first, the naming of higher frequency words was not affected by spelling inconsistency, favoring a whole word lexical access interpretation; second, in comparison to a whole word presentation, subjects shown both high and low frequency words with a syllable by syllable division experienced increased naming latencies, suggesting that subjects do not use syllables for lexical access, since breaking words down into syllables actually impeded response times; and third, word length (number of syllables) only affected naming latencies for lower frequency words, also casting doubt on the consistent use of syllables in visual word access.

In a masked priming experiment, Ferrand, Seguí, and Humphreys (1997) compared the effect of CV and CVC primes on the naming of words with a clear syllable boundary to those with an ambisyllabic boundary. They found that syllable based priming effects vary according to the clearness of the syllable boundary, suggesting that English readers vary in their use of syllables and do not consistently segment words into syllables or that syllables come into play in a later stage involving phonological encoding. Primes corresponding to the first syllable speeded naming of multisyllabic words with a clear first syllable boundary, but had no effect when the boundary was not clear. In contrast, the results of Experiment 5 in Ferrand et al. (1997) hinted that syllables may aid word recognition. In this experiment, they found that CV primes had a greater facilitative effect on the naming of words where the first syllable corresponded to CV than CVC primes, leading them to conclude that the facilitation was due to syllabic overlap and not due to phonological or orthographical overlap.

Replicating the materials, design and procedure of Experiment 5 from Ferrand et al. (1997), Schiller (2000) failed to find any statistical difference between CV, CVC, and neutral primes on the naming latencies of words beginning with CV syllables, with CV and CVC primes having equal effect and testing only a millisecond faster than neutral primes. Schiller (2000) also failed to replicate by increasing statistical power, having each participant complete all three experimental blocks two times –meaning that each participant saw every target six times. Only CVC primes facilitated naming of targets in comparison to neutral primes, suggesting that the facilitation was due to segmental overlap rather than syllables. Overall, the results from naming experiments are contested and do not clearly support an important role for syllables in visual word access.

Relatively few experiments have used lexical decision to examine the importance of syllables to visual word recognition in English. Ferrand et al. (1997) failed to find any effect of syllable based primes on lexical decision times. This result led them to conclude that syllable based effects were in output instead of lexical access processes.

Recently, Ashby and Rayner (2004) used eye-tracking in two experiments to examine if syllable information was used to read words (with either a CV or CVC first syllable) presented as a part of a continuous text. In the first experiment, they compared the effect of syllable matching, non-syllable matching, and neutral primes presented just before eye saccades reached the target word, finding that target words were read faster when preceded by CVC primes regardless of the syllable boundary. In their second experiment, they used the same materials, but changed the technique, having the primes constantly present in the text while the subjects were reading, and the presentation of the whole word being triggered by saccades just prior to reaching the target. With the changed technique, subject's first fixations on target words were shorter when primes corresponded to the syllable boundary, leading Ashby and Rayner to claim that readers do use syllabic information while reading. They further argued that Experiment 2 focused on later processes of word recognition and that syllable structures come into play in these later stages of word recognition in English, having to do with spoken output or short-term memory storage. They suggest that this use of syllabic information in later stages involving phonological assembly accounts for the previous inconsistent experimental results for syllables in visual word access in English, with some methods taping into early processes and others into later ones.

All in all, the experimental evidence supporting the role the syllable in visual lexical access in English is not entirely consistent and suggests that its use may come at a later stage, in marked contrast to Spanish –suggesting that the two languages differ in their use of prosodic representations in visual word access. In fact, the precise unit of visual word access in English is a matter of some contention, with some proposing a larger orthographically and morphologically based unit (Taft, 1979), others arguing against pre-lexical morphological decomposition (Butterworth, 1983; Cole, Beauvillain, and Seguí, 2000; Lukatela, Gligorijevic, Kostic, and Turvey, 1980), others claiming full morphological decomposition (Taft and Forster, 1975, 1976; Taft, 1994), and some claiming a mixed model dependent on prior knowledge of the word (Chialant and Caramazza, 1995). Recently, Ziegler and Goswani (2005) put forward that the access unit in English can vary greatly in grain size, with readers flexibly making use of both small size units and larger units owing to the degree of orthographic inconsistency. Overall, the unit of reading lexical access in the two languages appears to vary, with Spanish readers clearly exploiting the syllabic level of the prosodic hierarchy and English readers more commonly exploiting a larger unit.

Bilingual Reading

What kind of adaptation do bilingual readers of alphabetic languages make to the different languages that they are reading? Do they get the same phonological information out of letters regardless of which language they are reading? Do they follow the same pathway to visual lexical access as monolingual readers in both of the languages? These are some of the questions that are important to address in order to better understand how bilinguals adjust to reading in two scripts.

Most research that has examined literacy in bilingual readers has focused on if the accomplishment of knowing two languages confers some sort advantage in terms of metalinguistic awareness –generally finding an advantage in terms of word awareness and syntactic awareness (e.g., Ben Zeev, 1977; Bialystok, 1988; Galambos and Goldin-Meadow, 1990). The few studies that have studied phonological awareness in bilinguals have found an early advantage over monolinguals that diminishes with the onset of literary instruction (Bruck and Genessee, 1995; Yelland, Pollard, and Mercuri, 1993). This decrease in bilingual advantage that accompanies literary instruction is directly related to the language of instruction, with monolinguals and bilinguals developing similar phonological awareness after literary begins when the language of instruction is controlled for (Bialystok, Majumder, and Martin, 2003). Most importantly, any bilingual advantage in phonological awareness has been found to interact with the relationship between the two languages and the nature of their writing systems. In particular, one study showed that first and second grade English-Spanish bilinguals outperformed English monolinguals who in turn outperformed Chinese-English bilinguals in a phoneme segmentation task (Bialystok, et al., 2003).

This notion of the nature of the script affecting lexical access is key to the present study and one that has been approached in three distinct manners. First, some have argued that the consistency of mapping between graphemes or phonemes or opacity of the script may affect lexical access, particularly the use of phonology in lexical access when reading in a writing system that is more opaque (Katz and Frost, 1992). Some experimental evidence comparing monolinguals in languages with scripts of varying opacity suggests that monolingual readers differ in their access of phonology and that readers of opaque scripts are less reliant on phonology (Frost, Katz, and Bentin, 1987; Kang and Simpson, 1996). In addition, studies of monolinguals with reading difficulties have previously found that the nature of the script can affect the manifestation of reading deficits –with some suggesting that dyslexia is less prevalent in languages with closer letter-sound correspondences or a more transparent script (Lindgren, De Renzi, and Richman, 1985) and other claiming that dyslexics in all languages demonstrate a similar degree of disability in comparison to normal readers in their own culture (Paulesu et al., 2001; Ziegler, Perry, Ma-Wyatt, Ladner, and Schulte-Körne, 2003).

Recently, Ziegler and Goswami (2005) proposed a grain size theory of reading, in which readers of transparent scripts such as Spanish are more reliant on small grain size units, such as the phoneme, using the highly consistent grapheme-phoneme correspondences to efficiently convert the letters into phonemes and to gain lexical access. In comparison, readers of scripts with poor sound-letter correspondence, such as English, are forced to be flexible in the unit or grain size of lexical access, at times relying on small grain size grapheme/phoneme conversion, while in others relying on larger units such as onset/rimes and words. In support of the theory, they point to evidence that monolingual readers of transparent scripts reach ceiling in word recognition tasks within the first year of literacy instruction, whereas English accuracy is much lower (Bruck, Genesee, and Caravolas, 1997; Ellis and Hooper, 2001; Frith, Wimmer, and Landerl, 1998; Goswami, Gombert and De Barerra, 1998; Seymour, Aro, and Erskine, 2003) and research findings that suggest that English readers a more sensitive to units that are larger in grain size in comparison to readers of transparent scripts (Brown and Deavers, 1999; Goswami Ziegler, Dalton, and Schneider, 2001; Goswami, Ziegler, Dalton, and Schneider, 2003).

Next, research looking particularly at bilinguals includes studies of lexical access which support the hypothesis that literacy skills acquired in one language transfer to a second (e.g., Cummins, 1979, 1984; D'Angiulli, Siegel, and Serra, 2001), and particularly with respect to phonological awareness for languages that follow the alphabetic principal (Branum-Martin et al., 2006).

Third and most importantly to the present study, some research has directly examined how bilinguals adapt to reading in different languages. Most of these studies have tested if script differences between alphabetic, syllabic, or logographic writing systems affect lexical access in a second language –with results that suggest that the nature of an L1 script may affect phonological access in L2 reading (e.g. Koda, 1989; Saito, Inoue, and Nomura, 1979; Wang, Perfetti, and Liu, 2003; Wang, Koda, and Perfetti, 2003).

Very little research has examined bilingual readers in both languages to see if their reading varies in them or has compared them directly to monolinguals to see if lexical access varies according to bilingual status. Some have examined the speed and ease of bilingual readers in both their languages, finding that their reading was generally superior in L1 (e.g. Favreau, Komoda, and Segalowitz, 1980; Favreau and Segalowitz, 1983), but that this difference in speed can be affected by the nature of the scripts (Shimron and Sivan, 1994). Recently, research examining English/Hebrew bilingual dyslexics in both languages suggested that the reading deficits manifest themselves in both languages, but that the specific nature of the scripts causes the degree of the deficit to be different in both languages (Oren and Breznitz, 2005).

In summary, the nature of a writing system and its relationship to the language that it represents does appear to affect lexical access for bilingual readers, forcing them to adapt their word activation to the script in each of their languages. While bilinguals are forced to adapt their visual word access to the information available in the writing system being read, exposure to one script may affect another, meaning that bilingual readers' phonological access may differ from that of monolinguals in the same languages. Important questions are the directionality of the effect of one language on another and if it is affected by language dominance.

Developmental Reading

Another important consideration in considering visual word access and the use of phonology in bilingual and monolingual reading is the development skill level of readers. The manner in which words are visually accessed varies according to the skill level of the readers, with skilled readers developing phonological representations particular to the language and script that they read as they perfect the pathway of visual word access. In fact, developing language learners seem to make a generalized, sequential progression from sensitivity to larger phonological units to increased sensitivity to smaller phonological units even before beginning to learn literacy skills. In tasks designed to test knowledge of different phonological levels, children master word-level skills before syllable-level skills, syllable-level skills before onset-rime level skills, and onset-rime level skills before phoneme-level skills (Anthony and Lonigan, 2004; Anthony, Lonigan, Burgess, Driscoll, Phillips, and Cantor, 2002; Stanovich, 1992; Treiman and Zukowski, 1996). The finest grained level, phoneme awareness, only appears to develop when children are explicitly taught to break words into phonemes during literacy instruction. Thus children are only successful at tasks that involve phoneme segmentation when they are beginning to learn to read and write, perhaps because individual phonemes are less salient in speech (Goswami and Bryant, 1990; Zeigler and Goswami, 2005).

This progression of sensitivity from larger to smaller phonological units is generalized in the process of literacy acquisition. In the first stages of learning to read, young children are more sensitive to the onset-rime distinction than to individual phonemes (Goswami, 1988). In addition, even with increased awareness children take time to develop automaticity in using the appropriate phonological representations for the language and script they are reading. Three important factors seem to affect differences in development in reading in languages: the consistency of sound-letter relationships, the grain size of the appropriate orthographic and phonological representations and teaching methods (Zeigler and Goswami, 2005).

In English, developing readers need to develop a sensitivity to multiple levels of grain size, since the phoneme level provides inconsistent information due to the poor correspondence between graphemes and phonemes in written English. In contrast, more reliable information regarding the pronunciation of English words can be obtained at the level of rhymes, with evidence showing that children begin to develop a special sensitivity to this larger grained level (Treiman, Mullenix, Bijeljac-Babic, and Richmond-Welty, 1995). For this reason, skilled English readers develop sensitivity to multiple grain levels, with even young developing readers aged 7, 8, and 9, showing signs of using both larger units and smaller units simultaneously in phonological access in comparison to readers of a language such as German, where fine-grained units provide accurate information and the stimuli were controlled structurally to allow German readers access to higher level grain sizes if they needed it (Goswami, Ziegler, Dalton, and

Schneider, 2003). Since German is comparable to Spanish in its degree of correspondence between graphemes and phonemes and beginning readers both show high accuracy levels in word reading after the first year of literacy instruction (Seymour et al., 2003), arguably Spanish and German pattern similarly in contrast to English with respect to the grain size used by developing readers.

In general, developing readers of English and Spanish appear to develop phonological representations along somewhat different trajectories due to the differing natures of the two languages and the varying correspondence between the languages and the scripts with which they are written. English readers develop phonological access through larger units such as rhymes, as well as working on acquiring sensitivity to fine grained units such as phonemes. In contrast, Spanish readers are more sensitive to the fine-grained level of phonemes, since the script has good sound/letter correspondence. In addition, they develop greater sensitivity to syllables, due to the clear quality of syllables in Spanish and the fact that the traditional teaching of literacy in Spanish emphasizes syllables (the syllable segmentation and blending method) (Denton, Hasbrouck, Weaver, and Riccio, 2000). Since younger readers in both languages are still working on developing activations and representations of the language appropriate phonological levels to gain lexical access, their use of these levels will not be as fully developed as in adults.

Research Goals

In order to understand if English and Spanish readers differ in their use of phonological representations in visual word access, a direct comparison of reading in the two languages is needed. Bilinguals offer the most direct comparison of reading in the two languages since the same subject is reading in both languages. Such subjects will also allow an investigation into whether bilinguals vary their reading practices in their two languages, a question that has received scant prior attention. Accordingly, the goal of the present research is to compare visual word access in bilingual readers.

Additionally, a direct comparison of bilinguals to monolinguals in the two languages will help determine more precisely how the two subject populations differ in their lexical access. The differences in phonological structure between two languages should cause both types of readers to lexically activate words in a similar manner to one another, but in a different fashion in the two languages –meaning that bilinguals will activate words in a language determined manner comparable to monolingual readers in both languages. In other words, bilingual readers will adapt to the structure of the language, accessing word through the phonological level that provides the most accurate information and best lexical access in both languages.

Finally, reading may vary between adult and developing readers, with adult bilingual readers having more completely developed phonological representations at the appropriate level in both languages. Whereas children, whether they are monolingual or bilingual, may not be completely adapted to the language that they are learning to read in, needing more time and practice to develop appropriate phonological access skills.

In summary, the goal of the present research is to examine visual word access in two languages, by comparing adult and children bilingual and monolingual readers to see if differences in phonological structure between two languages cause readers to lexically activate words in different manners in the two languages. Examining and comparing visual word access in these subject populations will help reveal the nature of visual word access in both languages, in monolingual and bilingual readers, and in skilled and developing readers.

CHAPTER TWO

Experiments 1 and 2: CV and VC Priming

Skilled adult readers have fully developed phonological representations for the language that they have learned to read. Expert adult bilingual readers, in particular, will have acquired visual word access skills in both of their languages. Directly comparing adult bilingual readers in both of their languages will allow us to measure if they vary in the phonological units of lexical access in either of their languages and to understand if the phonological structure of the language and the nature of the script affects visual word access. Additionally, such a comparison will allow a greater understanding of how visual word access may vary in bilingual readers in their two languages. The two experiments presented in this chapter will compare units of activation in adult bilingual readers in English and Spanish, with the first experiment focusing on priming within the first syllable and the second on priming across the syllable boundary. We start with the following hypotheses: first, the different phonological structures of the languages means that adults will exploit different units of lexical access in English and Spanish, depending on a larger unit in English and activating words via syllables in Spanish; second, bilinguals will adapt the unit of activation that they use to the language that they are reading, exploiting different units in both languages.

Experiment 1

Priming within the first syllable of similar words in both languages will test whether bilingual readers differ in their use of syllables in lexical access in reading in the two languages and if bilingual readers vary in their use of phonological representations as they access words. We predict that bilingual readers would access differing information while reading in their two languages, with readers in Spanish decomposing words into syllables in lexical access and readers in English using some larger phonological unit. Priming the first syllable in Spanish should help readers gain access to the first syllable, but not any larger chunk of the word. In contrast, in English, syllabic information seems to be accessed later in word recognition processes and previous research suggests that readers use some undetermined larger unit for lexical access –meaning that priming the first syllable will help readers identify a larger unit. For this reason, we will compare bilingual readers' accuracy in recognizing syllables (CV) and all possible larger units, including first consonant/first vowel/second consonant (CVC) and word, predicting that priming will help Spanish readers identification of CV and that English readers' identification of CVC or word will be facilitated.

Method

Subjects: Twenty-six Bilingual English and Spanish readers recruited at Northwestern University and in the Chicago metropolitan area participated in the experiment. They were paid $8 for the hour-long experiment. Two subjects were excluded from analysis because their standardized reading scores fell two standard deviations below the norm in either English or Spanish, leaving twenty-four subjects. The sample included 12 men and 12 women. The average age of participants was 30.9 years old.

Design and Materials: This study used a partial identity masked priming task. Equivalent materials in both languages for all test conditions were developed. The stimuli consisted of two syllable words phonologically fitting the schema of CVCV, with stress on the first syllable. Orthographically, 30 words in English fit the pattern CVCV and 30 fit the pattern CVCVC. All 60 Spanish stimuli fit the orthographic and phonological pattern CVCV. The orthographic difference between English and Spanish arose from the limited number of orthographic CVCV words in English with stress on the first syllable. Obvious cognates were excluded from the stimuli in both languages. (See Appendix One for a list of the stimuli used.)

The stimuli were controlled for their word frequency and bigram frequency using the CELEX database for English (Baayen, Piepenbrock, and Gulikers, 1995) and the Diccionario de frecuencias de las unidades lingüísticas del castellano (Alameda and Cuetos, 1995) for Spanish. The word sets showed no significant difference between the two languages for word frequency and for token frequency for the first two bigrams (Table 1)[1]. The difference between the two languages for the last bigram's token frequency follows from the fact that relatively few letters can appear in word final position in Spanish. For this reason, we will confine our statistical analyses to the first two bigrams.

Bigram	**Language**	**Mean**	**SD**	**Significance**
CVxx	English	935.4	792.5	
	Spanish	1279.6	2041.7	p = .226
xVCx	English	951.4	1228.2	
	Spanish	1223.2	1792.5	p = .335
xxCV	English	946.5	973.9	
	Spanish	2185.9	2126.0	p = .000

Table 1: Bigram Token Frequency

Additionally, all stimuli were controlled for the token transitional probabilities of letters, with no significant difference between languages (Table 2). Within both languages, there was a significant difference between the transitional probability of the first two letters and the second

[1]The two sets of stimuli did have a significant difference in type frequency between the different bigrams. The mean type frequency for the first bigram for English was 37.37 and for Spanish was 9.80, yielding a significant difference of $p < .001$. For the second bigram, the mean in English was 27.55, and in Spanish it was 8.43 ($p < .001$). For the last bigram the mean type frequency for English was 29.33 and for Spanish 14.28 ($p < .001$). While both type and token frequency are important, token frequency, or how much the bigrams appear together in actual discourse, is more important than type frequency since it is an estimate of how much people in reality see the two letters.

two letters in both word sets (p < .001), but no significant difference existed between languages in either word set for this difference.

Bigram	Language	Mean	SD	Significance
CVxx	English	.21	.16	
	Spanish	.25	.19	p = .169
xVCx	English	.07	.08	
	Spanish	.09	.13	p = .380

Table 2: Token Transitional Probability

Procedures: Testing took place in a sound isolation booth on Northwestern University's Evanston campus. The test session lasted about an hour for each subject. Subjects were randomly assigned to whether they completed the English or the Spanish part of the testing first. When they were in either the Spanish or the English condition, the experimenter spoke to them in only that language. Before beginning the experiment in each language, the subjects took standardized tests in both languages to determine their reading level. In English, the Letter Word Identification (LWI) and the Passage Comprehension (PC) sub-tests from Woodcock Reading Mastery Test were used, while in Spanish the equivalent sub-tests from the Batería Woodcock-Muñoz were adopted (Woodcock, 1987; Woodcock, and Muñoz, 1995).

Subjects viewed all stimuli for the priming task on a SVGA monitor in a darkened room, with a desk lamp on the floor providing background ambient lighting. The Apple computer used Psyscope software designed to control the priming experiment (Cohen, MacWhinney, Flatt, and Provost, 1993). Subjects pressed an external button device to see the next presentation, controlling the stimulus presentation rate and recording their responses by writing on a test sheet.

Subjects saw different primes that corresponded to the first consonant of the word (C###), the first vowel (#V##), the first syllable (CV##), or, in the control condition, a series of number signs. The primes and the targets matched up in the manner demonstrated in Table 3.

Additionally, four counterbalancing conditions were presented at random to different subjects. The different counterbalancing conditions varied the primes that were shown with different words. Balanced presentation of stimuli ensured that each participant saw each condition equally often and that each item was preceded by each prime type equally often. Subjects viewed stimuli within each counterbalancing condition in a randomized order of presentation.

Status	Prime	Target
Test Conditions	S###	sofa
	#O##	sofa
	SO##	sofa
Control	####	sofa

Table 3: Experimental Conditions in Experiment 1

Subjects viewed primes and targets on a standard black background with white letters. The subjects first saw a fixation cross on the computer screen before each trial, and the participant was asked to press an external button box to begin each trial. When they triggered the trial, they then saw the prime in upper case letters and the target in lower case letters flash on the computer screen for 16 ms. each followed by a series of number signs for an additional 500 ms. The presentation of lower and upper case letters helped ensure that the task was not simply visual priming, but instead accessing abstract letter representations. The rate of presentation ensured interpretable accuracy levels (Berent and Perfetti, 1995; Lukatela and Turvey, 2000; Perry and Ziegler, 2002). Previous findings have held that less than 40% accuracy for word identification precludes strategic processing with this technique (Xu and Perfetti, 1999).

Before beginning each part of the experiment, subjects completed a practice set of four examples. The subject read instructions presented on the computer screen and the experimenter discussed them with the subject to ensure understanding before beginning the practice set. Subjects were instructed to do their best to guess even if they were uncertain of what they had seen. They were reminded of the importance of writing words with the appropriate number of letters for all trials. After completing the experiment, the researcher asked them questions about their language background, recording their answers on a Language Background Questionnaire. (See Appendix Two for samples.)

Results

Subjects: The results from the standardized tests of reading show that the subjects who participated in this experiment were overall English dominant and are summarized in Table 4 below, reporting the mean Standardized Score (SS) and the SD for the subjects on each sub-test. The SS on this test is based around 100, with half the participants in a particular age range scoring either higher or lower during norming. The SD of the sample population during norming was 15 points. Using the SD value from the normed test, we defined language dominance according to the following criteria: English and Spanish dominants had scores greater than 2/3 of a SD on both the LWI and PC in their dominant language, while balanced bilinguals had scores on at least one test with less than 2/3 of a SD between the two languages or scores greater than 2/3 of a SD on both tests, but with one test greater in each language. According to this analysis, 11 subjects were English dominant, 11 were balanced bilinguals and 2 were Spanish dominant. The subjects' English dominance was confirmed by t-tests comparing their scores in the two languages, with a significant difference in scores for the PC subtest ($t(46) = 2.74$, $p = .009$) and with the difference in scores approaching significance for the LWI subtest, ($t(46) = 1.99$, $p = .053$).

Letter Word ID –English	**Passage Comp. –English**	**Letter Word ID –Spanish**	**Passage Comp. –Spanish**
110.29 (18.65)	112.58 (20.09)	101.08 (12.96)	98.46 (15.36)

Table 4: Results of Standardized Tests for Experiment 1

Similar results were obtained from the Language Background Questionnaire, which was administered to each subject after they completed the experiment. Their responses are summarized in Table 5. From the questionnaire, 14 subjects' first language was Spanish, while 8 learned English first and 2 Portuguese. The average age when subjects learned their second language was 13 years old. Most subjects had spent far more time in an English speaking country than in a Spanish speaking one (20.3 vs. 8.8 years). Finally, subjects' self-rating of their language proficiency in English was higher than their rating of their proficiency in Spanish (5.3 vs. 5.0).

L1	**Age learned L2**	**Years in English Country**	**Years in Spanish Country**	**Self-Proficiency Rating (1-6)**
14 Spanish 8 English 2 Portuguese	13.0 (8.0)	20.3 (16.1)	8.8 (11.7)	English 5.3(0.97) Spanish 5.0(1.05)

Table 5: Results from the Language Background Questionnaire for Experiment 1

Priming Task: For each language and prime type accuracy levels in identifying first consonant/first vowel (CV), the first consonant/first vowel/second consonant (CVC), and words were calculated and averaged according to subjects and items. While Table 6 reports subject data, giving the accuracy of recognizing the different units and the standard error in parentheses, we report statistically significant findings for both the subject and the item analyses. We analyzed independent identification of all three units to see if they were identified on their own. Independent identification means that we are defining identification of the CV, for example, as being when uniquely those letters together were correctly recognized, without being a part of any larger unit.

2 x 2 x 2 ANOVAs (the first consonant primed vs. unprimed x the first vowel primed vs. unprimed x English vs. Spanish) examined accuracy of identification of CV, CVC and word units, with language as a within subject factor and a between item factor.

Language	Prime	CV	CVC	WORD
English	**C###**	23.07(2.19)	3.01(.87)	28.91(4.78)
	#V##	12.37(1.61)	1.38(.56)	15.36(3.28)
	CV##	49.33(4.78)	3.76(1.04)	36.79(5.35)
	####	8.55(1.69)	0.60(.41)	15.07(3.68)
Spanish	**C###**	32.37(3.30)	2.72(.77)	26.64(5.57)
	#V##	11.76(2.31)	3.05(.90)	16.70(4.07)
	CV##	59.90(4.22)	3.39(.83)	29.65(4.24)
	####	9.00(1.87)	1.86(.71)	16.48(4.30)

Table 6: Accurate responses according to prime types (with standard error) for Experiment 1

For CV identification, all three main effects were significant. The main effect of priming C was significant according to subjects ($F(1,23) = 146.56$, $p < .001$) and items ($F(1,118) = 272.01$, $p < .001$). The main effect of priming V was also significant according to subjects ($F(1,23) = 40.24$, $p < .001$) and items ($F(1,118) = 94.83$, $p < .001$). In addition, CV identification was greater in Spanish, with the main affect of language significant according to subjects ($F(1,23) = 4.62$, $p = .042$) and marginally significant according to items ($F(1,118) = 3.48$, $p = .064$). The interaction between C Primes and V Primes was significant according to subjects ($F(1,23) = 35.17$, $p < .001$) and items ($F(1,118) = 70.69$, $p < .001$), with CV## primes (and to a lesser extent C### primes) resulting in greater recognition of CV in comparison to the other primes. Finally, the interaction between C primes and language was significant according to subjects ($F(1,23) = 7.21$, $p = .013$) and items ($F(1,118) = 7.14$, $p = .009$) –with C Primes leading to increased identification of syllables in Spanish in comparison to English.

In order to tease apart the interaction between C primes and language and to examine the effect of individual primes, we ran paired sample t-tests for subjects and independent sample t-tests for items and present the identification rates of CV based on different prime types in Figure 1. The t-tests show that both C### and CV## primes result in significantly greater accuracy of identification of syllables in Spanish. For C### primes, CV identification was significantly greater in Spanish according to both subjects (t(23) = 2.41, p = .012) and items (t(118) = 2.30, p = .012). Also CV## primes resulted in significantly greater identification of CV in Spanish according to both subjects (t(23) = 2.19, p = .02) and items (t(118) = 2.17, p = .016). In contrast, #V## primes and #### primes did not result in significantly different identification of CV between languages (Figure 1). These results support the hypothesis of greater use of syllables in visual word access in Spanish.

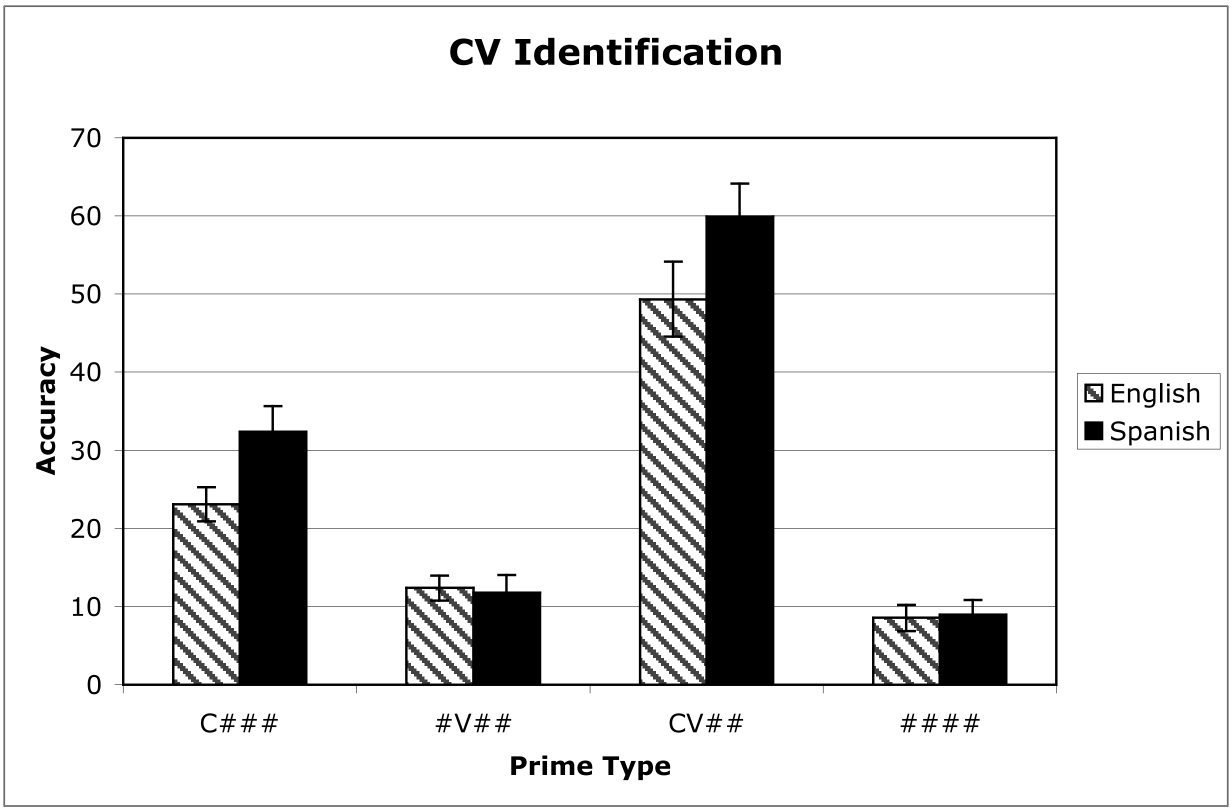

Figure 1: The effect of the various prime types on CV identification in English and Spanish.

Turning to identification of CVC the only significant result was the main effect of C primes which significantly affected accuracy in identifying CVC according to subjects (F(1,23) = 5.69, p = .026) and items (F(1,118) = 4.05, p = .046).

For word identification, the main effect of C primes was significant according to subjects (F(1,23) = 53.83, p < .001) and items (F(1,118) = 68.14, p < .001). According to both subjects (F(1,23) = 3.82, p = .063) and items (F(1,118) = 3.48, p = .064), word identification was marginally aided by V primes. The interaction between C Primes and V Primes was significant according to subjects (F(1,23) = 5.44, p = .029) and marginally significant according to items (F(1,118) = 3.27, p = .073), with C### and CV## primes resulting in greater recognition of the word than the other primes. Finally, the interaction between C Primes and Language approached significance for both subjects (F(1,23) = 3.20, p = .087) and items (F(1,118) = 3.32, p = .071), with greater priming effect of C primes in English.

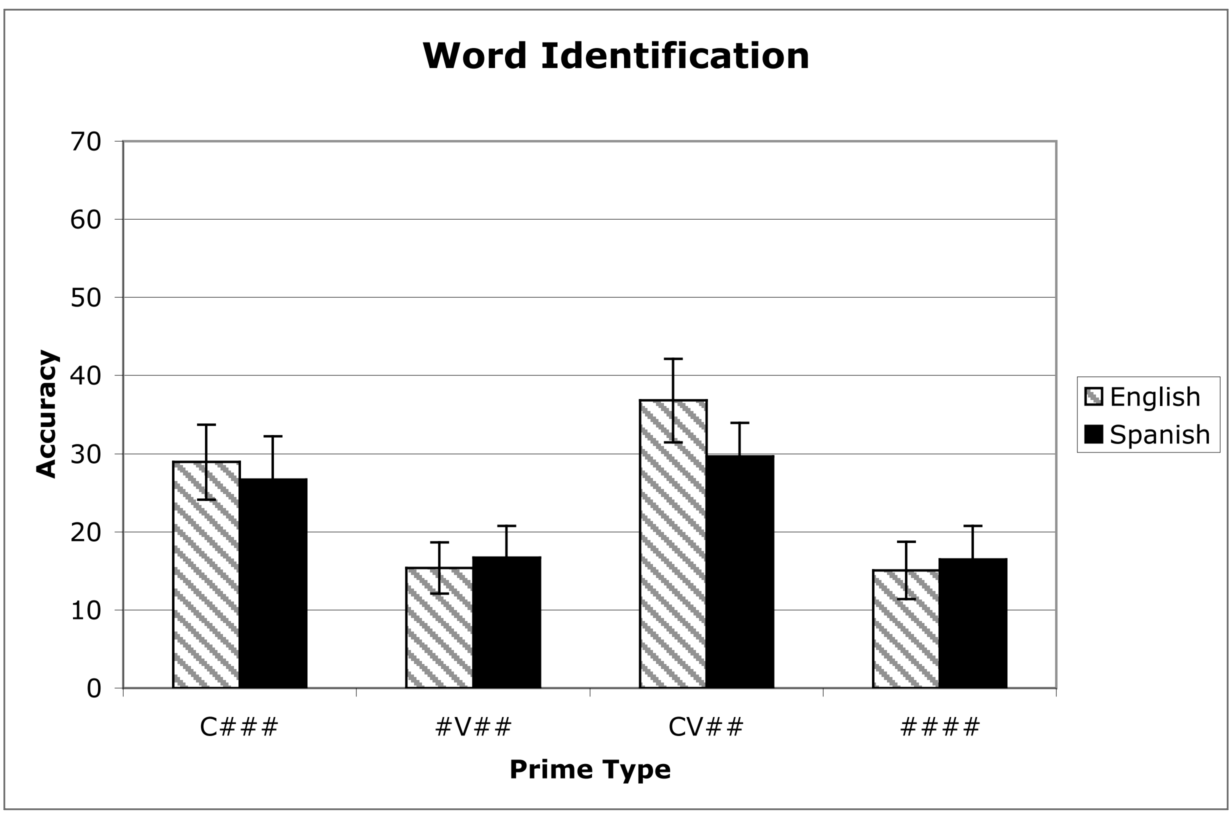

Figure 2: The effect of the various prime types on word identification in English and Spanish

Paired sample t-tests for subjects and independent sample t-tests for items further tested the interaction between C primes and language and looked at the effect of the different prime types. The effect of the individual primes is demonstrated in Figure 2, which presents identification rates of words based on different prime types. According to the t-tests, CV## primes resulted in marginally significantly greater word recognition in English according to subjects (t(23) = 1.370, p = .092) and items (t(118) = 1.538, p = .064). Other prime types did not result in statistically significant different rates of word identification between languages. The results support the hypothesis that English readers use a unit larger than the syllable in visual word access.

Language		**CV**	**Word**	**Total**
English	Count	83	103	186
	Expected	93	93	186
Spanish	Count	116	96	212
	Expected	106	106	212
Total	Count	199	199	398
	Expected	199	220	720

Table 7: χ^2 table for C### primes

In order to further test if subjects were more likely to recognize words over syllables in English and more likely to recognize the syllable as opposed to a larger unit in Spanish, we examined the recognition totals for CV and Word in a χ^2 test statistic for all prime types. For C### primes, the actual counts and the expected counts are reported in Table 7 and χ^2 (1, 398) = 4.04, p = .045, providing evidence to conclude that the units that are recognized are different in the two languages. For CV## primes, the actual counts and the expected counts are reported in Table 8 and χ^2 (1, 633) = 6.11, p= .013, leading to the conclusion that unit recognized varies in the two languages. For both #V## primes and #### primes, this result was not significant (respectively χ^2(1, 204) = .28, p= .598 and χ^2(1,176) = .033, p= .857), allowing us to conclude that there is no difference in recognition unit given these primes in either language.

To test if dominance affected performance, we contrasted the balanced bilinguals and the English dominant subjects, entering the results into a 2 x 2 x 2 x 2 ANOVA (C-prime x V-prime x language x dominance). The two Spanish dominant subjects were excluded from this analysis, to create two clear categories. No main effects of dominance were significant, nor were any interactions between dominance and any other main effects.

Language		**CV**	**Word**	**Total**
English	Count	178	133	311
	Expected	193.1	117.9	311
Spanish	Count	215	107	322
	Expected	199.9	122.1	322
Total	Count	393	240	633
	Expected	393	240	633

Table 8: χ^2 table for CV## primes

Discussion

The results of this experiment are consistent with the hypothesis that readers in Spanish access words through syllables, while readers in English use some larger unit. They also support previous research findings demonstrating the importance of the syllable in Spanish for lexical access and further suggest that English readers do not use this level of the prosodic hierarchy in the initial stages of visual word access. Both C### and CV## primes resulted in greater recognition of syllables in Spanish in comparison to English, whereas the results suggest that these primes may aid recognition of larger units in English. However, the results are not unequivocal for English, with ANOVA results that show only marginally significant greater word identification in English –with only marginally significant greater word identification in English given CV## primes confirmed by t-tests. Regardless, the chi squared test statistic confirms that readers in English and Spanish are recognizing different units given C### and CV## primes, providing further evidence that readers of English and Spanish use different levels of the prosodic hierarchy for initial lexical access.

Showing subjects C### and CV## primes in Spanish clearly helped them identify the CV or syllable significantly more than English readers, further confirming the importance of the syllable as a subunit of lexical access in Spanish, as found in prior experiments (Álvarez, et al., 1998; Álvarez et al., 2000; Álvarez et al., 2001; Álvarez et al., 2004; Carreiras et al., 1993; Carreiras and Perea, 2002; Domínguez et al., 1993; Perea and Carreiras, 1998). Because syllables are a key unit of early lexical access and Spanish readers are parsing words into syllables in the early stages of visual word recognition, giving Spanish readers information about the first syllable did not help them identify the word as much as it did English readers. Instead, because Spanish readers exploit the syllabic level of the prosodic hierarchy in early lexical access, priming within the first syllable helped Spanish readers identify significantly more first syllables.

The finding that CV## primes may have aided English readers to access a larger unit such as the word in comparison to Spanish suggests that experienced English readers are less reliant on parsing words into syllables at an early stage of lexical access and that the precise unit of lexical word access may not be as fixed as in Spanish. This agrees with previous studies that have found inconsistent evidence for the role of the syllable or that the syllable is more important in later stages of visual word access in English (Ashby and Rayner, 2004; Ferrand et al., 1997; Jared and Schiller, 2000; Seidenberg, 1987). The brief identification experimental technique is argued to tap into early word recognition process, as opposed to lexical decision and naming, so the syllable seems to be not critical for initial processes. The findings also agree with previous research into visual word access in English that suggests that English readers utilize some larger unit than the syllable to access words while reading (Butterworth, 1983; Chialant and Caramazza, 1995; Cole, et al., 2000, Lukatela, et al., 1980; Taft and Forster, 1975, 1976; Taft, 1979, 1994; Ziegler and Goswami, 2005). Because English readers may not use the syllabic level of the prosodic hierarchy in initial word access, priming within the syllable has little effect on their recognition of syllables.

Experiment 2

In order to further probe the differences in lexical access between the two languages and the differing exploitation of the syllabic level of the prosodic hierarchy, we decided to prime across the syllable boundary in Experiment 2, priming the first vowel/second consonant of the word (VC). Following from the differences in the use of prosodic information in early word recognition between the languages, showing readers information across the syllable boundary should have divergent effects in the two languages. In Spanish such priming crosses an important unit of word recognition, the syllable. Because such primes do not respect the level of the prosodic hierarchy used for early word recognition in Spanish, showing them such conflicting information should not aid their identification of syllables –meaning that in general Spanish lexical access will not be faciliated. In contrast, since evidence points to English readers' use of some larger unit in the prosodic hierarchy than the syllable in early word access, cross syllable primes should help their recognition of CVC or words.

Subjects: Twenty-seven Bilingual English and Spanish readers recruited at Northwestern University and in the Chicago metropolitan area participated in the experiment. They were paid $10 for the hour-long experiment. The standardized measures to determine language proficiency and reading level in both languages resulted in the exclusion of one subject from analysis because of standardized scores two standard deviations below the norm in either English or

Spanish, leaving twenty-six subjects. Two additional subjects were unable to perform the experimental task, by not providing complete words in their answers, leaving 24 subjects. The sample included 13 men and 11 women. The average age of participants was 31.5 years old.

Design and Materials: The task and the test words were the same as in Experiment 1. The only differences were in the primes. In the present experiment, subjects saw different primes that corresponded to the first vowel (#V##) of the word, the second consonant (##C#), the first vowel/second consonant (#VC#) together, or, in the control condition, a series of number signs. The primes and the targets matched up in the manner demonstrated in Table 8. The four counterbalancing conditions and the randomization were the same as in Experiment 1.

Status	**Prime**	**Target**
Test Conditions	#O##	sofa
	##F#	sofa
	#OF#	sofa
Control	####	sofa

Table 9: Experimental Conditions in Experiment 2

Procedures: The procedures were identical to Experiment 1.

Results

Subjects: The results from the standardized tests of reading show that the bilingual subjects who participated in this experiment were overall English dominant and their scores are summarized in Table 9. We used the same criteria to define language dominance as in Experiment 1. According to this analysis, 13 subjects were English dominant, 11 were balanced bilinguals and 1 was Spanish dominant. The subjects' English dominance was confirmed by t-tests comparing their scores in the two languages, with a significant difference in scores for both the PC subtest ($t(46) = 4.36$, $p < .001$) and the LWI subtest, ($t(46) = 2.84$, $p = .007$).

Letter Word ID -English	Passage Comp. -English	Letter Word ID -Spanish	Passage Comp. -Spanish
116.08 (17.85)	117.33 (16.33)	102.63 (14.99)	96.17 (17.29)

Table 10: Results of Standardized Tests for Experiment 2

Similar results to the standardized tests were obtained from the Language Background Questionnaire, which was administered to each subject after they completed the experiment. The subjects' answers are summarized in Table 10. From the questionnaire, 12 subjects' first language was Spanish, while 11 learned English first and 1 Portuguese. The average age when subjects learned their second language was 12.6 years old. Most subjects had spent far more time in an English speaking country than in a Spanish speaking one (20.8 vs. 9.5 years). Finally, subjects' self-rating of their language proficiency in English was higher than in Spanish (5.5 vs. 4.8).

L1	Age learned L2	Years in English Country	Years in Spanish Country	Self-Proficiency Rating(1-6)
12 Spanish 11 English 1 Portuguese	12.6 (6.8)	20.8 (15.9)	9.5 (12.7)	English 5.5 (0.83) Spanish 4.8(1.10)

Table 11: Results from the Language Background Questionnaire for Experiment 2

Priming Task: For each language and prime type accuracy levels in identifying first consonant/first vowel (CV), the first consonant/first vowel/second consonant (CVC), and words were calculated and averaged according to subjects and items. While Table 12 reports subject data, giving the accuracy of recognizing the different units and the standard error in parentheses, we report statistically significant findings for both the subject and the item analyses. We analyzed independent identification of all three units to see if they were identified on their own. Independent identification means that we are defining identification of the CV, for example, as being when uniquely those letters together were correctly recognized, without being a part of any larger unit.

Language	Prime	CV	CVC	WORD
	#V##	7.70(1.42)	1.41(.58)	15.81(3.93)
	##C#	0.82(.45)	2.57(1.00)	18.23(3.70)
	#VC#	2.19(.65)	5.80(1.38)	24.96(4.12)
English	**####**	3.83(1.14)	2.57(.90)	17.86(3.94)
	#V##	13.58(1.78)	2.16(.74)	10.38(2.75)
	##C#	1.08(.50)	2.57(1.00)	16.48(3.15)
	#VC#	0.82(.59)	6.62(1.04)	21.91(3.97)
Spanish	**####**	8.11(2.15)	1.04(.49)	10.94(3.00)

Table 12: Accurate responses according to prime type (with standard error) for Experiment 2

Accuracy of identification of CV, CVC and word units when primed with the first vowel or the second consonant were examined with 2 x 2 x 2 ANOVAs (the first consonant primed vs. unprimed x the first vowel primed vs. unprimed x English vs. Spanish) in the two languages, with language as a within subject factor and a between item factor.

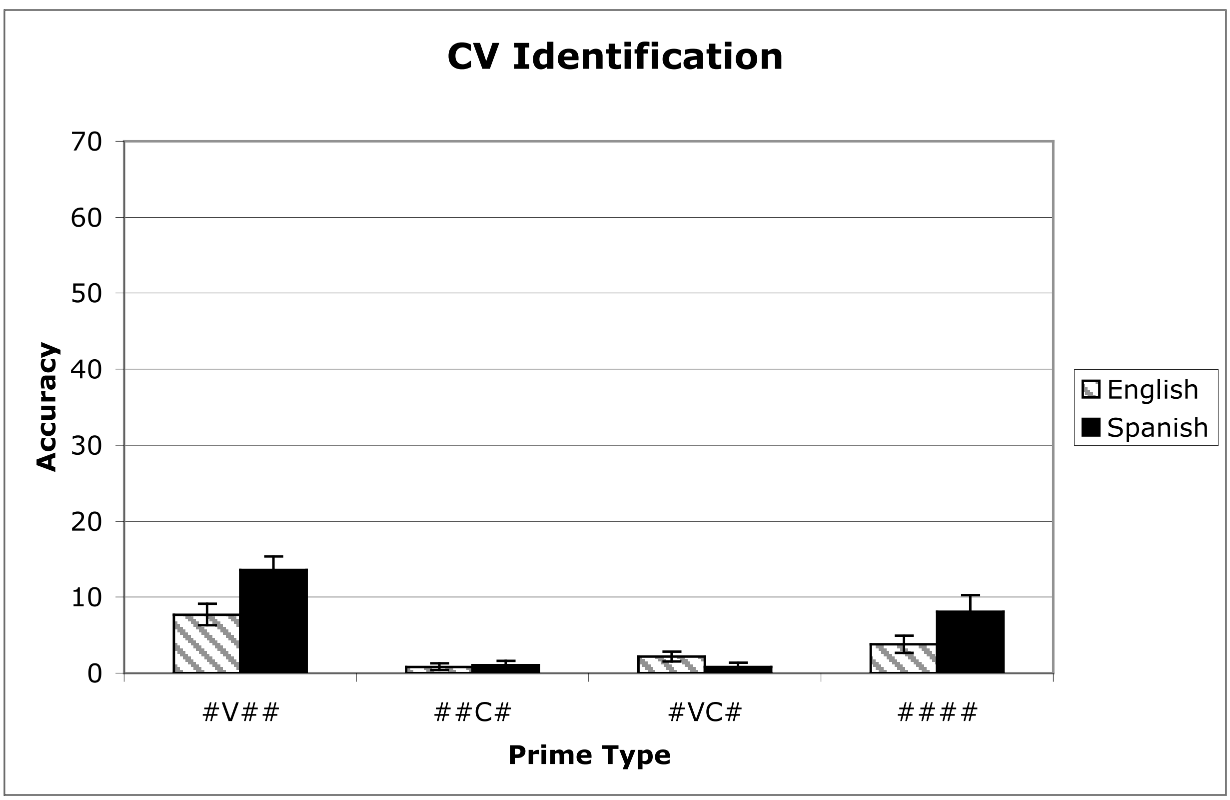

Figure 3: The effect of the various prime types on CV identification in English and Spanish.

For CV identification, all three main effects were significant. The main effect of priming V was significant according to subjects ($F(1,23) = 12.60$, $p = .002$) and items ($F(1,118) = 11.07$, $p = .001$). The main effect of C primes was also significant according to subjects ($F(1,23) = 56.39$, $p < .001$) and items ($F(1,118) = 94.84$, $p < .001$). In addition, CV identification was greater in Spanish, with the main affect of language significant according to subjects ($F(1,23) = 5.92$, $p = .023$) and items ($F(1,118) = 4.98$, $p = .027$). The interaction between V Primes and C Primes was significant according to subjects ($F(1,23) = 6.23$, $p = .020$) and items ($F(1,118) = 8.52$, $p = .004$), with #V## primes (and to a lesser extent #### primes) resulting in greater recognition of CV in comparison to the other primes. Finally, the interaction between C primes and language was significant according to subjects ($F(1,23) = 10.23$, $p = .004$) and items ($F(1,118) = 9.47$, $p = .003$) –with C Primes leading to lower identification rates of syllables in Spanish in comparison to English.

In order to better understand the interaction between C primes and language and to examine the effect of individual primes, we ran paired sample t-tests for subjects and independent sample t-tests for items and present the identification rates of CV based on different prime types in Figure 3. The t-tests show that #V## primes result in significantly greater accuracy of identification of syllables in Spanish according to both subjects ($t(23) = 3.58$, $p = .001$) and items ($t(118) = 2.13$, $p = .018$). Also #### primes resulted in significantly greater identification of CV in Spanish according to items (($t(118) = 2.52$, $p = .007$) and approaches significance according to subjects ($t(23) = 1.62$, $p = .059$). In contrast, ##C# primes and #VC# primes resulted in similarly low CV identification rates in both languages (Figure 3). This finding is consistent with the hypothesis that Spanish readers will show signs of activating words through syllables.

Turning to identification of CVC, the main effect of V primes significantly affected accuracy in identifying CVC according to subjects (F(1,23) = 6.55, p = .018) and items (F(1,118) = 9.34, p = .003). The main effect of C primes was also significant according to subjects (F(1,23) = 13.55, p = .001) and items ((F(1,118) = 13.43, p < .001). Finally, the interaction between V primes and C primes was significant according to subjects (F(1,23) = 13.20, p = .001) and items (F(1,118 = 7.20, p = .008), with greater identification of CVC with #VC# primes However, the interactions between the different primes and language were not significant.

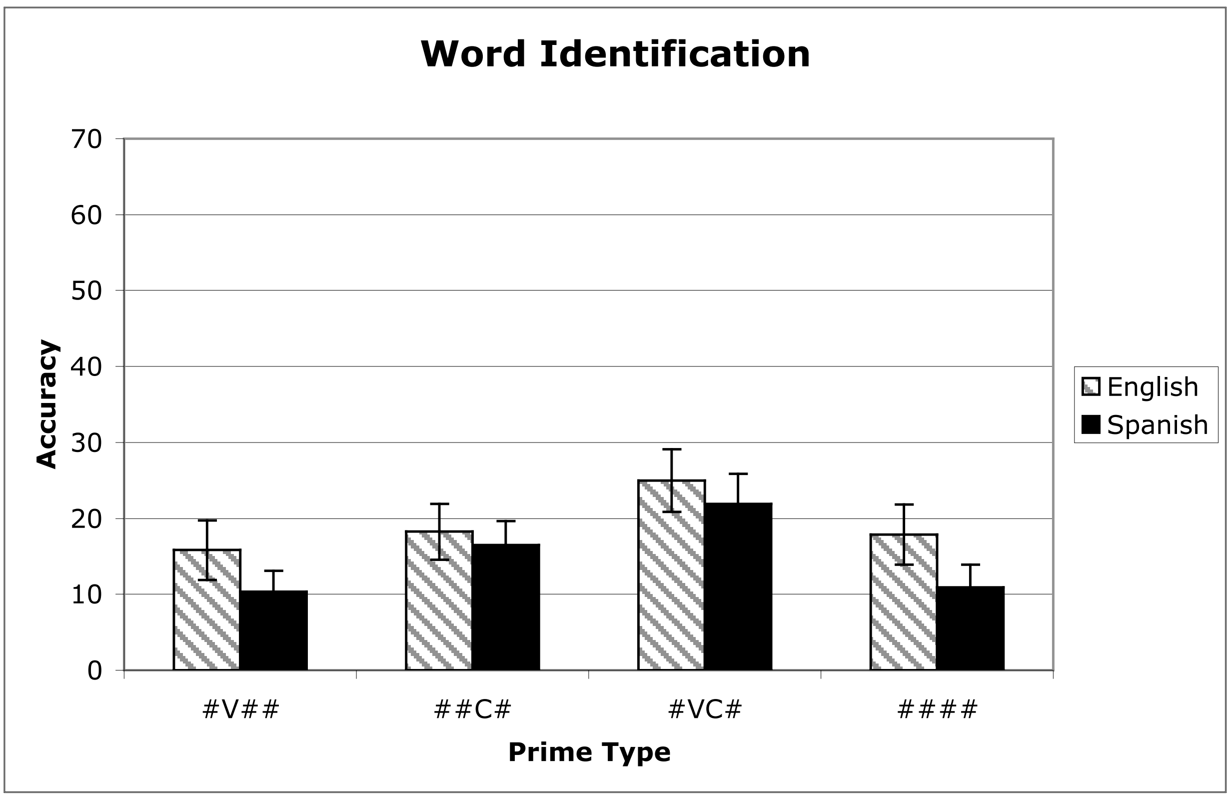

Figure 4: The effect of the various prime types on word identification in English and Spanish

For word identification, the main effect of priming V was significant according to subjects (F(1,23) = 12.09, p = .002), but was not significant according to items (F(1,118) = 2.26, p = .135). According to both subjects (F(1,23) = 17.83, p < .001) and items (F(1,118) = 26.54, p

< .001), the main effect of V primes was significant for word identification. The interaction between C Primes and V Primes was significant according to subjects (F(1,23) = 10.10, p = .003) and items (F(1,118) = 7.82, p = .006), with #VC# and ##C# (to a lesser extent) primes resulting in greater recognition of the word than the other primes. Finally, neither of the interactions between the different primes and language was significant. Given #V## primes, word identification was significantly greater in English according to an independent samples t-tests for items (t(118)= 1.68, p = .048, but only approached significance according to matched sample t-tests for subjects (t(23) = 1.50. p = .074. Given #### primes, word identification was significantly greater in English according to both a matched samples t-test for subjects (t(23) = 2.60. p = .008) and an independent samples t-test for items (t(118) = 2.30, p = .012). The effect of the various prime types is shown in Figure 4. This results is consistent with the hypothesis that English readers activate words through larger grained units.

Language		**CV**	**Word**	**Total**
English	Count	28	55	83
	Expected	37.8	45.2	83
Spanish	Count	49	45	86
	Expected	39.2	46.8	86
Total	Count	77	92	169
	Expected	77	92	169

Table 13: χ^2 table for #V## primes

In order to further test if subjects were more likely to recognize a larger unit such as CVC or word over the syllable in English and more likely to recognize the syllable as opposed to a larger unit in Spanish, we examined the recognition totals for CV, CVC/word and other/null in a χ^2 test statistic for all prime types. For #V## primes, actual and expected counts are reported in Table 13 and $\chi^2(1,169) = 9.20$, p = .002, providing evidence to conclude that the units that are recognized are different in the two languages. Also for #### primes, actual and expected counts are reported in Table 14 and $\chi^2(1,146) = 10.67$, $p = .001$, leading to the conclusion that unit recognized varies in the two languages. For both ##C# primes and #VC# primes, the test statistic result was not significant (respectively, $\chi^2(1,132) = .22$, $p= .638$ and $\chi^2(1,180) = 1.58$, $p = .209$), allowing us to conclude that there is no difference in recognition unit given these primes in either language.

Language		**CV**	**Word**	**Total**
English	Count	14	64	78
	Expected	23	55	78
Spanish	Count	29	43	68
	Expected	20	48	68
Total	Count	43	103	146
	Expected	43	103	146

Table 14: χ^2 table for #### primes

To test if dominance affected performance, we contrasted the balanced bilinguals and the English dominant subjects, entering the results into a 2 x 2 x 2 x 2 ANOVA (C-prime x V-prime x language x dominance). The one Spanish dominant subject was excluded from this analysis, to create two clear categories. The dominance main effect was not significant for identification of any of the units, nor were any interactions between dominance and the other main effects except for with language for CV identification ($F(1,9) = 5.40$, $p = .045$).

Discussion:

##C# and #VC# primes hindered readers' recognition of first syllables (CV) in a similar manner in both English and Spanish. In fact, given these primes, readers in both languages had similar identification rates for all of the key units under study including CV, CVC, and word.

However, when presented with primes that did not cross the syllable boundary, readers recognized different units in the two languages. Given #V## and #### primes, readers in Spanish recognized more syllables and readers of English identified more words. This result suggests that the difficult priming context of cross-syllable, mid-word primes may have disrupted normal word recognition processes in both languages and that readers were able to return to their more normal visual word recognition strategies in the control and first vowel priming conditions.

These findings are consistent with the hypothesis that readers of Spanish use syllables in early word recognition processes and that readers of English use some larger unit –based upon differing exploitation of the prosodic hierarchy in early visual word access in the two languages. The result further confirms prior research indicating that the syllable is a key sub-unit of early lexical access in Spanish (Álvarez, et al., 1998; Álvarez et al., 2000; Álvarez et al., 2001; Álvarez et al., 2004; Carreiras et al., 1993; Carreiras and Perea, 2002; Domínguez et al., 1993; Perea and Carreiras, 1998). The greater recognition of words in English with #V## and #### primes also follows from previous research that suggests that the use of syllables in initial visual word access in English is not as consistent as in Spanish or that use of syllables may come at later stages having to do with phonological assembly (Ferrand et al., 1997; Jared and Seidenberg, 1990; Schiller, 2000; Ashby and Rayner, 2004) and that English readers use some larger unit (Butterworth, 1983; Chialant and Caramazza, 1995; Cole, et al., 2000, Lukatela, et al., 1980; Taft and Forster, 1975, 1976; Taft, 1979, 1994; Ziegler and Goswami, 2005).

Showing Spanish readers the first vowel/second consonant crossed the key prosodic unit of word recognition in Spanish, hindered their ability to identify the first syllable. In the rapid presentation of the VC, Spanish readers perceived the two phonemes together and they were not able to parse them into their respective syllables. The presentation of VC did not correspond to any unit of visual word access in Spanish, violating the key level of prosodic hierarchy for lexical access and leading to greater inhibition of the recognition of the unit with which word recognition processes normally commence –the first syllable. Similarly, just showing them the second consonant distracted them from being able to identify the first syllable –a perfectly understandable result since nothing in the first syllable was primed in this case. However, being given just the vowel in the first syllable in this priming context helped them identify more syllables in Spanish than in English, since a part of this key prosodic unit was primed.

In English, ##C# and #VC# primes did not cross a key prosodic unit of early lexical access. Although recognition rates for CV, CVC and word did not differ significantly between languages, these primes may have resulted in less inhibition in English because these primes did not cross a key prosodic boundary for lexical word access in English. In contrast, in the control, unprimed condition (####), and to a lesser extent by priming the first vowel (#V##), the natural tendency of English readers to recognize a larger unit instead of the syllable reasserted itself.

Finally, #V## and #### primes had differing results between the first and second experiment. In the first experiment with these prime types, readers showed no difference in recognition rates of the different units in either language, while in the second experiment Spanish readers showed a preference for CV recognition, while English readers tended to identify more words. This difference must arise from the priming context, and will be discussed to a greater extent in the Chapter Four below.

CHAPTER THREE

Experiments 3 and 4: Bilingual and Monolingual Children

Based upon the findings of Experiments 1 and 2 with adults reported in Chapter Two, skilled bilingual readers do appear to adapt visual word access to the phonological nature language that they are reading in, with bilingual adults accessing more words in English and more syllables in Spanish. However, to be sure of how complete an adaptation is made, an explicit comparison of bilinguals to monolinguals is necessary. For this reason, the next experiments will directly compare bilinguals and monolingual visual word access using a similar experimental technique as in the previous experiments. In addition, we will study bilingual and monolingual children in these experiments to examine if the degree of reading development also affects lexical access. We start with the following hypotheses: first, the unit of lexical access will differ between Spanish and English, with readers in Spanish showing a preference for the syllable and readers in English accessing words through a larger unit in the prosodic hierarchy; second, bilingual readers will demonstrate adaptation to the languages they are reading in by showing a similar pattern of word access to monolinguals; and third, developing readers will show signs of clear adaptation to the different scripts that they are learning to read in.

Experiment 3

Because of the structural differences between English and Spanish, young bilingual readers are predicted to adapt their processes of visual word access in the two languages, showing clear differences between their use of the different levels of the prosodic hierarchy. Young developing bilingual readers should be sensitive to the prosodic differences between their two languages, accessing words differently in them. In particular, priming bilingual readers is predicted to result in more syllable based effects in Spanish, while readers of English should recognize larger units. For this reason, we will compare young bilingual readers' accuracy in recognizing syllables (CV) and all possible larger units, including first consonant/first vowel/second consonant (CVC) and word, predicting that priming will help Spanish readers identification of CV and that English readers' identification of CVC or word will be facilitated.

Method

Subjects: Twenty-six 11 to 15 year old Bilingual English and Spanish readers were recruited at a dual language immersion elementary school and a regular elementary school with a large bilingual population to participate in the experiment. They were paid $10 for the hour-long experiment. Two participants were excluded from analysis because their standardized reading scores fell two standard deviations below the norm in either English or Spanish, leaving twenty-four participants. The sample included 10 boys and 14 girls. The participants ranged in age from 146 months to 180 with an average of 160.41.

Design and Materials: This experiment used the same design and materials as Experiments 1 and 2.

Procedures: Depending on the preference of the cooperating school, testing took place either in two separate sessions of a half hour each during recess in the middle of the school day, or during a session when participants made a special trip into school on a non-attendance day or after school, completing both languages at the same time. The total time of testing lasted about an hour for each subject. Participants were randomly assigned to whether they completed the English or the Spanish part of the testing first. When they were in either the Spanish or the English condition, the experimenter spoke to them in only that language. Before beginning the experiment in each language, the participants took standardized tests in both languages to determine their reading level. In English, the Passage Comprehension (PC) sub-test from Woodcock Reading Mastery Test was used, while in Spanish the equivalent sub-test from the Batería Woodcock-Muñoz was adopted (Woodcock, 1987; Woodcock, and Muñoz, 1995).

Status	Prime	Target
Test Conditions	SOF#	sofa
	SO##	sofa
	#OF#	sofa
Control	####	sofa

Table 15: Experimental Conditions in Experiment 3

Participants viewed all stimuli for the priming task on a SVGA monitor in a darkened room, with shaded windows providing background ambient lighting. The Apple computer used Psyscope software designed to control the priming experiment (Cohen, MacWhinney, Flatt, and Provost, 1993). Participants recorded their responses by writing on a test sheet.

Participants saw different primes that corresponded to the first three letters of the word (CVC#), the first two letters (CV##), the first vowel and second consonant (#VC#), or, in the control condition, a series of number signs. The primes and the targets matched up in the manner demonstrated in Table 15. Four different counterbalancing conditions varied the primes that were shown with different words. Balanced presentation of stimuli ensured that each participant saw each condition equally often and that each item was preceded by each prime type equally often. Participants were assigned randomly to counterbalancing conditions and viewed stimuli within each counterbalancing condition in a randomized order of presentation.

Participants viewed primes and targets on a standard black background with white letters. The participants first saw a fixation cross on the computer screen before each trial, and the participant was asked to press an external button box to begin each trial. When they triggered the trial, they then saw the prime in upper case letters and the target in lower case letters flash on the computer screen for 32 ms. each followed by a series of number signs for an additional 500 ms.

The presentation of lower and upper case letters helped ensure that the task was not simply visual priming, but instead accessing abstract letter representations. The rate of presentation ensured interpretable accuracy levels (Berent and Perfetti, 1995; Lukatela and Turvey, 2000; Perry and Ziegler, 2002). Previous findings have held that less than 40% accuracy for word identification precludes strategic processing with this technique (Xu and Perfetti, 1999).

Before beginning each part of the experiment, participants completed a practice set of four examples. The subject read instructions presented on the computer screen and the experimenter discussed them with the subject to ensure understanding before beginning the practice set. Participants were instructed to give their best guess even if they were uncertain of what they had seen. They were reminded of the importance of writing words with the appropriate number of letters for all trials. After completing the experiment, the researcher asked them questions about their language background, recording their answers on a Language Background Questionnaire. (See Appendix Two for samples.)

Results

Subjects: The results from the standardized tests of reading show that the participants who participated in this experiment were overall English dominant. The mean Standardized Score (SS) of the PC subtest in English was 108.13, with a standard deviation (SD) of 13.21, while in Spanish the mean was 98.5, with a standard deviation of 13.9. The SS on this test is based around 100, with half the participants in a particular age range scoring either higher or lower during norming. The SD of the sample population during norming was 15 points. Using the SD value from the normed test, we defined language dominance according to the following criteria: English and Spanish dominants had scores greater than 2/3 of a SD on PC in their dominant language, while balanced bilinguals had scores with less than 2/3 of a SD difference between the two languages. According to this analysis, 11 participants were English dominant, 10 were balanced bilinguals and 3 were Spanish dominant. The participants' English dominance was confirmed by matched pair t-tests comparing their scores in the two languages, with a significant difference in scores for the PC subtest (t(23) = 3.137, p = .005).

L1	**Age learned L2**	**Years in Country Using Languages**	**Self-Proficiency Rating (1-6)**	**Experience Reading (1-6)**	**% of Day Using Languages**
19 Spanish 3 English 2 Both	5.33 (3.48)	English 10.6(3.92) Spanish 2.57(3.82)	English 4.91(0.71) Spanish 5.01(0.73)	English 4.90(1.00) Spanish 3.96(1.04)	English 57.5%(15.32) Spanish 42.5%(15.32)

Table 16: Results from the Language Background Questionnaire for Experiment 3

Similar results were obtained from the Language Background Questionnaire, which was administered to each subject after they completed the experiment. Their responses are summarized in Table 16. From the questionnaire, 19 participants' first language was Spanish, while 3 learned English first and 2 reported learning both languages from their earliest memory. The average age when participants learned their second language was 5.3 years old. Most participants had spent far more time in an English speaking country than in a Spanish speaking one (10.6 vs. 2.57 years). When asked to rate their overall proficiency in the two languages on a scale from 1 to 6, participants' ranked themselves higher in Spanish than in English (5.01 vs. 4.91). When asked about their experience in reading the two languages on a 1-6 scale, participants stated that they had read more in English than in Spanish (4.90 vs. 3.96). Finally, participants stated that they spoke more English during a typical day than Spanish (57.5% of the day vs. 42.5%).

Priming Task: For each language and prime type accuracy levels in identifying first consonant/first vowel (CV), the first consonant/first vowel/second consonant (CVC), and words were calculated and averaged according to subjects and items. While Table 17 reports subject data, giving the accuracy of recognizing the different units and the standard error in parentheses, we report statistically significant findings for both the subject and the item analyses. We analyzed independent identification of all three units to see if they were identified on their own. Independent identification means that we are defining identification of the CV, for example, as being when uniquely those letters together were correctly recognized, without being a part of any larger unit.

2 x 2 x 2 ANOVAs (the first consonant/first vowel (CV) primed vs. unprimed x the first vowel/second consonant (VC) primed vs. unprimed x English vs. Spanish) examined accuracy of identification of CV, CVC and word units, with prime type as a within subject and item variable and with language as a within subject factor and a between item factor.

Language	**Prime**	**CV**	**CVC**	**WORD**
	CVC#	15.14(2.09)	31.51(3.53)	32.03(3.42)
	CV##	56.03(3.98)	5.69(1.40)	10.94(2.73)
	#VC#	1.64(0.59)	5.65(1.35)	6.29(1.85)
English	**####**	5.10(1.56)	0.78(0.78)	3.50(1.26)
	CVC#	12.61(1.40)	20.46(2.42)	40.18(3.74)
	CV##	55.28(2.92)	5.02(1.10)	10.97(1.69)
	#VC#	2.49(0.88)	4.87(1.09)	10.94(1.88)
Spanish	**####**	6.25(1.48)	1.04(0.61)	3.46(0.93)

Table 17: Accurate responses according to prime types (with standard error) for Experiment 3

For CV identification, the prime type main effects were significant. The main effect of priming CV was significant according to subjects ($F(1,23) = 296.83$, $p < .001$) and items ($F(1,118) = 471.36$, $p < .001$). The main effect of priming VC was also significant according to subjects ($F(1,23) = 172.48$, $p < .001$) and items ($F(1,118) = 323.93$, $p < .001$). The interaction between CV primes and VC primes was significant according to subjects ($F(1,23) = 120.77$, $p < .001$) and items ($F(1,118) = 281.06$, $p < .001$), with CV## primes (and to a much lesser extent

CVC# primes) resulting in greater recognition of CV in comparison to the other primes. However, no interactions between language and prime type were significant, a finding demonstrated in Figure 5 showing the accuracy of identification of CV given different prime types in English and Spanish, thereby contradicting the hypothesis that bilingual readers of Spanish were more likely to exploit this level of the prosodic hierarchy in visual word access.

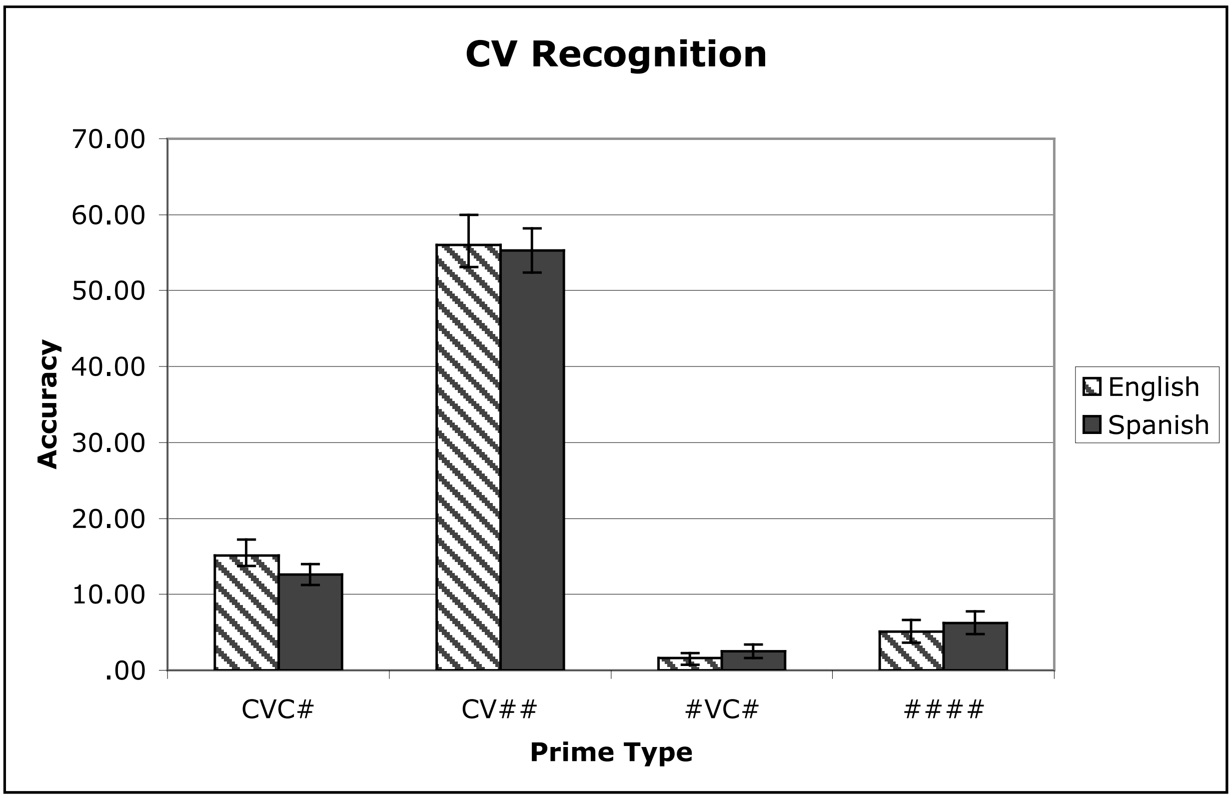

Figure 5: The effect of the various prime types on CV identification in English and Spanish.

Turning to identification of CVC, the main effect of CV primes was significant according to subjects ($F(1,23) = 96.64$, $p < .001$) and items ($F(1,118) = 98.4$, $p < .001$). According to both subjects ($F(1,23) = 106.61$, $p < .001$) and items ($F(1,118) = 88.35$, $p < .001$), CVC identification was significantly aided by VC primes. The interaction between CV Primes and VC Primes was significant according to subjects ($F(1,23) = 60.58$, $p < .001$) and items ($F(1,118) = 60.08$, $p < .001$), with CVC# resulting in greater recognition of CVC than the other primes. Next, the interaction between CV Primes and Language was significant for both subjects (F(1,23) = 5.22, p = .032) and items (F(1,118) = 4.97, p = .028), with greater priming effect of CV primes in English. Also the interaction between VC Primes and Language was significant according to both subjects (F(1,23) = 7.16, p = .013) and items (F(1,118) = 4.46, p = .037), with greater priming effect of CV primes in English. Finally, the three way interaction between CV primes, VC primes and Language approaches significance according to subjects (F(1,23) = 4.89, p = .073) and is significant according to items (F(1,118) = 5.16, p = .025.

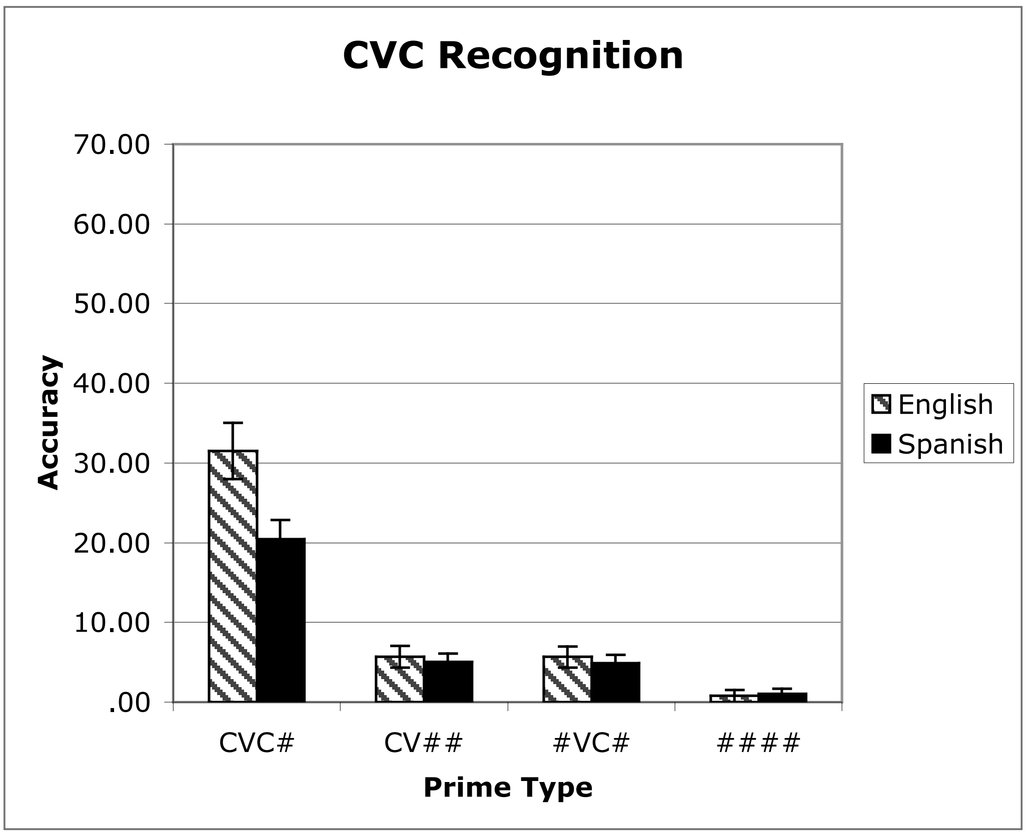

Figure 6: The effect of the various prime types on CVC identification in English and Spanish.

Paired sample t-tests for subjects and independent sample t-tests for items further tested the significant interactions between the main effects and looked at the effect of the different prime types on CVC identification. The effect of the individual primes is demonstrated in Figure 6, which presents identification rates of words based on different prime types. According to the t-tests, CVC# primes resulted in significantly greater CVC recognition in English according to subjects ($t(23) = 2.69$, $p = .007$) and items ($t(118) = 2.39$, $p = .009$), providing evidence supporting the hypothesis that English readers are accessing a larger unit based on these primes. Other prime types did not result in statistically significant different rates of word identification between languages.

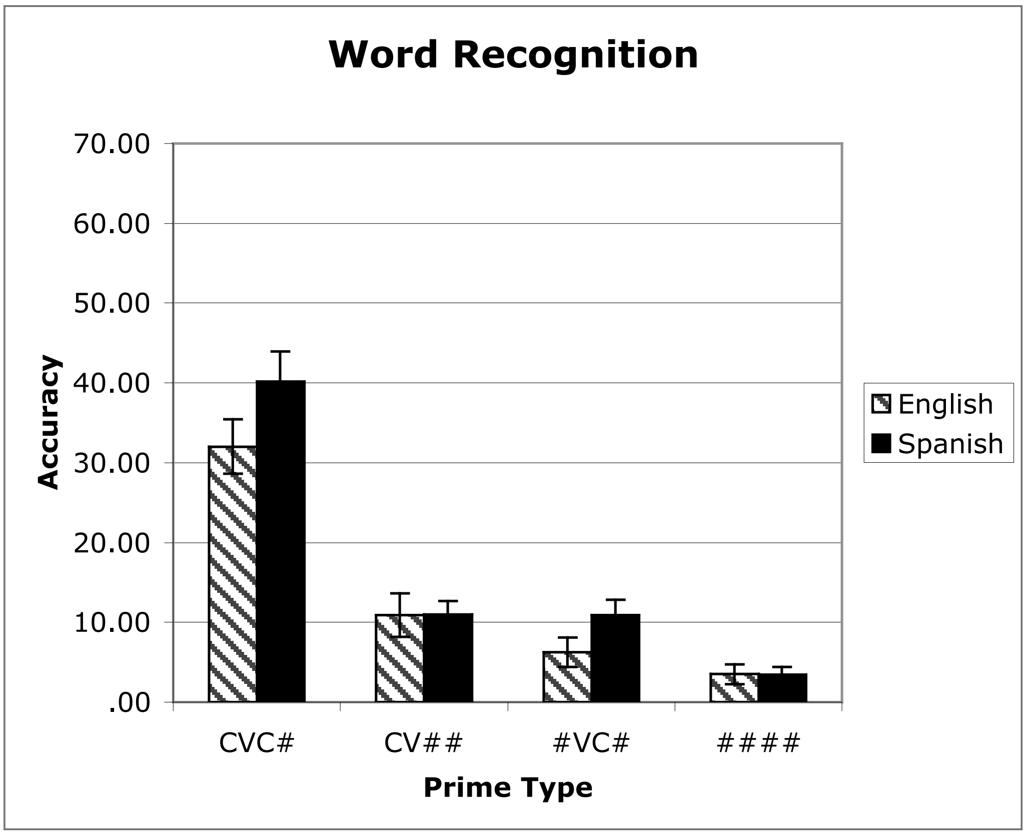

Figure 7: The effect of the various prime types on Word identification in English and Spanish.

For word identification, the main effect of CV primes was significant according to subjects ($F(1,23) = 156.5$, $p < .001$) and items ($F(1,118) = 105.61$, $p < .001$). According to both subjects ($F(1,23) = 122.32$, $p < .001$) and items ($F(1,118) = 120.48$, $p < .001$), word identification was significantly aided by VC primes. The interaction between CV Primes and VC Primes was significant according to subjects ($F(1,23) = 48.72$, $p < .001$) and items ($F(1,118) = 58.43$, $p < .001$), with CVC# primes resulting in greater recognition of the word than the other primes. Finally, the interaction between VC Primes and Language was significant according to both subjects ($F(1,23) = 4.41$, $p = .047$) and items ($F(1,118) = 5.27$, $p = .023$), with greater priming effect of VC primes in Spanish.

Paired sample t-tests for subjects and independent sample t-tests for items further tested the interaction between VC primes and language and looked at the effect of the different prime types. The effect of the individual primes is demonstrated in Figure 7, which presents identification rates of words based on different prime types. According to the t-tests, #VC# primes resulted in significantly greater word recognition in Spanish according to both subjects ($t(23) = 1.74$, $p = .048$) and items ($t(118) = 2.06$, $p = .021$. This finding contradicts the hypothesis that English readers would access a larger unit, but follows from the statistical difference in frequency between languages for the last bigram. The other prime types did not result in statistically significant different rates of word identification between languages.

To test if dominance affected performance, we contrasted the balanced bilinguals and the English dominant subjects, entering the results into a 2 x 2 x 2 x 2 ANOVA (CV-prime x VC-prime x language x dominance). The three Spanish dominant participants were excluded from this analysis, to create two clear categories. No main effects of dominance were significant, nor were any interactions between dominance and any other main effects.

Discussion

Only two different prime types resulted in differing recognition of CV, CVC or word units between languages by bilingual children in this experiment with bilinguals reading in English and Spanish: CVC# primes resulted in greater recognition of CVC in English and #VC# resulted in greater word recognition in Spanish. The significant findings for CVC# primes provides evidence of English readers accessing a larger unit given these primes and is consistent with the results reported in Chapter Two showing adult bilinguals accessing larger units in English.

In comparison, the finding that #VC# primes resulted in greater word recognition in Spanish is interesting and markedly different from the previous experiments with adults reported in Chapter Two, where these primes did not result in significantly different word recognition in either language. The greater word access may be related to the significantly greater bigram frequency in Spanish, with the #VC# primes giving them the first letter in the last bigram. In particular, greater word recognition in children may be a reflection of beginning readers' greater sensitivity to larger units, with younger learners typically progressing from larger to smaller units in phonological awareness (Anthony and Lonigan, 2004; Anthony et al., 2002; Stanovich, 1992; Treiman and Zukowski, 1996). Since the readers in the present experiment were still learning, they may not have developed full access to the appropriate smaller grain units in both of their languages, and therefore been more prone to recognizing larger units. This is particularly relevant to Spanish in the present experiment because the focus on larger units coupled with higher bigram frequency in the last bigram would likely produce greater word recognition.

In general, the present experiment does not provide clear evidence that readers were using the syllabic level of the prosodic hierarchy in either language. CV recognition was statistically similar given all prime types. This finding contrasts with Experiments 1 and 2 with adults reported in Chapter Two showing the importance of the syllabic level of the prosodic hierarchy in visual word recognition in Spanish for bilingual adults. The result also differs from other prior research indicating that the syllable is a key sub-unit of early lexical access in Spanish (Álvarez, et al., 1998; Álvarez et al., 2000; Álvarez et al., 2001; Álvarez et al., 2004; Carreiras et al., 1993; Carreiras and Perea, 2002; Domínguez et al., 1993; Perea and Carreiras, 1998).

However, these studies were all been done on adults, so it possible that sensitivity to the syllable level in Spanish reading develops over time with more reading experience.

Based on the present experimental results, young bilingual readers do not seem to generally adapt to the structure of the language that they are reading in, contrary to our hypothesis that they would, since they largely accessed the same units based on different primes in both languages. This finding does not agree with previous research that showed that adult bilinguals' reading in each of their languages was affected by the nature of the script being read (Shimron and Sivan, 1994; Oren and Breznitz, 2005; Strid and Booth, 2006). However, these previous studies all focused on adult bilinguals, suggesting that perhaps developmental bilingual readers need more time to fully adapt to reading in two scripts.

Experiment 4

Monolingual readers should be more sensitive than bilingual readers to the structural differences between English and Spanish, meaning that they will show signs of using different units in visual word access in the two languages, showing clear differences between their use of the different levels of the prosodic hierarchy. In general, developing readers may need more exposure to reading in a language to develop representations that are specific to that language (e.g. Ziegler and Goswami, 2005). This evolution may take even longer in bilinguals, due to the exposure to two different writing systems. In contrast, young developing monolingual readers may be more adapted to reading in their one language, relying more on the specific grain size and the prosodic representation relevant to reading in that language. In particular, priming in monolingual readers is predicted to result in more syllable based effects in Spanish, while readers of English will recognize larger units. For this reason, we will compare young monolingual readers' accuracy in recognizing syllables (CV) and all possible larger units, including first consonant/first vowel/second consonant (CVC) and word, predicting that priming will help Spanish readers identification of CV and that English readers' identification of CVC or word will be facilitated. In general, in comparison to young bilingual readers, monolingual readers are predicted to show clear signs of adapting to the structure of the two languages.

Subjects: Twenty-nine monolingual English readers recruited at public and private elementary schools in the metropolitan Chicago area participated in the experiment. They were paid $5 for the half-hour long experiment. The standardized measures to determine language proficiency and reading level in English and Spanish (where appropriate) resulted in the exclusion of three participants from analysis because of standardized scores two standard deviations above the norm, leaving twenty-six participants. Two additional participants were unable to perform the experimental task, by not providing complete words in their answers, leaving 24 participants. The sample included 10 boys and 14 girls. The age of the participants ranged from 155.23 to 176.1 months, with an average of 166.11.

Thirty monolingual Spanish readers recruited at a private middle school in Puebla, Mexico and at a dual language immersion public school in Chicago, Illinois participated in the experiment. They were paid $5 for the half-hour long experiment. The standardized measures to determine language proficiency and reading level in Spanish and English resulted in the exclusion of two participants from analysis who tested as having too much reading knowledge of English –one within two standard deviations of the norm and the other as testing greater than two standard deviations above the norm, leaving 28 participants. Four additional participants were unable to perform the experimental task, by not providing complete words in their answers, leaving 24 participants. The sample included 15 boys and 9 girls. The age of the participants ranged from 142.8 to 174.9 months, with an average of 159.35.

Design and Materials: The design, the task and the test words were the same as in Experiments 1, 2, and 3.

Procedures: Depending on the preference of the cooperating school, the half hour testing took place either in a session during recess in the middle of the school day or when participants were pulled out of class. Testing was held in all locales in a dim room with shades, with similar equipment placement.

Before beginning the experiment in each language, the participants took a standardized test in the appropriate language to determine their reading level. The same standardized tests were used as in Experiment 3. Participants only completed the experiment in the appropriate language. If they had some exposure to the other language, they took the standardized test in the other language after completing the experimental procedure.

In all other respects, the procedures were identical to Experiment 3.

Results

Subjects: The results from the standardized tests of reading show that the monolingual participants in both languages who participated in this experiment had similar reading scores in their respective languages. The Standardized Score (SS) on this test is based around 100, with half the participants in a particular age range scoring either higher or lower during norming. The SD of the sample population during norming was 15 points. The mean SS on the PC subtest for the English monolingual participants was 107.71, with a standard deviation (SD) of 8.92. Only five of the twenty-four participants had had any exposure to Spanish and completed the PC subtest in Spanish; all of the Spanish scores were more than one and a half standard deviations below their English score and more than one and a half standard deviations below the normal score of 100. The mean score in Spanish for these participants was 72, with a standard deviation of 4.43.

The mean SS on the PC subtest for the Spanish monolingual participants was 103.25, with a standard deviation (SD) of 8.37. All of the twenty-four participants had had some exposure to English; for this reason all completed the PC subtest in English; all of their English scores were more than one and a half standard deviations below their Spanish score and more than one and a half standard deviations below the normal score of 100. The mean score in English was 54.54, with a standard deviation of 13.72. The English PC SS of the English participants was not significantly greater than the Spanish score of the Spanish monolingual participants, ($t(23) = 1.81$, $p = .078$).

Subject Population	**L1**	**Age learned L2**	**Years in Country Using Languages**	**Self-Proficiency Rating (1-6)**	**Experience Reading (1-6)**	**% of Day Using Languages**
English Monolinguals	14 English 3 Spanish 2 Both 5 Other	6.2 (4.19)	English 13.06(1.39) Spanish 0.44(1.04)	English 5.13(.81) Spanish 2.48(.97)	English 5.65(.63) Spanish 1.78(1.06)	English 84.96%(17.26) Spanish 9.65%(16.26) Other 5.4%(11.23)
Spanish Monolinguals	24 Spanish	6.5 (2.72)	English 0.21(.83) Spanish 12.5(1.18)	English 2.8(1.4) Spanish 4.98(.96)	English 2.21(1.59) Spanish 4.88(1.19)	English 5.42%(1.41) Spanish 94.58%(1,41)

Table 18: Results from the Language Background Questionnaire for Experiment 4

Similar results to the standardized tests were obtained from the Language Background Questionnaire, which was administered to each subject after they completed the experiment. The means with the standard deviation for the participants' answers to the questions on the survey are summarized in Table 18. 14 of the English monolingual participants' reported that their first language was English, while 3 learned Spanish first, 2 reported learning both languages at the same time, 2 learned Gujarati, 1 each learned Malayalan, Korean, and Punjabi. The average age when English participants learned their second language was 6.2 years old, while 4 reported never learning another language. All English monolinguals participants had spent far more time in an English speaking country than in a Spanish speaking one (13.06 vs. 0.44 years). Also, English participants' self-rating of their language proficiency in English on a six point scale was higher than in Spanish (5.13 vs. 2.48). Participants reported reading far more in English than in Spanish on a six point scale (5.65 vs. 1.78). Finally, English participants reported using English 84.96% of the time in comparison to only 9.65% for Spanish.

Turning to the Spanish monolingual participants, all 24 of them reported that their first language was Spanish. The mean age when the Spanish participants started learning English was 6.5 years. The Spanish participants reported that they had spent an average of 12.5 years in a Spanish speaking country, while they only spent .21 years in an English speaking country. They rated their overall Spanish proficiency at 4.98 on a six point scale and their English proficiency at 2.8. When asked to rate how much they had read in Spanish on a six point scale, they gave themselves 4.88, while in English 2.21. They reported spending 94.58% of a typical day using Spanish, and 5.42% of the day using English.

Priming Task: For each language and prime type accuracy levels in identifying first consonant/first vowel (CV), the first consonant/first vowel/second consonant (CVC), and words were calculated and averaged according to subjects and items. While Table 19 reports subject data, giving the accuracy of recognizing the different units and the standard error in parentheses, we report statistically significant findings for both the subject and the item analyses. We analyzed independent identification of all three units to see if they were identified on their own. Independent identification means that we are defining identification of the CV, for example, as being when uniquely those letters together were correctly recognized, without being a part of any larger unit.

Language	Prime	CV	CVC	WORD
English	CVC#	11.16(2.22)	31.29(2.86)	38.17(3.74)
	CV##	51.38(3.82)	8.67(1.49)	14.25(3.02)
	#VC#	1.93(0.85)	2.27(0.80)	7.37(1.85)
	####	3.72(1.10)	.60(0.41)	5.02(1.72)
Spanish	CVC#	11.20(1.93)	12.35(1.83)	60.08(3.75)
	CV##	46.09(2.91)	5.80(1.14)	29.17(3.28)
	#VC#	2.94(0.96)	3.53(0.94)	22.84(3.07)
	####	7.78(1.53)	.89(0.65)	8.97(2.02)

Table 19: Accurate responses according to prime type (with standard error) for Experiment 4

2 x 2 x 2 ANOVAs (the first consonant/first vowel (CV) primed vs. unprimed x the first vowel/second consonant (VC) primed vs. unprimed x English vs. Spanish) examined accuracy of identification of CV, CVC and word units, with language as a between subject and item factor.

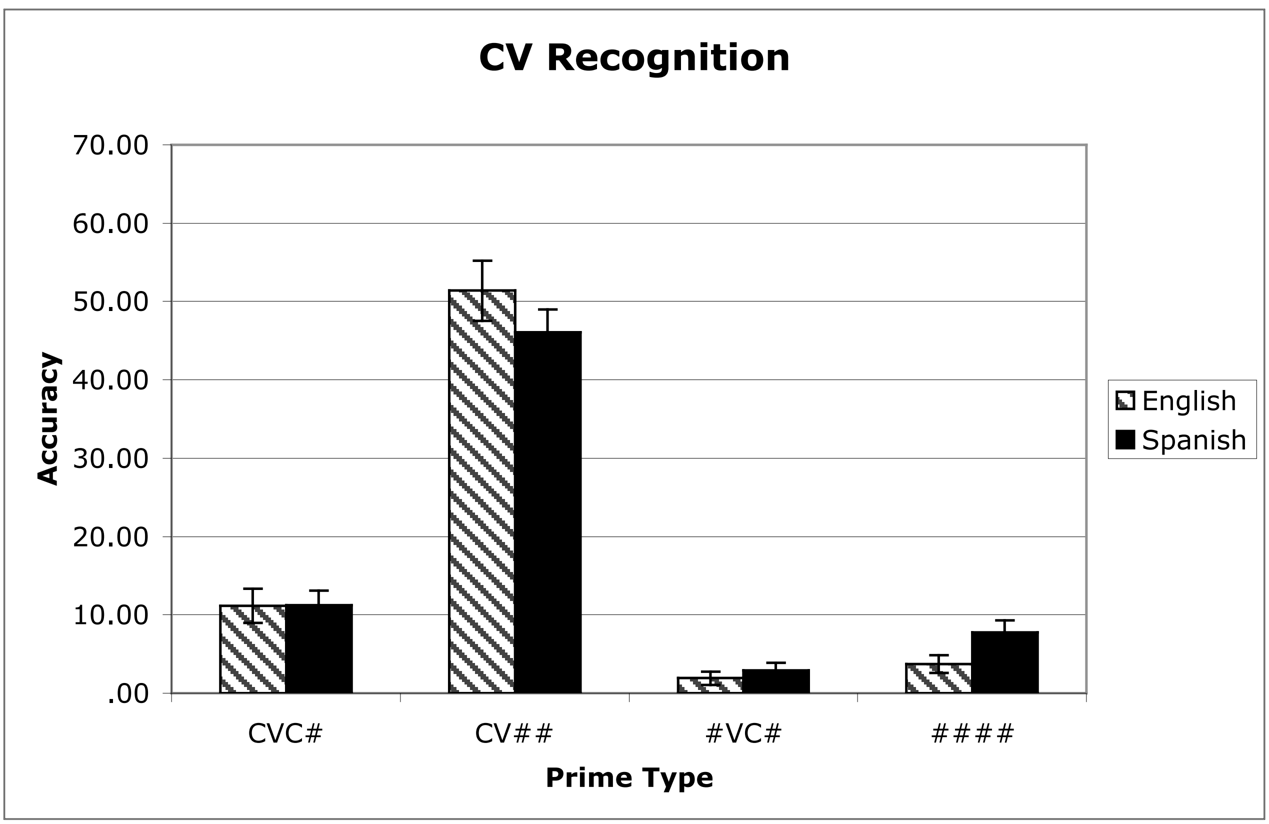

Figure 8: The effect of the various prime types on CV identification in English and Spanish.

For CV identification, the prime type main effects were significant. The main effect of priming CV was significant according to subjects ($F(1,46) = 225.88$, $p < .001$) and items ($F(1,118) = 401.3$, $p < .001$). The main effect of VC primes was also significant according to subjects ($F(1,46) = 197.05$, $p < .001$) and items ($F(1,118) = 225.72$, $p < .001$). The interaction between CV Primes and VC Primes was significant according to subjects ($F(1,46) = 171.44$, $p < .001$) and items ($F(1,118) = 179.15$, $p < .001$), with CV## primes resulting in greater recognition of CV in comparison to the other primes. Finally, the interaction between CV primes and language was significant according to items ($F(1,118) = 4.39$, $p = .038$) but not according to subjects ($F(1,46) = 2.24$, $p = .141$) –with CV Primes leading to slightly higher identification rates of syllables in English in comparison to Spanish.

In order to better understand the interaction between CV primes and language and to examine the effect of individual primes, we ran paired sample t-tests for subjects and independent sample t-tests for items and present the identification rates of CV based on different prime types in Figure 4. The t-tests show that #### primes result in significantly greater accuracy of identification of syllables in Spanish according to both subjects ($t(46) = 2.15$, $p = .019$) and items ($t(118) = 2.08$, $p = .02$). This finding could indicate very rapid syllable activation in Spanish –offering some support to the hypothesis that the syllable is an important unit of word activation in Spanish. In contrast, CVC# primes, CV## primes and #VC# primes did not result in significantly different CV identification rates in the two languages (Figure 8).

Turning to identification of CVC, all main effects and all interactions were significant. The main effect of CV primes significantly affected accuracy in identifying CVC according to subjects ($F(1,46) = 139.39$, $p < .001$) and items ($F(1,118) = 80.99$, $p < .001$). The main effect of VC primes was also significant according to subjects ($F(1,46) = 93.07$, $p < .001$) and items

((F(1,118) = 63.18, p < .001). The between subjects main effect of language was also significant according to subjects (F(1,46) = 18.88, p < .001) and items (F(1,118) = 10.35, p = .002). The interaction between CV primes and language was significant according to both subjects (F(1,46) = 29.58, p < .001) and items (F(1,118) = 16.88, p < .001). Additionally, the interaction between VC primes and language was significant according to subjects (F(1,46) = 18,94, p < .001 and items (F(1,118) = 12.38, p = .001). Also, the interaction between CV primes and VC primes was significant according to subjects (F(1,46) = 38.16, p < .001) and items (F(1,118 = 41.38, p < .001), with greater identification of CVC with CVC# primes. Finally, the three way interaction between CV primes, VC primes, and language was significant according to subjects (F(1,46) = 17.94, p < .001) and items (F(1,118) = 19.64, p < .001).

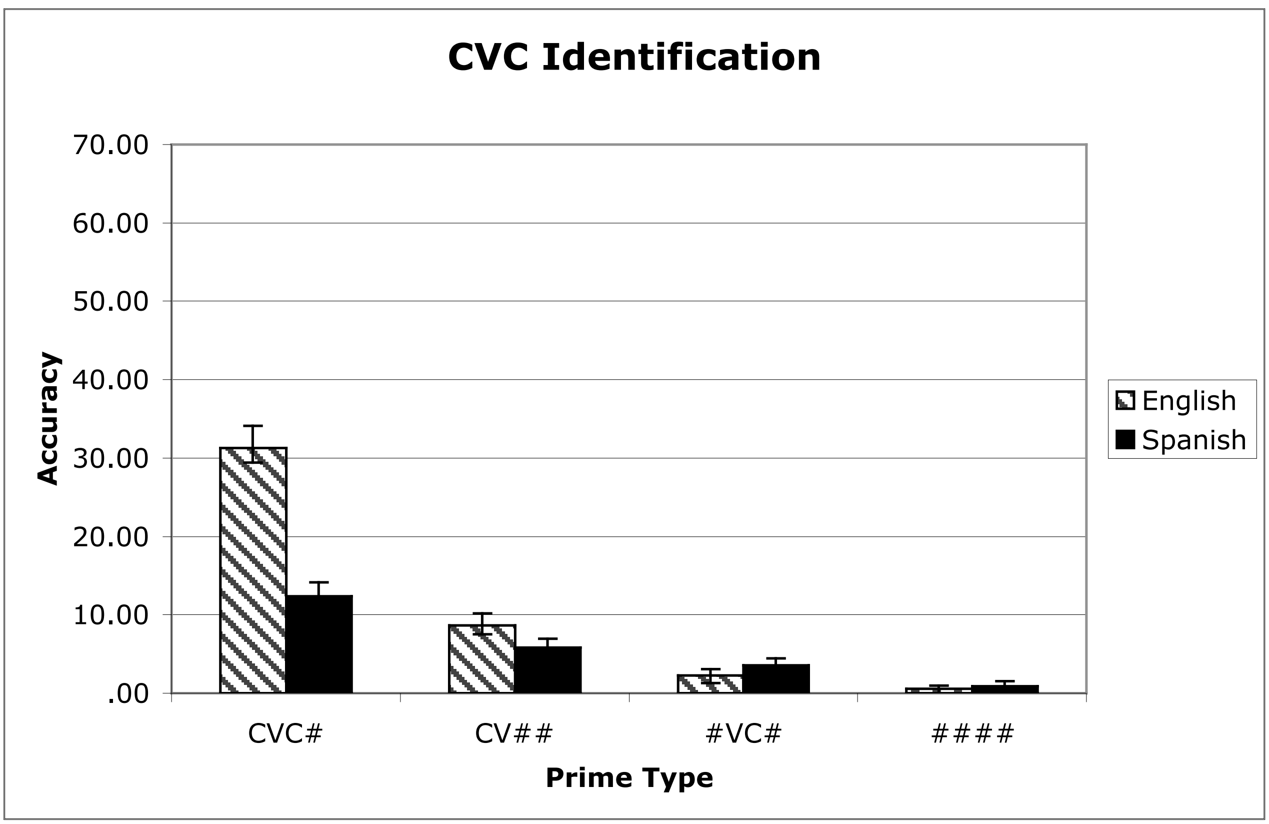

Figure 9: The effect of the various prime types on CVC identification in English and Spanish

In order to better understand the interactions between prime types and language and to examine the effect of individual primes, we ran independent sample t-tests for subjects and for items and present the identification rates of CVC based on different prime types in Figure 9. The t-tests show that CVC# primes result in significantly greater accuracy of identification of CVC in English according to both subjects ($t(46) = 5.58$, $p < .001$) and items ($t(118) = 4.43$, $p = .001$). Once again, this finding supports the hypothesis that English readers activate a larger unit. In contrast, #VC# primes, CV## primes and #### primes did not result in statistically different CVC identification rates between the languages.

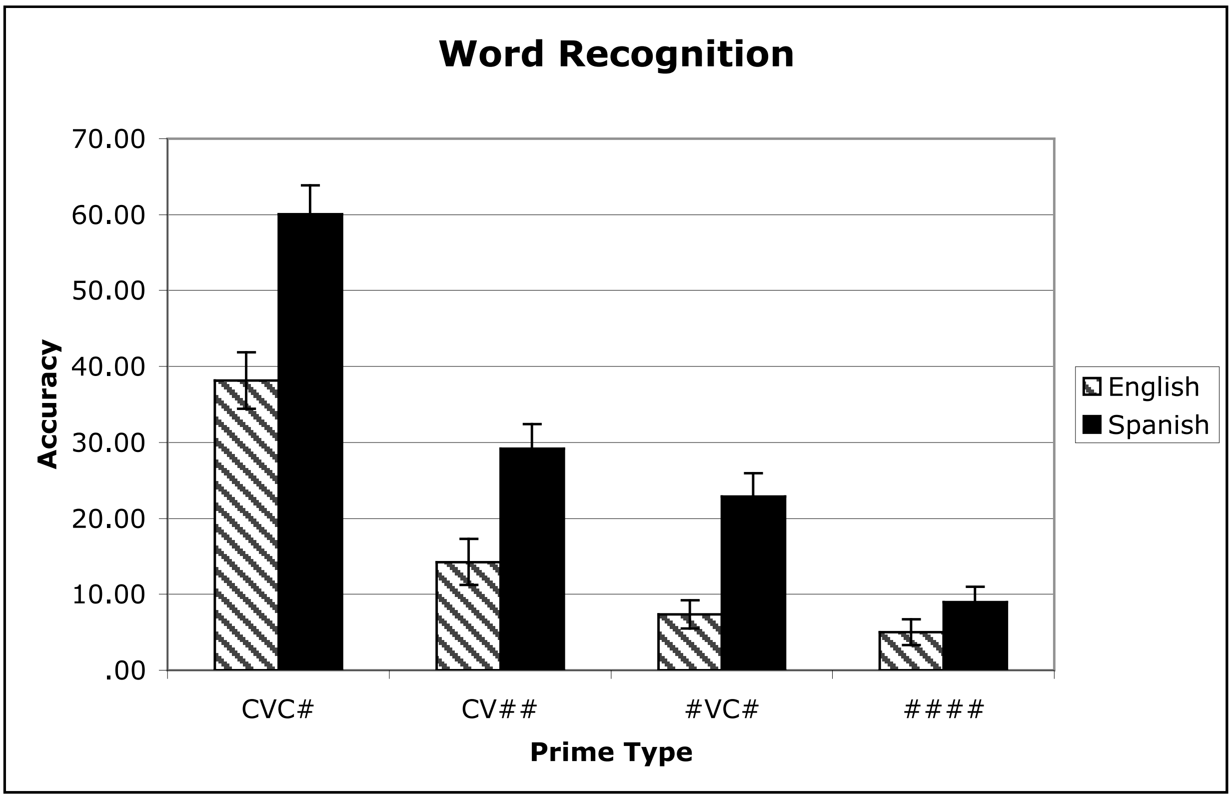

Figure 10: The effect of the various prime types on Word identification in English and Spanish

For word identification, the main effect of priming CV was significant according to subjects ($F(1,46) = 286.86$, $p < .001$) and items ($F(1,118) = 154.55$, $p < .001$). According to both subjects ($F(1,46) = 164.39$, $p < .001$) and items ($F(1,118) = 92.17$, $p < .001$), the main effect of

VC primes was significant for word identification. The between subjects main effect of language was significant according to subjects ($F(1,46) = 17.34$, $p < .001$) and items ($F(1,118) = 30.81$, $p < .001$), with greater word identification in Spanish. The interaction between CV Primes and VC Primes was significant according to subjects ($F(1,46) = 60.11$, $p < .001$) and items ($F(1,118) = 42.64$, $p < .001$), with CVC# primes resulting in greater recognition of the word than the other primes. Also, the interaction between CV primes and language was significant according to both subjects ($F(1,46) = 9.15$, $p = .004$) and items ($F(1,118) = 4.72$, $p = .032$). Finally, the interaction between VC primes and language is significant according to both subjects ($F(1,46) = 11.18$, $p = .002$) and items ($F(1,118) = 6.36$, $p = .013$).

To further understand the interaction between prime type and language and the effects of the individual primes on word recognition, we ran independent sample t-tests for the different prime types. Given CVC# primes, word identification was significantly greater in Spanish according to subjects ($t(46) = 4.14$. $p < .001$) and items ($t(118)= 4.02$, $p < .001$. Given CV## primes, word identification was significantly greater in Spanish according to both subjects ($t(46) = 3.35$. $p = .002$) and items ($t(118) = 3.76$, $p < .001$). Also when shown #VC# primes, monolingual Spanish subjects identified significantly more words according to both subjects ($t(46) = 4.32$, $p < .001$) and items ($t(118) = 4.43$, $p < .001$). For #### primes, monolingual subjects recognized significantly more words according to items ($t(118) = 1.81$, $p = .037$ and marginally more according to subjects ($t(46) = 1.49$, $p = .072$). These results argue that Spanish monolingual readers are extracting much greater information from the rapid priming, perhaps related to the difference in frequency for the last bigram. The effect of the various prime types is shown in Figure 10.

Comparison of Results of Experiments 3 and 4

The standardized test results for the monolingual subjects did not differ statistically from those of the bilingual subjects in either language. In English, the mean Woodcock Johnson PC standardized score for monolingual subjects was 107.71 with a standard deviation of 8.92, in comparison to an average score of 108.13 with a standard deviation of 13.21 for bilinguals. The difference between the scores was not significant (t(46) = .13, p = .90). For Spanish the monolingual readers had a mean Woodcock-Muñoz PC standardized score of 103.25 with a standard deviation of 8.37, while bilinguals had a mean of 98.5 with a standard deviation of 13.90. This difference in means also was not statistically significant (t(46) =1.43, p = .16).

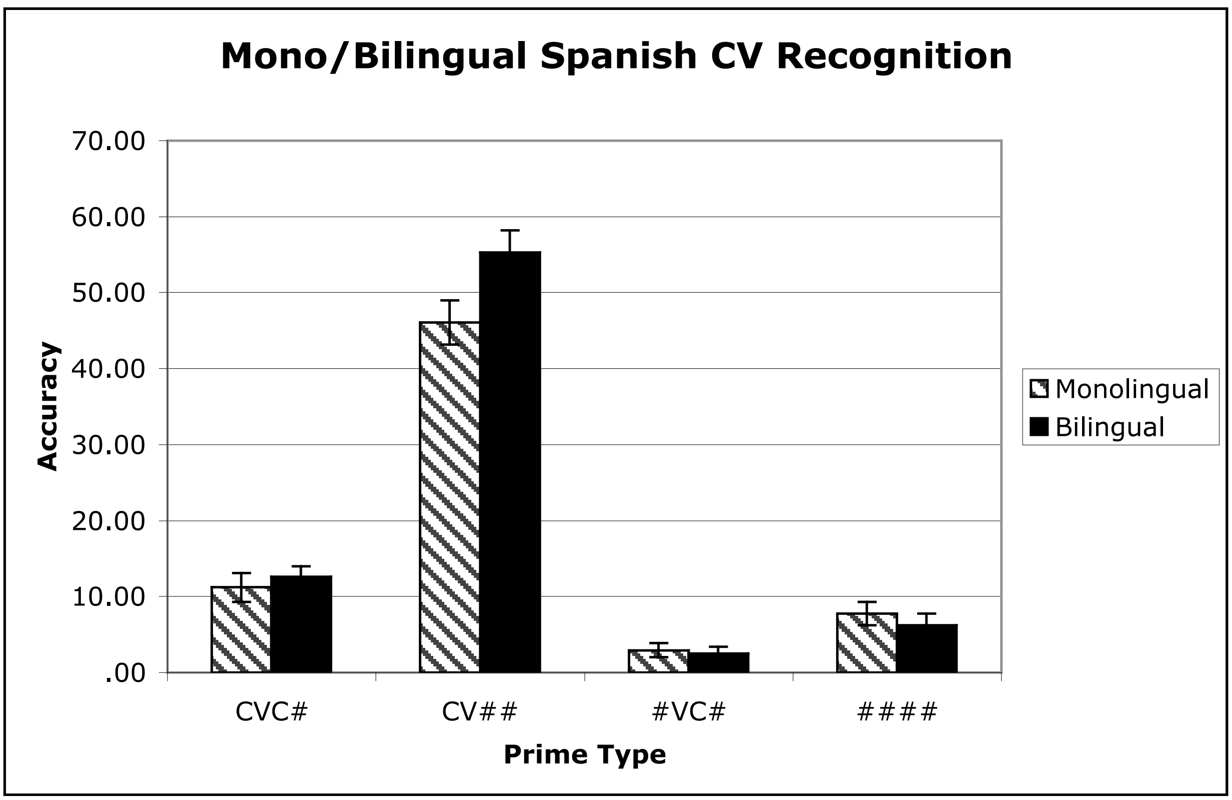

Figure 11: The effect of the various prime types on CV identification in Spanish for Monolinguals and Bilinguals

2 x 2 x 2 ANOVAs for each language (the first consonant/first vowel (CV) primed vs. unprimed x the first vowel/second consonant (VC) primed vs. unprimed x monolingual vs.

bilingual) examined accuracy of identification of CV, CVC and word units, with bilingual status as a between subjects and items factor. In reporting the results of these ANOVAs, we will focus on the interactions between bilingual status, since the main effects and the other interactions pattern very similarly as the results reported above from the two experiments.

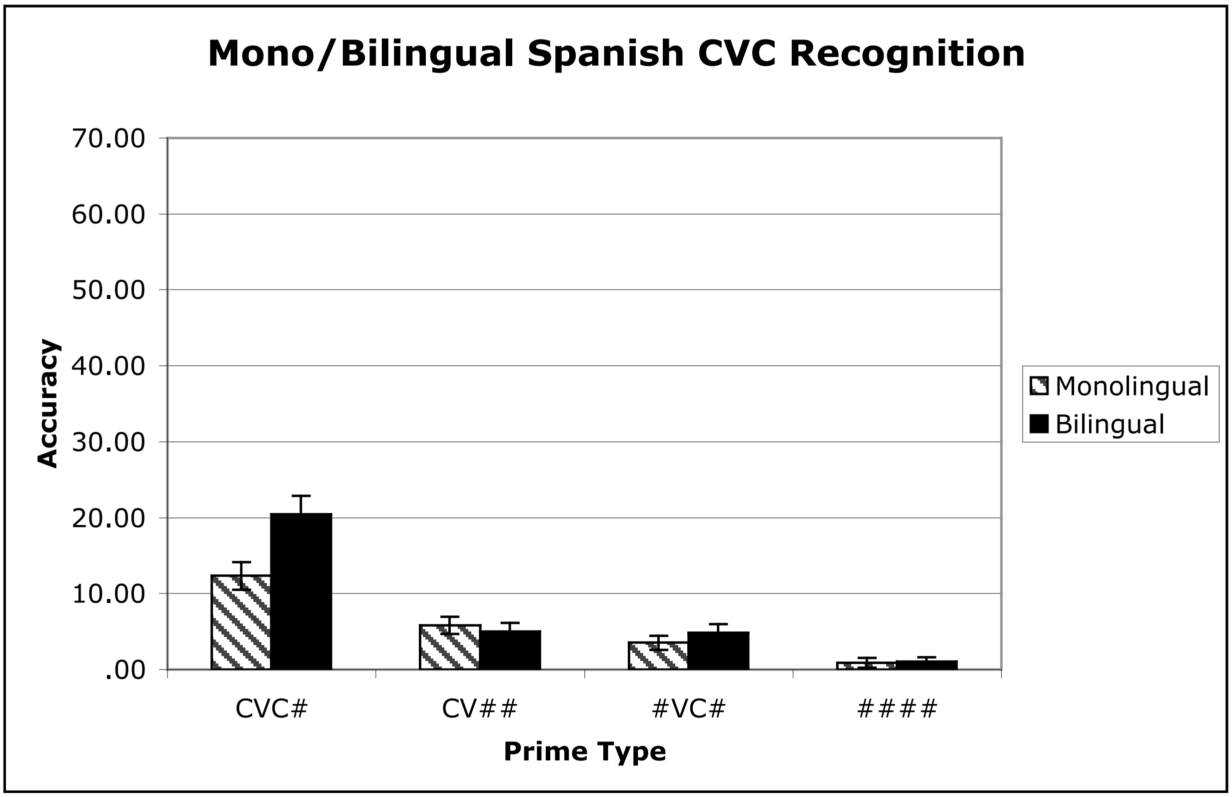

Figure 12: The effect of the various prime types on CVC identification in Spanish for Monolinguals and Bilinguals

In English, none of the interactions between prime types and bilingual status were significant for the different recognition units under consideration: CV, CVC, and word. In contrast, in Spanish, many of the bilingual status interactions were significant for the different units. For example, for CV identification, the interaction between CV primes and bilingual status was significant according to subjects ($F(1,46) = 4.98$, $p = .031$) and items ($F(1,118) = 4.94$, $p = .028$. This interaction between CV primes and bilingual status was further examined and confirmed with independent sample t-tests comparing CV recognition given the different prime types showing that only CV## primes resulted in a significant difference according to subjects (t(46) = 2.23, p = .016) and items (t(118) = 1.80, p = .03), with bilingual readers identifying more CV units than monolingual readers (Figure 11). This finding suggests that early word recognition in Spanish is not proceeding in the same manner in bilinguals as in monolinguals (arguing against the hypothesis that bilinguals adapt to the language that they are reading and show similar word activation patterns to monolinguals).

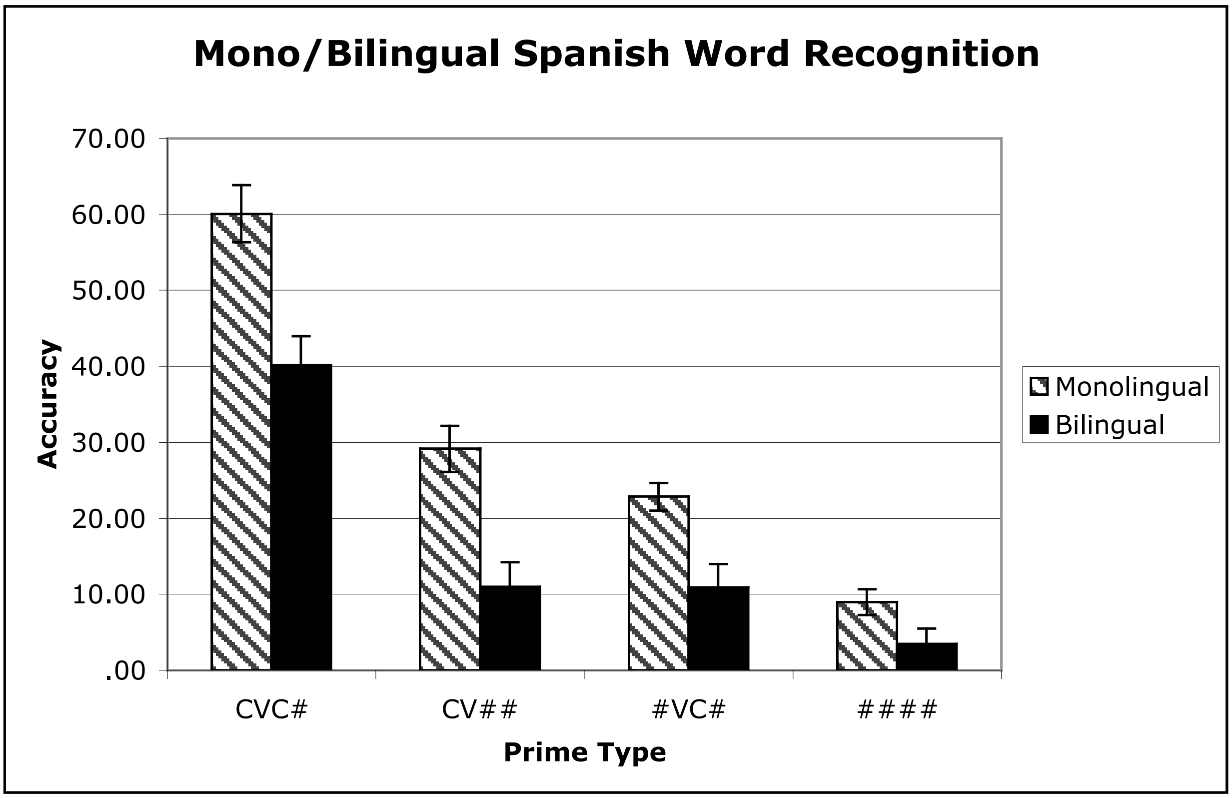

Figure 13: The effect of the various prime types on Word identification in Spanish for Monolinguals and Bilinguals

Turning to Spanish readers' identification of CVC, the interaction between VC primes and bilingual status was significant according to subjects (F(1,46) =11.31, p = .002 and items (F(1,118) = 4.27, p = .041. Also, the three way interaction between CV primes, VC primes and bilingual status was significant according to subjects (F(1,46) = 4.72, p = .035) and items (F(1,118) = 4.79, p = .031). Further examining the interactions with independent sample t-tests showed that CVC# primes resulted in significantly greater CVC identification for bilingual readers according to subjects ($t(46) = 2.67, p = .005$) and items ($t(118) = 2.06, p = .021$), further showing that bilingual readers are not as adapted to reading in Spanish since this unit does not theoretically represent a unit of word recognition in Spanish (Figure 12). Bilinguals' greater recognition of CVC units in Spanish in comparison to monolingual readers bears a marked resemblance to the finding that both monolinguals and bilinguals demonstrated greater activation of CVC in English, suggesting that exposure to English is influencing bilinguals' Spanish reading.

For Spanish word identification, the interaction between CV primes and bilingual status was significant according to subjects ($F(1,46) = 11.25, p = .002$) and items ($F(1,118) = 7.74, p = .006$). To further understand the interaction between prime type and bilingual status and the effects of the individual primes, we ran independent sample t-tests for the different prime types (Figure 13). Given CVC# primes, word identification was significantly greater in Spanish for monolinguals according to subjects ($t(46) = 3.76. p < .001$) and items ($t(118)= 4.13, p < .001$. Given CV## primes, word identification was significantly greater for monolinguals according to both subjects ($t(46) = 4.94. p < .001$) and items ($t(118) = 4.60, p < .001$). Also when shown #VC# primes, monolingual Spanish subjects identified significantly more words according to both subjects ($t(46) = 3.31, p = .001$) and items ($t(118) = 3.18, p < .001$). Finally, even for #### primes monolingual readers identified significantly more words in Spanish according to subjects ($t(46) = 2.47, p = .009$) and items ($t(118) = 2.46, p = .008$.

The fact that young Spanish monolingual readers activated significantly more words compared to bilingual readers regardless of prime type may be as a result of greater sensitivity to larger units typically found in developing readers, meaning that the monolingual Spanish readers took advantage of the difference in bigram frequency of the last bigram to activate more words. Alternatively, the greater word access may show that they are more highly adapted to reading in Spanish, using the consistent phoneme grapheme correspondence to more efficiently activate words.

Discussion:

Monolingual readers demonstrated varying activation of many different units in the two languages based on the different prime types in Experiment 4. Similar to Experiment 3, CVC# primes resulted in significantly greater recognition of CVC in English. Additionally, these primes resulted in significantly increased word identification in Spanish. These results suggest that readers are accessing a larger unit in English while in Spanish they are most probably aided by the higher bigram frequency of the last bigram or, alternatively, they could be helped by the superior Spanish grapheme/phoneme correspondence.

In fact, all prime types, except the control condition (####), led to greater word recognition for Spanish readers. This greater word recognition for Spanish readers has different potential interpretations. On the one hand, higher bigram frequency for the last two letters in Spanish could have aided them in guessing words based on the limited priming information provided in the experiment. While one can argue that higher bigram frequency was the key difference allowing Spanish monolinguals to access more words, this difference should have aided bilinguals, particularly adults, as well –which it did not in Experiment 3 with bilingual children and in Experiments 1 and 2 with adults. However, children seem to be especially sensitive to larger phonological units, sequentially developing greater sensitivity to smaller and smaller units, (e.g., Anthony and Lonigan, 2004; Anthony et al., 2002; Stanovich, 1992; Treiman and Zukowski, 1996). Children's focus on the larger units may have resulted in greater word recognition, especially for the monolingual Spanish readers because of the higher final bigram frequency.

Another potential explanation of the greater word recognition in Spanish compared to English for Spanish monolinguals may be the close match between Spanish phonology and graphemes, suggesting that Spanish monolingual readers are more skilled and automatic at accessing phonological information from letters. This more efficient conversion of graphemes into phonemes may be related to the much better sound/letter correspondence in Spanish in comparison to English. The shallow orthography allows readers to recognize words more efficiently, allowing them to activate words based on the limited information found in the different primes. While, according to this reasoning, the bilingual adults in Experiments 1 and 2 reported in Chapter Two should also have recognized more words in Spanish because of the transparent grapheme/phoneme correspondence, the more highly skilled adults had time to develop a greater dependency on syllables for word activation. All in all, the combination of factors favoring larger unit recognition, especially the difference in bigram frequency, is the most likely explanation of greater Spanish monolingual word recognition.

Greater word recognition in Spanish being aided by a transparent script agrees with research that has shown faster word recognition for participants reading in a shallow orthography (Frost et al., 1987; Kang and Simpson, 1996), studies that have shown more accurate use of phonology by learning readers in a more transparent writing system (Bruck et al., 1997; Ellis and Hooper, 2001: Frith et al., 1998; Goswami et al., 1998; Seymour et al., 2003) and with the grain size theory of reading (Ziegler and Goswami, 2005).

The last significant finding for Experiment 4 was also the only instance where we saw greater recognition of CV in either of the two experiments. Given #### primes, Spanish identified significantly more first syllables than English readers did. In essence, in the absence of priming, in the control condition, Spanish readers demonstrated a greater facility at recognizing the CV than English readers. This finding suggests that developing Spanish readers may be exploiting the syllabic level of the prosodic hierarchy at some point, but that their syllabic representations are not as developed as in adults and word access may not automatically use the syllabic level. Since partial identity priming is thought to tap into very early word recognition processes (Berent and Perfetti, 1995; Lukatela and Turvey, 2000; Perry and Zeigler, 2002), this result suggests that syllable activation is rapid and transitory in Spanish for young monolingual readers. In essence, when developing Spanish monolingual readers are given additional information, they move so quickly beyond the syllabic level of the prosodic hierarchy, to larger units, that priming effects are not readily apparent in the syllabic level. In fact, this finding may demonstrate less developed syllabic representations in younger, less experienced readers, further demonstrating their greater reliance on larger phonological units.

All in all, the results of the fourth experiment demonstrate that monolingual readers do read differently in English and Spanish, with Spanish readers most likely being helped by the higher bigram frequency in Spanish because of children's less developed representations of smaller phonological units. Alternatively, young Spanish monolingual may be making greater use of the phonological information given to them by the rapid partial identity priming paradigm to access significantly more words, taking advantage of Spanish's highly transparent script to efficiently convert graphemes into phonemes. Additionally, the greater recognition of syllables in the control condition suggests that developing Spanish readers' activation of syllables is fast and transitory, with a greater dependency on larger units for word access.

Comparison of Children Bilinguals to Adult Bilinguals

In Experiments 1 and 2 with adults, we used the same research technique and some of the same primes (CV## and #VC#) as we did in Experiments 3 and 4 with bilingual and monolingual children. In order to be able to directly compare the effect of skill level on bilingual reading, a statistical comparison of the results of the experiments is necessary. Accordingly, we ran 2 x 2 ANOVAs (adult status x language) to examine accuracy of identification of CV, CVC and word units, with both adult status and language a between subjects and items factor.

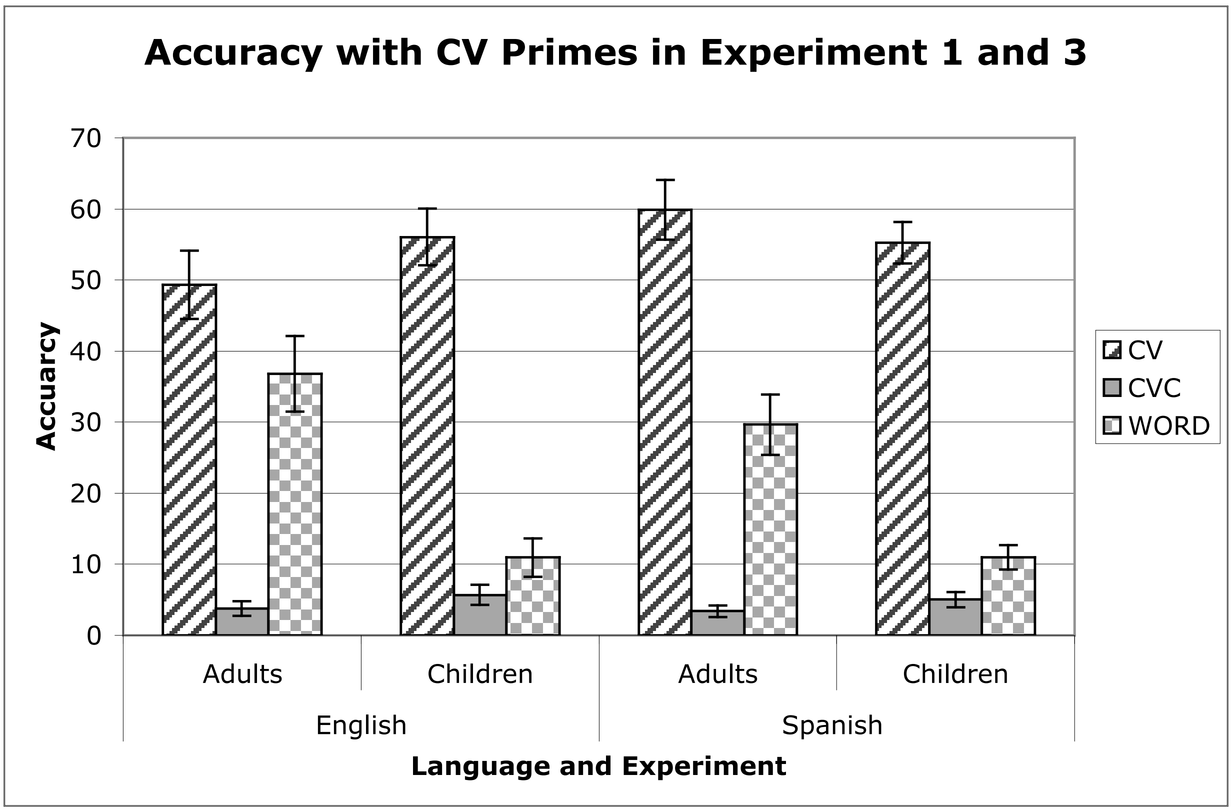

Figure 14: The effect of the CV## primes types on CV, CVC and Word identification for adults and children bilinguals in English and Spanish

For CV## primes, only the main effect of adult status was significant for word identification according to both subjects ($F(1,92) = 34.87$, $p < .001$) and items ($F(1,236) = 64.41$, $p < .001$). For all other identification units, the main effects and interactions were not significant. The difference in word recognition between adults and children given CV## primes was confirmed with t-tests, with adults recognizing significantly more words in English according to subjects (t(46) = 4.31, p < .001) and items (t(118) = 6.59, p < .001), as well as identifying significantly more words in Spanish according to both subjects (t(46) = 4.09, p < .001) and items (t(118) = 4.75, p < .001) (Figure 14). Similar to the ANOVA test statistic results, the t-tests showed that no other unit of recognition was significantly different according to adult status.

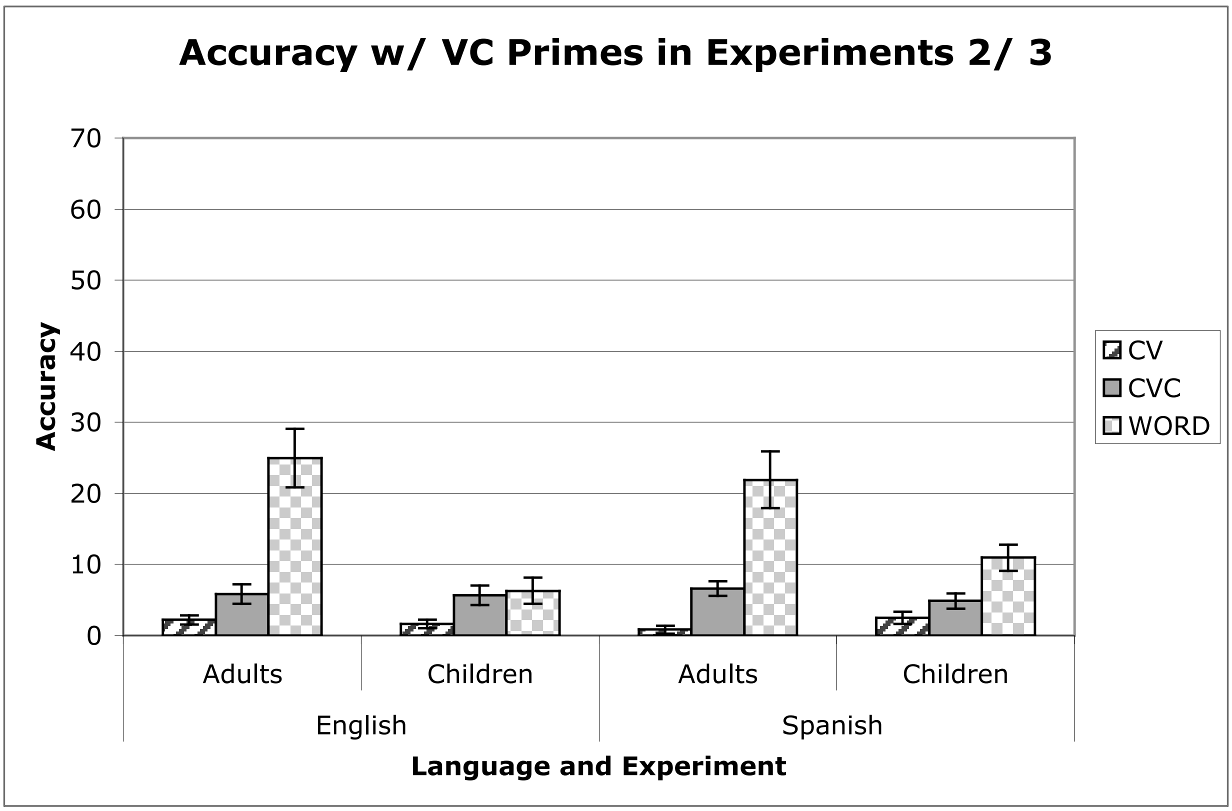

Figure 15: The effect of the VC## primes types on CV, CVC and Word identification for adults and children bilinguals in English and Spanish

An ANOVA comparison of the different units of recognition given #VC# primes according to adult status and language yielded comparable results, with the main effect of adult status significant for word recognition according to both subjects (F(1,96) = 5275.48, p < .001) and items (F(1,236) = 44.11, p < .001) (Figure 15). Once again this was the only significant main effect or interaction for all units of recognition. T-tests confirmed that adults recognized more words in English according to subjects (t(46) = 4.14, p < .001) and items (t(118) = 6.18, p <

.001) and in Spanish according to subjects ($t(46) = 2.50$, $p = .008$) and items ($t(118) = 3.31$, $p < .001$.

Discussion

A direct statistical comparison of the two primes that were the same for the adult bilingual subjects in Experiments 1 and 2 and the child bilingual subjects in Experiment 3 (CV## and VC## primes) demonstrates that given both prime types, adults activated more words than children did in both English and Spanish. Since adults have more experience with reading from many additional years of practice, this result is entirely comprehensible. Because of the many years to perfect reading skills, adults are likely to have much more complete phonological representations (Ziegler and Goswami, 2005). These phonological representations are adapted to the scripts that they have experience reading in, which in the case of these bilingual readers, included both English and Spanish. Additionally, since adults have greater word knowledge and a greater vocabulary base to draw on, they are more likely to able activate words just from the fact that they would be more familiar with them.

CHAPTER FOUR

General Discussion and Conclusion

General Discussion

These four experiments taken together further the case that readers of Spanish and English depend on different levels of the prosodic hierarchy in visual recognition of words. In addition, they provide evidence that experienced bilingual adult readers adapt to the languages that they read in. In contrast, developing bilingual readers may need additional practice to develop language specific activations for both of their languages. In this chapter we will discuss the results from Experiments 1 and 2 with adults first and then turn to the results from Experiments 3 and 4 with bilingual and monolingual children, before concluding.

Experiments 1 and 2

In Experiments 1 and 2, we see clear evidence that adults are activating words through different levels of the prosodic hierarchy depending on if they are reading English or Spanish. These results confirm the differing status of the syllable in Spanish and English in visual word access, with readers in Spanish exploiting the syllabic level of the prosodic hierarchy early in the visual word recognition process and readers in English using some larger unit in early word recognition during reading, with the syllable perhaps taking on greater importance in a later stage of activation.

The results from Experiments 1 and 2 corroborate prior findings that the syllable is a key sub-unit of lexical access in Spanish (Álvarez, et al., 1998; Álvarez, et al., 2000; Álvarez, et al., 2001; Álvarez, et al., 2004; Bradley et al., 1993; Carreiras, et al., 1993; Carreiras and Perea, 2002; Domínguez, et al., 1993; Perea and Carreiras, 1998). While prior research used either lexical decision or naming, the results from the present task complement previous work by demonstrating the importance of the syllable for lexical access in Spanish using a different experimental paradigm and directly comparing Spanish lexical access to English. The partial identity priming experimental method is argued to tap into early word recognition processes, with comparable techniques (e.g. backward masking) being used in previous research to garner evidence for prelexical generation of phonology (Naish, 1980; Perfetti and Bell, 1991; Perfetti, Bell, and Delaney, 1988) and the serial nature of phonological assembly processes (Berent and Perfetti, 1995; Lukatela and Turvey, 2000; Perry and Zeigler, 2002). While Perry and Zeigler (2002) noticed that the type of priming technique used in the present experiments is prone to strategic guessing by participants (since they are asked to write down a word even when they are unsure), we controlled for any difference in the ability to guess in the two languages through equating word frequencies, bigram frequencies and the transitional probabilities of the letters between the languages.

The most important finding from Experiment 1 was greater recognition of syllables in Spanish compared to English in response to first C### and CV## primes, which corroborates the syllable as a key unit in early visual word access. Also, because of this fundamental role of the syllable in early word recognition in Spanish, any priming within the first syllable does not robustly activate the entire word. The second experiment further confirmed the importance of the syllable in Spanish in comparison to English, as demonstrated by the greater recognition of first syllables in Spanish when readers are not presented with primes that cross the syllable boundary (#V## or #### primes). When Spanish readers saw a #VC# or a ##C# prime, they were hindered in their normal word recognition process. For adult readers of Spanish this prime did not give them access to the level of the prosodic hierarchy normally used in word access –despite the fact that one letter of the first syllable was supplied by a #VC# prime. Because of the rapid presentation technique, Spanish readers may not have been able to break the VC apart and parse the letters into their respective syllables. They were thus hindered in their recognition of the first CV. Supplying Spanish readers with the VC may have hurt Spanish readers' identification of the first syllable because this ensemble is not a unit or a part of any unit and does not respect the normal pathway of Spanish word recognition.

The results of Experiments 1 and 2 further the claim of previous research that suggested the use of the syllabic level of the prosodic hierarchy may come later in English visual word recognition (Ashby and Rayner, 2004; Ferrand et al., 1997; Jared and Seidenberg, 1990; Schiller, 2000). In general, the results support proposals that English readers use some larger pre-lexical unit than the syllable in visual word access. In particular, finding that English speakers are more likely to identify larger units, as shown with χ^2 test statistic, and the marginally greater word identification with C### primes, lends support to the claim that they use such a unit for lexical access. Also while English readers generally reacted to #VC# primes in a similar manner to Spanish readers, they showed slightly less inhibition in CV recognition given these primes and, suggesting that primes crossing the syllable boundary did not disrupt the normal English recognition process as much in Spanish. Also with the primes that did not cross the syllable boundary in the second experiment, readers' identification rates of English first syllables increased, but significantly less than in Spanish, further reinforcing the hypothesis that syllables are not as important in early word recognition processes in English. Finally, given #V## and #### primes readers reported the word more in English than in Spanish, thereby giving further support to the hypothesis that a larger unit is of greater importance in the initial processes of visual word recognition in English.

This difference between English and Spanish in their exploitation of the syllabic level of the prosodic hierarchy in visual word access may arise from structural differences between the two languages. In particular, Spanish has readily distinguishable syllables, with very clear boundaries unaffected by stress movement (Sánchez-Casas, 1996; Harris, 1983). Spanish speakers can easily and accurately segment words into syllables, with a large degree of reliability among raters (Carreires et al., 1993). In contrast, the syllable in English has a less clearly delineated phonology with syllable boundaries modified by such factors as stress, with many cases where a consonant on the border between two syllables has a quality of belonging to both syllables. Different theoretical accounts have attempted to clarify the phonological process at work that account for the structure of such medial consonants including ambisyllabicity (Kahn, 1976; Rubach, 1996), resyllabification (Selkirk, 1982), and the prosodic approach (Jensen, 2000). In general, syllabification of English words is often variable and native English speakers are not consistent in their syllabification judgments (Treiman and Danis, 1988a; Treiman and Danis, 1988b; Treiman et al., 1994). This suggests that syllables may not provide consistent cues for lexical access and that for this reason experienced readers may not initially or consistently exploit this level of the prosodic hierarchy in English. Positing a parser that sometimes exploits the syllabic prosodic level and sometimes not depending on the prosodic structure would seem to be highly inefficient, particularly in the initial stages of word recognition, when a reader is just gaining access to phonological and lexical information. However, recently just such a flexible parser was proposed for English with Ziegler and Goswami's (2005) grain size theory.

The present findings do not settle which unit is commonly exploited in early word recognition processes in English. While the results argue that some sort of larger sub-lexical unit plays a role in visual word access in English, they do not mediate between the different possibilities that have been theorized in the literature, including orthographically and morphologically based units (Taft, 1979), prelexical morphological decomposition (Butterworth, 1983; Cole, et al., 2000; Lukatela, et al., 1980), full morphological decomposition (Taft and Forster, 1975, 1976; Taft, 1994), a mixed morphological/whole word model (Chialant and Caramazza, 1995), or a flexible grain size model (Zeigler and Goswami, 2005).

In general, while previous researchers have theorized that some morphological based unit may be important in English visual word access, phonology must also play some role in activating words during reading. While morphologically based units may be important in English visual word access, phonology at some stage must also play some role, since words ultimately do have a phonological form. Gaining lexical access implies by its very nature gaining access to the phonological form of a word as well as its other aspects. During the time course leading to full lexical access or identification of the word, is phonology a bystander, while readers exploit other units, such as morphological ones or direct access? Our findings support Ashby and Rayner's (2004) argument that the prosodic level of the syllable is not exploited in initial visual word access and that its importance comes into play in later stages requiring phonological assembly. Additionally, our English results are not inconsistent with an interpretation that holds for a generalized later activation of phonology, with English readers first activating words in reading through orthographic units, such as morphologically based units.

However, phonology must play some role in early visual word access, since part of the role of letters in an alphabetic system is to provide phonological information. So the key question becomes: what is the present unit of activation? In addition to examining morphologically based units, phonologically based ones should be explored as well. So if syllable based units do not play a role in initial word access in English, then do higher levels such as the foot and the word play an earlier role? To study the issue of unit size from a phonological perspective, examining the next levels of prosodic hierarchy, including the foot and the prosodic word, would be helpful. In short, while morphology may play a role in visual word access, a complete model must allow some role for phonology, and if the syllable is not the key unit of lexical access, then larger units in the prosodic hierarchy should be investigated as well, as well as the timing of their exploitation. Or is the timing of the activation of phonology later in a language like English, or perhaps variable as suggested by the grain size theory? The issues of timing and variability also merit further exploration. If, in fact, English readers are flexible in their use of different sized phonological units, some of the next questions include if there is a preferred unit size and if the different units are exploited at different points in the visual word activation process.

Answering these questions will help determine the role of phonological representations in visual word access, and how their use may differ from spoken word recognition. In terms of timing, a speech stream already is initially received in a syllabic format (which does not necessarily correspond to actual words due to resyllabification effects), and must then be parsed into words to complete lexical access; whereas, in reading, the print stream (text) is divided into words when it is first encountered and the role of the parser is to divide the words into syllables, in effect giving them a phonological form. This initial difference in the ordering of phonological access makes it clear that the use of syllabic level of phonological representations is quite different in terms of timing between visual and oral lexical access. However, the difference in timing does not speak to whether and how the precise role of phonological representation may vary between spoken and visual word access. While the findings of Álvarez et al. (2004) suggest that the use of syllables by Spanish readers actually involves accessing phonological representations as opposed to orthographic ones, the same has not been found for English, with some researchers suggesting that English orthographic representations differ from phonological ones (e.g. Rapp, Folk, and Tainturier, 2001). For this reason, the role of phonological as opposed to orthographic representations is an open question in English and exploring the other levels of the prosodic hierarchy and the issue of timing is of fundamental importance to clarify the role of phonological representations in visual word access in English.

Next, #V## and #### primes had varying effects in Experiments 1 and 2. In the first experiment, these primes did not result in differing accuracy levels between English and Spanish for any of the studied recognition units. In contrast, in the second experiment, #V## and #### primes resulted in significantly greater identification CV in Spanish in comparison to English and greater word recognition in English. This difference in results arises from the different presentation contexts, since we controlled all other relevant variables such as subject characteristics and presentation, meaning that the effects of individual primes can vary according to which other primes that they appear with. Due to the serial nature of word recognition processes, primes representing varying positions within the words have differing effects (Berent and Perfetti, 1995; Lukatela and Turvey, 2000; Perry and Ziegler, 2002).

In the first experiment, #V## and #### primes were the least favorable primes; in comparison, in the second experiment, they were much more favorable –being earlier in the serial letter position in the case of the vowel and in both cases not violating a boundary in the prosodic hierarchy. In the first experiment, subjects followed their natural tendency to fixate on the first consonant and were reinforced by learning that this strategy was helpful. In contrast, in the context of the second experiment, subjects accommodated to the experimental primes by fixating on the first vowel. After a number of trials, subjects began to know that fixating on the first consonant was not helpful and shifted their attention to the first vowel. This difference in fixation led to the different priming effects of #V## primes, with these primes giving subjects more syllables in Spanish and more words in English. The difference in the baseline condition (#### primes) also arose from this difference in fixation. In the second experiment, subjects were concentrating on the first vowel. When presented with #### primes, the greater fixation on the first vowel boosted its recognition, leading to increased CV recognition in Spanish and greater Word report in English. In English, focusing on the first vowel, further on in serial position in the word, made subjects more likely to get the larger unit. In contrast, in Spanish focusing on the first vowel only gives subjects access to the syllable due to the importance of the syllabic level of the prosodic hierarchy in visual word recognition in Spanish.

Based on these experimental results, adult bilingual readers seem to adapt to the structure of the language that they are reading in, since differences in accuracy in identifying units of words and words varied in bilingual readers according to the language that they were reading in. Our findings agree with previous research that showed that bilinguals' reading in each of their languages was affected by the nature of the script being read (Oren and Breznitz, 2005; Shimron and Sivan, 1994). In addition, our findings do not contradict previous research that demonstrated that bilingual readers from a first language background where the script contains less phonological information are less dependent on phonology while reading in a second language in which the script offers greater phonological information (Koda, 1989; Saito, Inoue, and Nomura, 1979; Wang, Perfetti, and Liu, 2003: Wang, Koda, and Perfetti, 2003). In contrast to the present experiments, these studies did not directly compare bilinguals reading in both of their languages and did not look at the use of phonology in natural reading conditions. However, additional follow-up research directly comparing adult bilinguals to adult monolinguals is needed to clarify precisely how bilingual readers adapt to reading in different languages and how they differ in their practices from monolinguals.

All in all, our results support the claim that early visual word access in English and Spanish exploit different levels of the prosodic hierarchy, with the syllable playing a key role in Spanish and a less important role in English. Instead in English, some larger unit plays an important role in the early stages of visual word recognition.

Experiments 3 and 4

Experiments 3 and 4, taken together, supply additional evidence that readers of Spanish and English depend on different levels of the prosodic hierarchy in visual recognition of words. These results provide evidence that visual word access Spanish and English makes use of different units, suggesting that readers in English activate some larger unit in early word recognition during reading while providing weak evidence that Spanish readers may activate words via syllables.

Most importantly, the results of Experiments 3 and 4 support previous suggestions that English readers use some unit larger than the syllable, consistent with previous claims that English readers access words via larger grained units (Butterworth, 1983; Chialant and Caramazza, 1995; Cole, et al., 2000, Lukatela, et al., 1980; Taft and Forster, 1975, 1976; Taft, 1979, 1994; Ziegler and Goswami, 2005), without providing evidence to settle precisely which unit is used. Following these claims, bilingual readers recognized significantly more CVC units in English, given CVC# primes, as did monolingual readers. In fact, monolingual English readers and bilingual English readers did not differ from one another in CVC recognition given CVC#

primes. In addition, bilinguals reading Spanish recognized significantly more CVC units in Spanish than monolinguals, suggesting that they were accessing words in a similar fashion in both languages and in a manner very comparable to English monolinguals –a claim that will be discussed in further depth below.

In comparison, few results in Experiments 3 and 4 suggested greater use of the syllabic level of the prosodic hierarchy in Spanish. Only Spanish monolingual readers differed in CV recognition from English monolinguals given #### primes, recognizing more CV units. While this finding does not provide strong evidence that Spanish readers rely more on the syllabic level of the prosodic hierarchy, being in the baseline condition, it nonetheless suggests that this level of the prosodic hierarchy has some importance in Spanish for developing readers. In fact, Spanish monolinguals' access of the syllable level may be fast and transitory, with younger readers instead more sensitive to larger units. They have yet to develop the strong syllabic representations found in adult readers of Spanish. This interpretation is consistent with the large body of previously mentioned research that has shown that the syllable is a key unit of lexical access in Spanish for adult monolingual readers. The previous experiments have shown speed and accuracy effects with lexical decision and naming tasks (Álvarez, et al., 1998; Álvarez, et al., 2000; Álvarez, et al., 2001; Álvarez, et al., 2004; Bradley et al., 1993; Carreiras, et al., 1993; Carreiras and Perea, 2002; Domínguez, et al., 1993; Perea and Carreiras, 1998) but did not specifically examine the time course of syllable activation or the development of syllable sensitivity.

Otherwise the only other example of greater CV recognition was in comparing Experiments 3 and 4, with bilingual Spanish readers recognizing more CV units than monolinguals given CV## primes. This result seems inconsistent with greater activation in

Spanish of the syllabic level, because monolinguals should be more sensitive to this level of the prosodic hierarchy given the fact that they have been exposed to one language and script, meaning that they should have more completely developed phonological representations for Spanish. However, this finding may not be inconsistent, because monolinguals were much more likely to activate larger units than bilinguals. The monolinguals' greater skill in reading Spanish may have allowed them to access words given the CV, owing to the younger readers' less fully developed syllabic representations. In contrast, bilinguals, in comparison to monolingual Spanish readers, were not able to activate much more than the prime itself.

The weak evidence for syllable activation in Spanish in Experiments 3 and 4 contrasts with the results of Experiments 1 and 2 with adult bilingual subjects, in which the adults, reading in both English and Spanish, activated significantly more CV units in Spanish compared to English in response to both C### and CV## primes in Experiment 1 that primed within the syllable boundary, as well as when primed with #V## in Experiment 2 that primed across the syllable boundary. While the present experiments did not completely control for the effect of teaching techniques, all available evidence points to both the monolingual and bilingual Spanish developing readers being taught literacy using the traditional syllable segmentation and blending method.[2] Since this is the traditional teaching method in Spanish literacy, no reason exists to think that adults and children would have been taught in differing manners. For this reason, the logical interpretation of the varying use of syllables in adult and children readers is the difference in their experience and expertise in reading. Specifically, the difference between adults and

[2] In an observation of literacy training in Spanish at the dual language immersion school that provided over 60% of the developing bilingual subjects by the first author, the teacher was using the syllable segmentation and blending method. Also, when asked about the literacy training of the Spanish monolingual subjects, the lead teacher of the Spanish monolingual subjects indicated that this method had also been used with them (J.D.D. Peña-Ortega, personal communication, July 24, 2006)

children argues that the children are still developing language representations in reading, whereas the adult bilinguals are more fully adapted to the appropriate phonological level of activation for both of their languages. That children's sensitivity to language appropriate phonological units is still developing is well documented in the literature, generally moving from larger to smaller units (Anthony and Lonigan, 2004; Anthony et al., 2002; Stanovich, 1992; Treiman and Zukowski, 1996).

In general, the progression from larger units to smaller units and the less developed representation of the appropriate unit of visual word access may mean that young readers have not yet acquired the robust syllable activation found in adult Spanish word reading. For this reason, young readers may be more sensitive to effects spanning the whole word such as the difference in frequency for the last bigram found in our stimuli. Monolingual readers in Spanish may have identified more words because of the higher bigram frequency in the final portion of the word, permitting them to recognize more words than monolinguals reading in English given CVC#, CV## and #VC# primes. In addition, they also recognized more words than bilinguals reading in Spanish given CVC#, CV##, and #VC# primes. Monolinguals have had more experience with reading in Spanish than bilinguals, thereby further enhancing their word recognition ability given all prime types and the potential help given them by the difference in bigram frequency. All in all, young monolingual and bilingual Spanish readers have not yet developed solid syllable activations, making them more sensitive to larger units and the differences in bigram frequency.

Alternatively, the greater Spanish monolingual word recognition could be explained by the difference in orthographic consistency between English and Spanish. Research has found a greater reliance on phonology in adults reading in a transparent script (Frost et al., 1987; Kang and Simpson, 1996), and more rapid development of the phonological pathway to achieve accurate reading in transparent scripts (Bruck et al., 1997; Ellis and Hooper, 2001: Frith et al., 1998; Goswami et al., 1998; Seymour et al., 2003). Developing monolingual Spanish readers may have been much more efficient in their use of phonology due to the high degree of correspondence between graphemes and phonemes in comparison to English, allowing them to activate words much more swiftly and accurately in comparison to English monolinguals and bilinguals reading in Spanish. In comparison, adult readers have much more highly developed syllabic phonological representations in Spanish, meaning that their activation of syllables was much greater in response to syllable based primes. However, this alternative interpretation cannot overcome the fact that the difference in bigram frequency of the last two letters combined with the greater sensitivity of developing readers to larger units, less well developed syllabic representations and greater monolingual exposure to words in their one language favored word recognition in Spanish monolinguals in a more structural manner.

Regardless of whether the monolingual Spanish readers were more aided in word access by the difference in bigram frequency or the transparent letter-sound correspondence, they are clearly doing something different than the bilinguals. In fact, the bilinguals reading in Spanish showed evidence of being influenced by their exposure to English. When bilinguals reading in Spanish are compared to Spanish monolinguals, the bilinguals activated more CVC units given CVC# primes, similar to the pattern of what they recognized in English and also what English monolinguals identified given the same primes.

This suggests that the bilinguals must have been affected by their exposure to a language with an opaque script. In contrast, in the present study, bilinguals reading in English did not differ statistically in activation units from monolinguals. Bilingual exposure to Spanish did not appear to affect their English reading. So while monolinguals may adapt to the language that they are reading (e.g. Shimron and Sivan, 1994; Oren and Breznitz, 2005; Strid and Booth, 2006), their direct access to phonology may be disrupted by exposure to a script that has poor sound-letter correspondence. The present results suggesting that bilingual readers are affected by exposure to a language with poor sound/letter correspondence agree with previous research that demonstrated that bilingual readers from a first language background where the script contains less phonological information are less dependent on phonology while reading in a second language in which the script offers greater phonological information (Koda, 1989; Saito, et al., 1979; Wang, et al., 2003: Wang, et al., 2003). Whether this is only true of children readers, or an effect of language dominance, or if adults are also hurt in their use of phonology by exposure to a more opaque script would merit additional study, directly comparing adult monolinguals to bilinguals, as well as manipulating dominance.

In summary, Experiments 3 and 4 investigated the effect on being bilingual on lexical access in two languages, testing whether young Spanish and English monolingual and bilingual readers differed in the units of activation in visual word access. Our results suggest that English readers activated words using a larger unit than Spanish readers. Developing Spanish readers may need additional practice to fully develop visual word activation via syllables. In addition, the Spanish monolingual readers showed signs of being sensitive to larger units and the higher bigram frequency difference in the Spanish stimuli. This study also directly compared monolinguals to bilinguals to see if they adapted themselves to the nature of the script they are reading. While monolingual readers supplied clear evidence that lexical access precedes differently in the two languages, developing bilingual readers did not appear to adapt completely to the different scripts, with their exposure to English affecting their visual word access in Spanish.

Conclusion

In conclusion, these experiments have demonstrated that readers adapt to the phonological structure of languages and the script factors, including differing phoneme/grapheme correspondence and appropriate grain size. Results from the Experiments 1 and 2 demonstrate that adult bilinguals access different units in the language they are reading, exploiting the syllabic level in Spanish and using larger units in English. In contrast, Experiments 3 and 4 show that children bilingual readers need additional time developing activation of the appropriate phonological levels for each of their languages. While they show signs of activating larger units in English, they did not appear to activate Spanish words via syllables. In fact, their reading in Spanish appeared to be heavily influenced by English, arguing that they may need more time to develop appropriate Spanish activation routes, or that exposure to a more opaque script may have affected visual word access in Spanish. In contrast, monolingual readers in Spanish, activated words in a manner clearly different from bilinguals, identifying more words given all prime types.

Additional research will further the research goal of increasing our understanding of how different writing systems are processed in the brain, allowing a greater examination of the effect of differing phonological structure, script differences, developmental changes, and exposure to two writing systems. While not directly concerned with pedagogy, these results allow scientifically appropriate teaching strategies to assist at risk second language learners, suggesting that pedagogy should adapt to the phonological structure of the target language. Therefore, in

English, the focus should be on teaching larger units as well as more fine-grained ones. In comparison, in Spanish, teach literacy should highlight finer grained units like phonemes and syllables. In the case of teaching bilingual reading, teachers should focus on helping learners understand the differences between the two systems they are being exposed to. These findings can specifically help the large numbers of Spanish-English bilinguals in the US and the world, but also second language learners in general. In an age of increasing globalization, with great numbers of second language learners, understanding how scripts are processed in the brain is an important goal for reading theory, with wide-reaching implications for education and second language learning.

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Appendix One: Test Stimuli

Table 15: Examples of stimuli

English Test Words									
Group 1:									
bevy	gory	nosy	tuna	wavy	yoga	memo	hazy	lily	duly
pony	posy	wary	rosy	tidy	lazy	zero	navy	sofa	vary
pity	copy	holy	busy	duty	tiny	lady	baby	body	many
Group 2:									
savor	cedar	diner	giver	lager	mover	donor	meter	rotor	rover
sever	maker	poker	finer	lever	razor	ruler	sober	safer	liver
baker	vicar	lover	fever	sugar	cover	river	paper	later	water
Spanish Test Words									
Group 1:									
bono	gafe	leño	jota	doma	bobo	beca	foro	cano	vilo
coco	loro	reja	mona	bala	dale	rota	paja	roca	tomo
vela	hoja	raro	loco	dedo	luna	baja	boca	cara	cada
Group 2:									
jaco	gula	faja	lego	faro	feto	duna	nata	rima	foca
pato	mole	pala	lodo	mago	mora	foco	pera	lata	sano
codo	lobo	mono	raza	rico	rato	mala	sola	bajo	modo

Appendix 2: Language Use Survey

Name ______________________ Subject Number___________

Language Use Survey

1. When is your birthday?

2. What was the first language that you learned?

3. What the language that you used most frequently when growing up?

4. Did you learn other languages as a child?

    If yes, which ones and when did you start to learn them.

    How much did you use them?

5. In which language did you learn to read first?

6. What language do you speak the best?

7. What other languages do you speak? How would you describe your proficiency in all of your languages on a scale from 1-6, with 6 being good and 1 being bad?

8. How long have you studied the languages that you learned at a foreign language and at what age did you learn them?

9. How much have your read in the languages that you know? Use a scale from 1-6, where 1 is little and 6 is a lot.

10. In everyday life, how much do you use the various languages that you speak?

11. In what countries have you lived? How long have lived in each one?

Nombre______________________ Número de participante___________

Enquesta sobre el uso del lenguaje

1. ¿Cuándo es tu cumpleaños?

2. ¿Cuál es el premier idioma que aprendiste?

3. ¿Qué es el idioma que utilizaste lo mas como niño(a)?

4. ¿Aprendiste otros idiomas como niño(a)?

   Si aprendiste otros, ¿cuáles y a qué edad?

   ¿Cuánto utilizaste los otros idiomas?

5. ¿En qué idioma aprendiste a leer en premiero?

6. ¿Cuál es tu idioma dominante o mejor?

7. ¿Cuáles otros idiomas conoces? ¿Qué es tu nivel de competencia en aquellos? Utiliza una escala donde 1 es debil y 6 es fuerte.

8. ¿Durante cuánto tiempo estudiaste los idiomas que has aprendido como segundo idioma y a qué edad empezaste a aprenderlos?

9. ¿Cuánto has leído en los idiomas que conoces? Utiliza una escala donde 1 es poco y 6 es mucho.

10. En tu vida normal, ¿cuánto tiempo utilizas tu idiomas diferentes?

11. ¿En cuáles paises has vivido? ¿Durante cuánto tiempo has vivido en cada uno?