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Sentence recognition in native and foreign languages : comprehension of form and meaning

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Abstract

The goal of language comprehension is to retrieve and retain the meaning of speech or text. Research with monolinguals has shown that participants' ability to detect structural changes in sentences decreases with time, while their ability to detect meaning changes remains accurate (Sachs, 1967). In this study I examined whether this monolingual pattern holds for bilingual speakers in a second language. English-Spanish bilinguals at three different proficiency levels participated in a reading task in which native (L1) and non-native (L2) language sentences were presented. Participants read both L1 and L2 sentences and were then tested for their recognition of the sentences. The test sentences were either identical to the original sentences, or were altered in meaning or in form from the originals. Results confirm a significant main effect of change type, two-way interaction effects (proficiency x change type and language x change type), and a three-way interaction between language, change type, and proficiency. The results are discussed using a new model for understanding second language reading comprehension.

I certify that I have read this thesis and find that, in scope and quality, it satisfies the requirements for the degree of Master of Arts.

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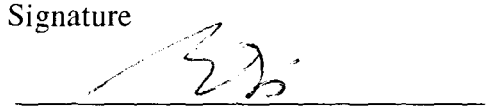

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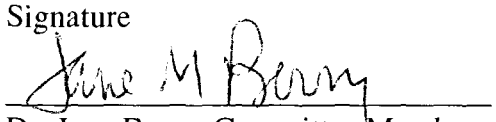

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SENTENCE RECOGNITION IN NATIVE AND FOREIGN LANGUAGES: COMPREHENSION OF FORM AND MEANING

By

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Sentence Recognition in Native and Foreign Languages:

Comprehension of Form and Meaning

The brilliance, efficiency, and creativeness of language have both fascinated and perplexed researchers for decades now. Topics within the domain are as extensive as the many languages spoken across the globe. Second language learning, in particular, has become a subject of great attention and prolific research. Scientists are increasingly intrigued by the differences between native (L1) and non-native (L2) language learning. A first language is rather effortlessly acquired in a naturalistic setting. In contrast, second-language learning can take a variety of forms, with proficiency being influenced by a number of cognitive, motivational, personality, age, and aptitude variables (Harrington, 1992).

Reading comprehension is a primary component of second language learning. The topic provides a practical line of inquiry not only for scholars, but for educators who wish to increase the efficacy of second language teaching. For instance, if an individual is already well skilled in reading his/her first language, will reading in the second language simply build upon the general skills acquired from L1? Or does reading comprehension in L2 depend more on language-specific factors such as knowledge of orthography, vocabulary, and syntax?

In this study I examine the influence of a person's language proficiency level on attention to and memory for written sentences. Before delving into theory and literature however, it might be helpful to begin with an example. Take a moment to read through the following passage.

> I have two passions in life - monkeys and wrestling. Wrestling is a fun sport. Monkeys are a fun animal. You know what's great? ... combining the two! Wrestling monkeys is entertaining. Usually I wrestle only one at a time. Every now and then I like a challenge though. On those occasions I compete against two or three. Some people call me creepy because I like to wrestle monkeys. Is it really that weird?

Now, without looking back at the passage, which of the following sentences did you read?

1. Wrestling monkeys are entertaining.
2. Wrestling monkeys is entertaining.
3. It is entertaining to wrestle monkeys.

Most likely, you chose either sentence 2 or 3 as your answer. Both of these sentences communicate the same idea, whereas sentence 1 communicates something different than what was read in the passage. The correct answer is in fact sentence 2. Note that sentence 1 looks nearly identical however; it differs from sentence 2 by only one word. Yet, this one word makes a dramatic difference in how the sentence is interpreted. In sentence 1 *monkeys* is the subject of the sentence and *wrestling* is simply an adjective describing what kind of monkeys. In sentence 2 *wrestling* is the subject and *monkeys* is a direct object. If you had read and understood the passage, even if you did not remember the exact wording of the sentence, you should know that the author enjoys the act of wrestling monkeys, which is communicated in sentences 2 and 3.

This example provides the opportunity to lay out some key terminology used throughout the past and current research. Sentence 1 is what will be referred to as a *meaning change* sentence throughout the paper. A meaning change sentence looks nearly

identical to the original sentence. It may only be altered by one word, or even just a few letters. However, that alteration causes a change in semantics. Contrastingly, sentence 3 will be referred to as a *form change* sentence throughout this paper. Form change sentences do not resemble the original sentence in structure, but they do preserve meaning.

As a follow up to this example, try reading the following passage.

> Mang narkloft ippity chut swerd. Cringy blickets swump bri chird lengoford. Wick spem ratchmud alumso dibbo. Libe jarsdifer noque. Hipperass wap limvetter chie.

Now, without referring back to the passage, which of the following sentences did you read?

1. Aight lengoford cringy bri blickets.
2. Cringy blickets swump bri chird lengoford.
3. Cringy blickets swurp bri chird lengoford.

Again, sentence 2 is the correct answer. This time you most likely debated between choosing sentence 2 and sentence 3, even though sentence 3 involves a meaning change (think of the swump/swurp distinction as similar to the is/are distinction in English). You probably remembered that the original sentence did not look like sentence 1, which involves a form change.

Hopefully these examples not only clarify the terminology that will be used throughout this paper, but they attune you to your own processing in a native versus foreign language. When we are familiar with a language, we process it based on meaning; exact wording becomes relatively inconsequential (Sachs, 1967). In contrast,

when we are less familiar with a language and have no way to make sense of it, we pay attention to other aspects such as form.

The purpose of this study is to examine sentence recognition in L1 and L2 by incorporating theories of language learning, discourse comprehension, memory, and attention. Of central interest is whether proficiency level in a second language affects the features of discourse to which an individual attends. Thus, when reading a passage, do those who are more proficient in a second language pay attention to different aspects of a text than those who are less proficient? If so, what are the implications for memory and comprehension? Since these questions cover a range of research areas, it is necessary to review several lines of relevant background literature prior to detailing any hypotheses.

The Critical Period

The concept of a critical period for language has been a hotly debated topic since 1967, when Lenneberg posed a biological constraint theory of language learning. This paper can hardly navigate the extensive literature on the subject area, but two consistent findings from critical period research are foundational to this study. First, there is not just one critical period, but more likely several sensitive periods that extend across language type (L1 and L2) and language components. Thus, there may not be any critical period for vocabulary, yet a very distinct and early critical period for phonology. If this were the case, we could acquire new words throughout our lives, but correct pronunciation and associated accents would be constrained by some confluence of biology, cognition, and environment (Harley & Wang, 1997). Secondly, despite disagreement over biological determinism, studies consistently find that with increasing

age of L2 acquisition comes decreasing proficiency in that language (Bialystok & Miller, 1999; Birdsong & Millis, 2001; Hakuta, Bialystok, & Wiley, 2003; Johnson & Newport, 1989). Late learners of L2 are less likely to master a second language than early learners. Naturally there are exceptions and qualifications to this assertion. For one, Birdsong and Millis (2001) report that amount of L2 use acts as a strong predictor of performance. Thus, age is hardly everything; variables such as practice can indeed influence L2 proficiency.

Levels of Representation

Language can be represented hierarchically, proceeding from a bottom layer of the most simplistic element to a top layer of the most complex or abstract. According to Craik and Lockhart's (1972) *depth of processing theory*, perceptual processing is similarly hierarchical. Lower levels of processing are concerned with the analysis of physical and sensory features, whereas higher levels focus on semantic analysis and elaboration. The stage at which processing occurs determines the memory trace that is left behind. Thus, higher levels of analysis are associated with stronger, more elaborate traces that last longer in memory because they have undergone deeper processing.

The number of items held in memory depends on the level at which the processor is operating. Because semantically relevant material can make use of past knowledge and rules, it is more easily retained. More superficial visual analyses, such as randomized letter strings, are difficult to retain for long because there is no coherent way to integrate and meaningfully elaborate on them. Because practical tasks in daily life generally require only meaning extraction from various stimuli, it is advantageous to store

information at a higher level of representation. Contrastingly, there is little rationale for storing the products of preliminary, lower-level analyses (Craik & Lockhart, 1972).

Using the logic of the depth of processing model, McClelland and Rumelhart (1981) explicated their own *interactive activation model,* a model of letter perception based on hierarchical levels of representation (see Figure 1). Rather than providing a broad picture that simply contrasted low versus high levels of processing, the authors suggested that perceptual processing occurs in a system composed of several specific levels. Each of these levels is concerned with forming a representation at a different stage of abstraction. McClelland and Rumelhart attempted to explain their model using a typical process in daily life, word recognition. According to the model, words correspond to one level of the hierarchy with sentences and themes located above, and letters and their constituent features located below. The lower elements build upon each other to form higher levels of representation. Therefore, a feature makes a letter, a letter makes a word, a word makes phrase, et cetera. However, despite the hierarchical form of the model, visual perception need not proceed through just one linear pathway. Rather, processing occurs in parallel such that several levels feed into each other simultaneously. This means that if we encounter a word in context, there are multiple routes for processing and attaching meaning to that word. For one, we can process the individual letters, piecing them together to compose the word itself. We can also process the word from a more global understanding of its relationship to the discourse.

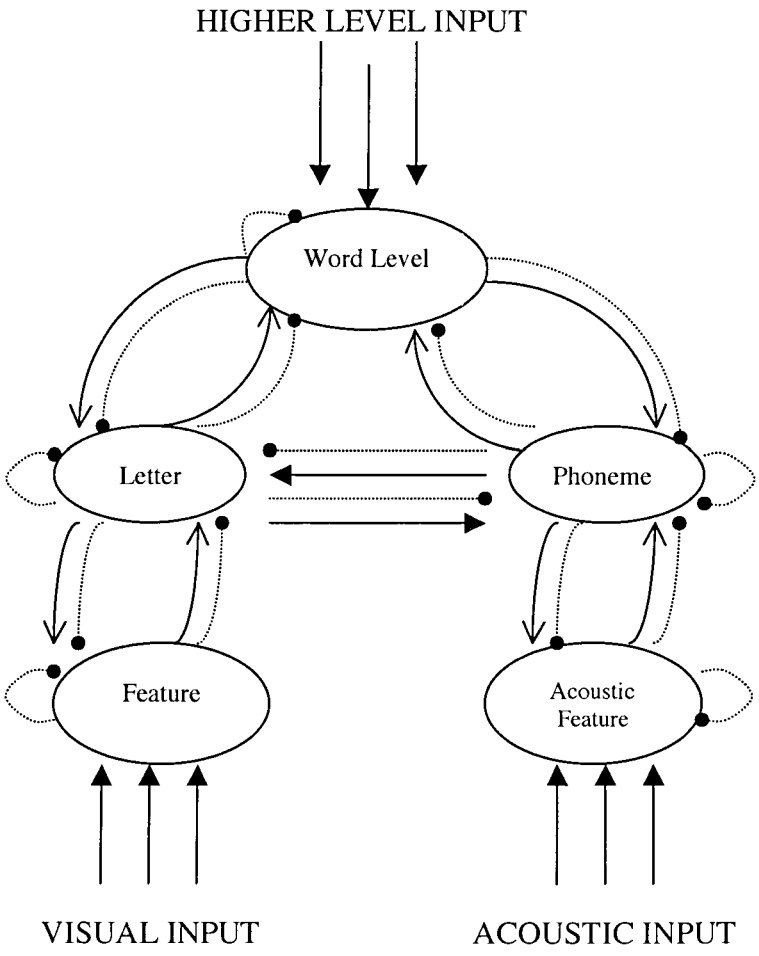

Figure 1. McClelland and Rumelhart's (1981) interactive activation perceptual model. Linguistic elements are arranged hierarchically from the most basic on the bottom, to the most abstract on top. Processing occurs in parallel, with several levels feeding into each other at the same time.

These two methods respectively define bottom-up and top-down processes. In a situation where cognition works top-down, prior knowledge and expectations drive the perceptual process. In a bottom-up situation, more basic data, such as orthographical features, act as the driving force, building up to increasingly complex levels of representation. In regard to word recognition, McClelland and Rumelhart advocate an interactive process that simultaneously uses top-down and bottom-up processing. Many variables contribute to the weight of directionality, for example, one's familiarity with the

material being read and the conceptual congruence of the discourse (Townsend & Bever, 1988).

Discourse Comprehension

In the language hierarchy, discourse finds itself at the top. According to the levels of representation theory, this has consequential implications for comprehension. Because discourse contains features, letters, words, sentences, and themes, it can be understood through its component parts, or bottom-up processing. At the same time, discourse provides a fascinating area of analysis because of the influence of context. Even if a word is unfamiliar or if a sentence is vague, the discourse as a whole can provide clues using top-down processes to clarify any uncertainties. Whereas a sentence out of context can be ambiguous, a sentence in connected discourse is rarely unclear (Graesser, Millis, & Zwaan, 1997).

Scholars have come to distinguish discourse according to three representational levels: the surface code, the textbase, and the referential situation model. The surface code is the most superficial of the levels. It preserves exact wording and syntax of clauses. Using Craik and Lockhart's conceptualization, surface code is a low-level, shallow means of processing. A step above surface code, the textbase preserves meaning, but in a stripped-down form rather than via exact wording. Finally, the situation model is the larger content of the text. Through both explicit features of the text and one's background knowledge of the world, the situation model constructs a microworld of the discourse (Graesser, Millis, & Zwaan, 1997). The situation model entails the deepest level of processing.

Studies confirm that when given sentence recognition judgment tests, individuals show a rapid decay of the surface code and a very slow decay of the situation model. The textbase remains in between. As might be expected, attention to each of these levels is situation dependent however. When reading certain pieces of literature, surface code is enhanced in relation to the situation model. Yet, when reading a newspaper article, the situation model is enhanced and surface code reduced (Zwaan, 1994). Imagine the difference between reading a passage from Shakespeare and reading an article about rising oil prices. Shakespeare's work is appreciated for its structure and rhyme. Compared to a news story, which merely requires the reader to extract gist, a Shakespearean passage is often committed to memory verbatim. Thus, it seems that intention plays a key role in determining which level of representation is most activated.

Sentence Recognition

In her classic study on recognition memory for sentences, Sachs (1967) presented English monolinguals with passages of approximately 160 syllables, generally totaling 14 sentences. In the test phase of the experiment subjects were asked to choose, from four options, the sentence that they had heard in the passage just moments before. Of these options, one sentence was identical to the original, one was altered in meaning, one was altered in voice (active versus passive), and one was altered in form. A form change sentence essentially switched clauses of the sentences around while still preserving the meaning. For example, Sachs changed the original sentence, "He sent a letter about it to Galileo, the great Italian scientist," to, "He sent Galileo, the great Italian scientist, a letter about it". A semantically altered sentence changed the meaning: "Galileo, the great

Italian scientist, sent him a letter about it." As time elapsed between the initial listening phase and the testing phase, participants' abilities to detect form and voice changes in sentences fell, while detecting meaning change remained fairly accurate (see Figure 2). It was concluded that once a sentence was understood, little of its grammatical form was remembered. Instead, meaning abstraction and retention were key. Lower levels of processing were forsaken for higher, semantically rich levels of elaboration that could be more easily retrieved from memory. Though this experiment only tested native English speakers, it provides a pleasing bridge to more modern topics in bilingual research.

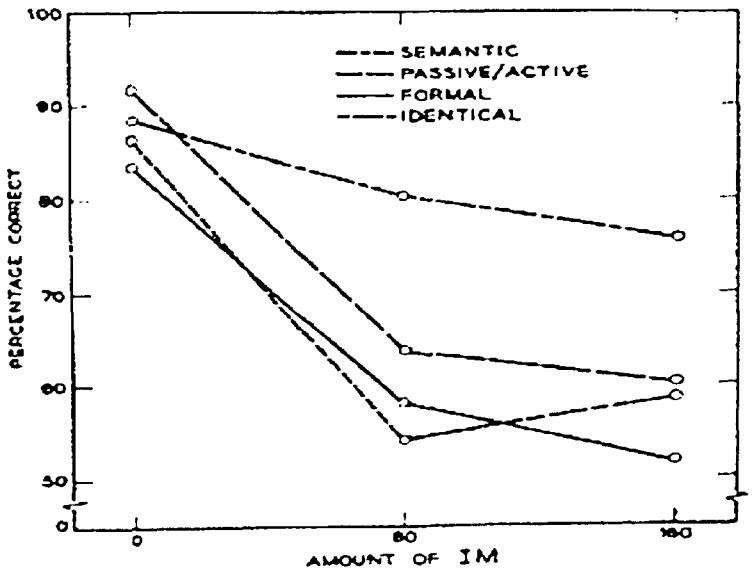

Figure 2. Results from Sachs research (1967). Meaning change sentences were comparatively easier to identify after 80 syllables of interpolated material than form change, voice change, and identical sentences.

Bilingual Memory

One of the key issues in bilingual research is language representation, the process of mapping a word's form to its meaning. The central debate within this line of research focuses on how linguistic information is represented in bilingual memory. While some theorists advocate a single code system, others maintain the existence of a dual code mechanism. The former is modality independent such that words are represented in a supralinguistic code that does not depend on the language in which words occur. The latter is modality specific, asserting that separate language codes exist but that these codes can be coordinated via associative links (Durgunoglu & Roediger, 1987).

Researchers have developed several methods to test these competing theories of bilingual memory and processing; sentence priming, lexical decision tasks, picture-naming tasks, and reading/translating are just a few (for a review, see de Groot & Kroll, 1997). However, because bilinguals are by no means a homogenous group, and since different tasks tap into different types of processing, the results of several studies appear contradictory, supporting both of the coding systems mentioned above.

Hoping to better understand the bilingual coding mechanism, Potter et al. (1984) tested two types of hierarchical models. Though the models differ in their suppositions, both are based on a language independent view of conceptual memory. According to this view, there are two levels of representation in bilingual memory – lexical and conceptual. Words are represented at the lexical level. Semantics and general knowledge about the world are represented at the conceptual level (Altarriba, 2003). Furthermore, separate lexicons exist for the bilingual, an L1 lexicon and an L2 lexicon (de Groot et al., 1994).

Because the L2 lexicon is less developed, it is represented with a smaller box (see Figures 3, 4, 5).

The *word association model* poses a direct link between the L1 and L2 lexicons and a direct link between the L1 lexicon and the conceptual store. However, no such conceptual link exists between the L2 lexicon and the conceptual store (see Figure 3). Thus, words in one's second language can only access concepts via words in one's native language. In contrast, the *concept mediation model* adds a link between the L2 lexicon and the conceptual store, allowing for direct access to concepts in both languages (see Figure 4).

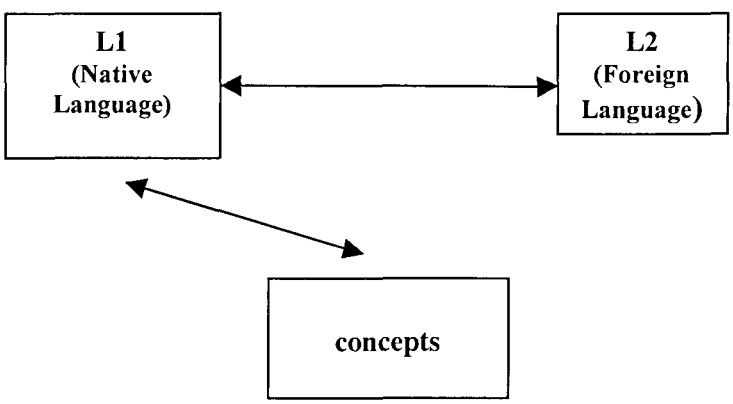

Figure 3. Potter et al.'s (1984) word association model. A lexical link exists between L1 and L2. There is a link between L1 and concepts, but no direct link between L2 and concepts.

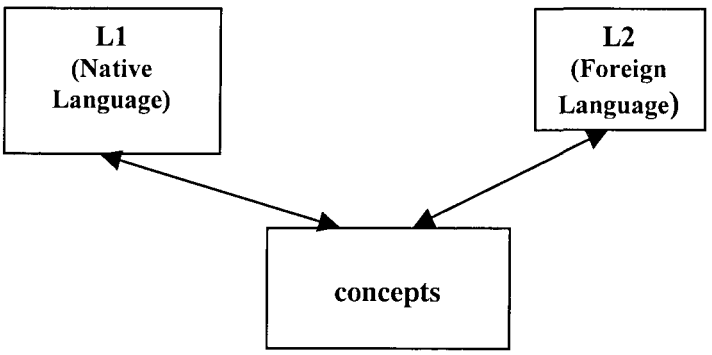

Figure 4. Potter et al.'s (1984) concept mediation model. Conceptual links exist for both L1 and L2 lexicons.

In order for the word association model to be valid, translation from the first language to the second language would have to be faster than naming a picture in the second language. This is because picture naming requires conceptual mediation whereas translation does not. In fact, Potter et al. found that translating into the second language took bilinguals approximately the same amount of time as naming pictures in the second language. Thus, both tasks must have used conceptual processing, thereby supporting the concept mediation model.

The explanation is not nearly that simple though. In 1988 Kroll and Curley carried out a similar study taking L2 proficiency level into account. Results supported the word association model for less proficient second language learners and the concept mediation model for more proficient second language learners. These results seem to indicate a developmental tract from lexical to conceptual processing as proficiency in a language increases (de Groot & Kroll, 1997).

In order to incorporate new findings, a *revised hierarchical model* was formulated. This revised model assumes that the bilingual has access to both lexical and

conceptual memory links but that the strength of the links differs as a function of fluency in the foreign language and the relative dominance of native language to foreign language (Kroll & Stewart, 1994). Figure 5 provides a depiction of this model. The central premise of this paradigm is that connections in the bilingual's memory are asymmetric. More specifically, translation is conceptually mediated from L1 to L2 but lexically mediated from L2 to L1. The revised hierarchical model maintains that since the links between L1 words and concepts are stronger than links between L2 words and concepts, L1 words have privileged access to meaning (Sholl, Sankaranarayanan, & Kroll, 1995).

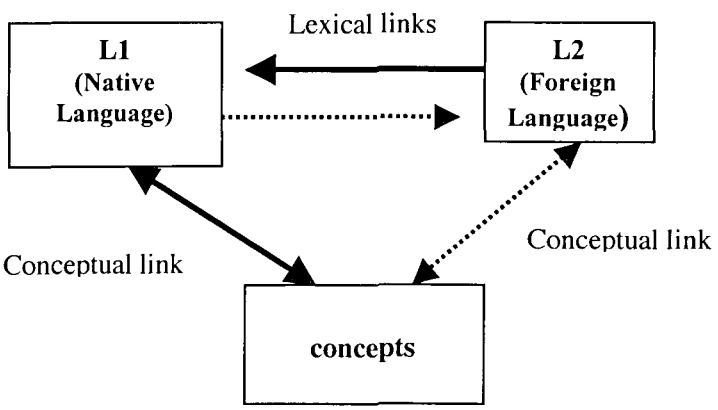

Figure 5. Revised Hierarchical Model (from Kroll & Stewart, 1994). Words in each language are interconnected by lexical and conceptual links. Lexical links are stronger from L2 to L1 than from L1 to L2. Conceptual links are stronger for L1 than for L2.

Research continues to add support to the revised model. As proficiency level in L2 increases, individuals experience a shift from reliance on form to reliance on meaning. Researcher and teacher, Adrienne Talamas (1999), was intrigued when she noticed that high school students in basic level Spanish courses made form-related lexical errors that were only rarely observed in students from more rigorous Spanish classes. Students in

the basic class, which operated at a slower pace and covered less vocabulary and grammar than the enriched class, confused words with similar spelling, even when such words were not semantically congruent with the context. In contrast, students in the enriched class rarely committed the same type of errors. Talamas reports several anecdotes, one in particular about a student who interpreted "Como es la **mujer**?" (What is the woman like?) as a question about his best friend. This is certainly reasonable since in Spanish ***mejor*** means *best*.

Subsequently, Talamas, Kroll, and Dufour (1999) used a translation recognition task to tease apart the developmental sequence of second language learning. In such tasks, participants are presented with a word in one language and asked to decide if a second word is the correct translation. Thus, in a correct translation example, the following pair might be presented: garlic–ajo. For this experiment, correct, form-related, and semantically-related translations were presented to English-Spanish and Spanish-English bilinguals with varying levels of L2 proficiency. In the form-related translation examples, the second word looked similar to the first word (e.g., garlic-ojo (eye)). In the semantically-related condition, the second word was related in meaning to the first word (e.g., garlic-cebolla (onion)). Results confirmed Talamas' informal classroom observations. Less fluent bilinguals showed impaired performance when presented with translation pairs that were similar in form but not when pairs were semantically related. The reverse was true for the more proficient bilinguals.

This fluency variable has provided an exciting new route for understanding bilingual word mapping. Recently, Silverberg and Samuel (2004) offered further

empirical support for the revised hierarchical model, but made note of essential additions and qualifications, particularly establishing age of L2 acquisition as an integral factor in determining the activation architecture of an individual. Learning a language in childhood (prior to age 7) appears to result in a fundamentally different representational architecture than learning a language later in life. In fact, it seems that even highly proficient bilinguals who learn a language past age 7 have different lexical and conceptual representations than their early bilingual counterparts.

The authors made these conclusions after finding that cross-language semantically-related primes facilitated lexical decision making for early bilinguals but not for late bilinguals. In contrast, cross-language form-related primes had no effect on early bilinguals; yet, late bilinguals experienced an inhibitory effect when such primes were presented. For late bilinguals there was competition between the form-related prime and target, suggesting a shared lexical store for L1 and L2 but different conceptual stores. On the other hand, early bilinguals share a conceptual store for both languages but have separate lexical stores.

Approaching bilingual processing from a different angle, cross-language Stroop tasks have also lent support to this general model. Stroop tasks require one to name the color of a word when the word itself is a conflicting color; for instance, the word *red* might be printed in green ink. The task is essentially a competition between meaning retrieval (e.g., What color is this I see?) and word recognition (e.g., What is this word I'm reading?). Early studies with bilinguals reported that at the beginning stages of L2 learning, Stroop interference was greater in the native language than in a second

language. A similar pattern was found for response times in picture-word tasks. Inconsistent words in the dominant language produced greater semantic interference than inconsistent words in the weaker language (Magiste, 1984).

Investigations like these have added support to the contention that less proficient second language learners suffer more interference from form-related words than from semantically-related words. As one becomes more proficient in a language, he/she progresses from reliance on form to reliance on meaning.

Searching for a Link

The background literature of this study draws on a number of substantial fields that may seem scattered and disjointed. Fortunately, a recent model by Barcroft (2002) manages to bring these various theories and findings full circle. Barcroft has expanded on Craik and Lockhart's 1972 theory by introducing the *type of processing-resource allocation* model (TORPA). This model visualizes structural (form) and semantic elaboration as a sort of teeter-totter such that as structural elaboration and memory increase, semantic elaboration and memory must thereby decrease. In essence, it is difficult for learners to process input for both form and meaning simultaneously.

With this in mind, the current study aims to examine the processing strategies of native English speakers learning Spanish as a second language in a classroom setting. Despite the number of tests evaluating bilingual word recognition, up to this point there has been little research examining memory for sentences in bilinguals. Thus, the purpose of this experiment is to understand how bilinguals of different proficiency levels process and remember sentences embedded in discourse.

Based on the literature reviewed here, two very distinct possibilities are hypothesized. First, because less proficient bilinguals may not have direct access to meaning in their foreign language (Sholl et al., 1995), and because they demonstrate greater interference effects from form than from meaning (Silverberg & Samuel, 2004; Talamas et al., 1999), they will most likely process the second language based on its structural components. As a result, the main memory traces for these sentences will be based on shallow-level representations. Conversely, in their native language, there should be greater attention paid to semantic aspects of a sentence with structural components being secondary. Accordingly, it is hypothesized that the lexical and semantic interference differences that have been supported in bilingual word processing will extend to sentence processing. While higher proficiency bilinguals should show a similar relationship in accuracy for detecting form and meaning changes across languages, low-proficiency bilinguals should be attuned more to the structural components of L2 and the semantic components of L1. As a result, they should be less accurate at answering Spanish meaning change questions compared to those with higher L2 proficiency. Furthermore, because they will be more attuned to form, low proficiency individuals should be more accurate than high proficiency individuals at detecting form changes in L2. If this is the case, a three-way interaction between language, type of sentence change, and proficiency level should result.

On the other hand, reading single words contrasts greatly with reading connected discourse. It is certainly feasible that the top-down perceptual processes involved in reading natural discourse could override the less proficient bilinguals' focus on form, as

they would have more opportunities for abstracting meaning from context. If this is the case there should be no interaction effect. Regardless of proficiency level and language, participants would be better at detecting meaning changes than form changes.

The aim of this study is to discover which of these alternatives is most likely. English-Spanish bilinguals of different proficiency levels were tested in both their native and second languages to determine if there are any differences between L1 and L2 discourse processing and subsequent sentence recognition. Because lexical and conceptual development co-occur in early childhood (de Groot & Kroll, 1997), the college-aged population served as a suitable sample for this study. Relatively speaking, college-aged students who are learning in a classroom setting are a controlled bilingual population. As most U.S. schools do not begin language instruction until middle school, these students' exposure to Spanish is past any assumed childhood critical period for second language acquisition. Additionally, all participants were English dominant; even the proficient Spanish speakers did not have balanced abilities across languages. This clarification is essential since the revised hierarchical model pertains particularly to the late bilingual who is unbalanced in L1 and L2 skills (Altarriba, 2003). Furthermore, by controlling for language learning environment (Chen, 1990), it is possible to assess the specific nature of classroom instruction.

To summarize, this study investigates the three-way interaction between language, sentence change type, and proficiency level. If patterns of bilingual word processing extend to discourse, proficiency level should impact accuracy scores across language and sentence change type. However, if reading in a second language is under

similar influences as reading in the native language, namely context effects, then top-down processes should reduce the import of proficiency level. Regardless of L2 proficiency level, the participants should perform similarly across languages because they are motivated to abstract general meaning and gist, even in the face of unfamiliarity.

Method

Participants

Forty undergraduate students at the University of Richmond took part in this experiment. Students ranged in age from 18 to 22 years. Seventeen males and 23 females participated. All students claimed English as a native language and learned Spanish at various ages, largely in classroom settings. Participants were recruited with the assistance of the Department of Modern Languages and Literatures at the university. Spanish professors, particularly those teaching beginner and advanced-level courses, were provided with information about the study and asked to advertise it in their classes. Students were compensated for their time with $10.

Because money was limited, potential participants were pre-screened to ensure their language history matched what was required of the experiment. If potential participants expressed an interest in the study, they were asked to e-mail a research assistant the answers to four basic questions: 1-native language, 2–number of years studying Spanish, 3–estimated overall proficiency in Spanish on a five point scale, 4-incidence of study abroad or immersion experience. Students who did not list English as a native language or who were immersed in a Spanish-speaking area for longer than three

months were not eligible for the study. Those who qualified were contacted and a testing time was coordinated.

Materials and Design

Due to the complex nature of language learning, this study necessitated a within-subjects design. Since the research question focused on native versus foreign language encoding and recognition strategies, assessment of both languages in the same individual was key. Furthermore, intelligence level and motivation, among other variables, are correlated with language learning (Moskovsky, 2001). Therefore, by using the same participants across levels of the independent variables, there was some level of control over individual differences.

Upon reporting to the testing room, participants were asked to complete a Language History Questionnaire (Sepanski & Li, in press; see Appendix A). This questionnaire assesses a number of language-relevant variables. For example, the survey requires participants to list all languages they have studied, age of exposure to each language, length of time studied, and the environment/context of language learning. Self-perceived competence in reading, writing, speaking, and understanding for each language is evaluated using a Likert scale (1 = extremely poor, 7 = comparable to English). In addition, questions assessing verbal SAT score, current or most recent Spanish course taken at the university, and grade received in that course were also included in the questionnaire for potential use in follow-up analyses.

Text passages and questions were created several months earlier and piloted on another sample of English-Spanish bilingual students. The English passages were

designed first. Passages were either original creations, submitted by student research assistants (Megan Kuhn, Allison McCarthy, Amanda Cobb) of the Cognitive Science Laboratory group at the University of Richmond, or they were published stories that were altered to fit the experiment's requirements. There were five passages altogether, each 12 sentences long with an average sentence length of 10 words. All passages used a concrete story line, rather than focusing on scene descriptions or other abstract scenarios. Four sentences from each passage were chosen as test sentences. A meaning change and form change sentence was created for each of these, resulting in 40 possible sentence change test questions. In addition to that, 20 questions were available to test the no change condition. After several modifications, both the test sentences and the passages were approved by the lab group and Dr. Ping Li. See Appendix B for an example of English testing materials.

Dr. Ted Peebles and two undergraduate teaching fellows, all from the University of Richmond Spanish Department, greatly aided this project by composing sentences for the Spanish portion of the experiment. The teaching fellows were given the English testing materials and asked to mimic the style, specifically creating passages of similar sentence and word length. The passages were considered to be intermediate level and all had concrete plot lines similar to the English passages. The types of meaning and form changes across languages were held constant as best as possible. Some original test sentence submissions were not in line with the English portion of the experiment; these were modified as necessary. See Appendix C for example Spanish testing materials.

E-Prime computer software (Psychological Software Tools, 2001) was used to administer the experimental portion of the study on a PC.

Procedure

Students individually reported to a testing room where they were seated in front of a computer. After completing the Language History Questionnaire and consent form, they were given a brief overview of the experiment. Once the participant indicated readiness to begin, he/she read directions on the computer screen. The directions simply informed participants that they would be presented with several passages, one at a time, and requested that they read each carefully. The instructions provided information on how to navigate through the experiment by pressing either the Y, N, or spacebar key. The computer software blocked all other keys such that only input from the three target keys was accepted.

On average, testing time took twenty minutes. E-Prime presented participants with a reading passage, immediately followed by seven yes/no questions. The order of language presentation was randomized across participants. In other words, some participants were exposed to the Spanish portion first, others to the English portion first. However, within each language the ordering of passages remained the same. Results from a multivariate analysis of variance indicated that order effects generally were not a problem, except in the English form condition. Participants who were exposed to the English portion of the experiment first made more mistakes on English form questions and responded slower to these questions than the group exposed to Spanish first.

Participants were presented with ten passages altogether, five in Spanish and five in English. Each passage was followed by seven questions. All questions were similar in format. One sentence was presented on the screen and the student was asked to respond (yes or no) if he/she saw that sentence in the previous passage. For each passage read, three sentences presented in the corresponding test portion were altered in meaning from the original, three were altered in form, and one remained identical (see Appendix B). Therefore, all totaled, there were 35 yes/no questions in each language. Fifteen of these questions involved form changes, fifteen involved semantic changes, and five were identical to the originals. Because attention to form versus meaning was the primary area of investigation, only five identical sentences were used in an attempt to reduce participants' time and effort.

E-Prime was programmed to store data on two types of dependent measures - the number and type of sentences correctly identified in each language and reaction time for each question.

Results

Although there is a method for determining an individual's overall proficiency score from the Language History Questionnaire, such a score would be misleading for this type of experiment. Because this study taps into reading comprehension rather than speaking fluency or speech comprehension, the aggregation method would provide insight into a student's overall Spanish proficiency, a much broader concept of interest than reading ability. In fact, according to Sepanski and Li (in press), regression analyses confirm that the combination of self-assessed reading proficiency and number of years

learning the second language account for nearly 77% of the variance in an individual's aggregate score ($R = .875$). Therefore, the combination of these two variables was considered sufficient for dividing participants into Spanish proficiency groups.

The original intent was to analyze data according to Spanish proficiency, a two-level (high, low) between-subjects factor. However, with twenty of the participants giving themselves a score of 5 out of 7 for reading comprehension ability, there were a large number of students who rated themselves at mid-level. As a result, dividing this group in half and arbitrarily appointing ten of the participants to the high proficiency group and ten of the participants to the low proficiency group would only cancel out any potential effects of proficiency level. Thus, three proficiency groups were used in analyzing the data. Six participants were regarded as high proficiency Spanish users. Twenty participants were of mid level proficiency. Fourteen participants were deemed to be at a low level of Spanish proficiency.

Verbal Intelligence as a Covariate

It is possible that a person's L2 proficiency level is not the sole determinant of accuracy and speed at identifying various types of sentence changes in L1 and L2. Research in first language reading consistently finds that reading performance can be predicted by word knowledge (Dixon et al., 1988; Hannon & Daneman, 2001). In fact, assessments of adult vocabulary knowledge and memory capacity are associated with the ability to infer unfamiliar words from text. According to Cain et al. (2004), children with poor reading comprehension are poor at inferring the meanings of novel words from context. Results like these suggest that individual difference variables such as verbal

intelligence are integral factors in predicting reading comprehension (Hannon & Daneman, 2001).

According to this line of research, students with higher verbal intelligence scores might be better at using context clues and translating because they simply have a greater capacity for language. If verbal intelligence does in fact play a role in a person's ability to detect form versus meaning changes across L1 and L2, then using a student's verbal SAT score as a covariate should cancel out any three-way interaction between language, proficiency level, and sentence change. In other words, reaction time and accuracy effects may not be explained by a person's proficiency in L2, but by his/her ability to use verbal cues and inference strategies in general. Thus, proficiency may simply be a by-product of verbal intelligence. People who are less verbally inclined may not reach the same level of L2 proficiency as those who are verbally adept. In effect, proficiency may only act as a mediator in the relationship between verbal ability and sentence identification.

Using this logic, verbal SAT scores were examined for any relationship with the dependent variables and proficiency level. Some students ($n = 6$) failed to report their SAT scores on the Language History Questionnaire. However, because three out of six missing values were the result of using an older version of the questionnaire (that did not ask for SAT score), the missing data were not assumed to be missing for a systematic reason (ex. participants who did not report SAT had lower scores). In other words, there is no reason to believe that most students who failed to report scores did so for any other

reason than not being asked. Consequently, a substitution method was employed; the mean SAT score of the sample was calculated and substituted for any missing values.

An analysis of variance confirmed that there was no difference in verbal SAT score across proficiency level groups, $F(2, 37) = .22$, $p = .80$. Curiously however, verbal SAT score was correlated with both accuracy and reaction time for identifying English meaning change sentences. This association suggested that the influence of verbal intelligence should be partialed out through an analysis of covariance.

Two analyses were run for each dependent variable – one using SAT as a covariate and one without the covariate. The inclusion of a verbal intelligence measure did not change the overall findings of the study. Since most group differences were maintained, even after controlling for verbal intelligence, all statistics below are reported from ANOVA tests rather than ANCOVA tests.

Sentence Identification Accuracy Data

A 2 (language: English, Spanish) x 2 (type of sentence change: form, meaning) x 3 (proficiency: low, middle, high) mixed-subjects ANOVA was conducted to analyze the first dependent variable, sentence identification accuracy scores. Data were coded based on the number of inaccurate responses a participant made, for no other reason than this was the most convenient way to transcribe participant responses.

Although the main effect of language was not significant, there was a significant difference in type of sentence change on accuracy. Participants made more form change mistakes ($M = 7.1$) than meaning change mistakes ($M = 2.2$), $F(1, 37) = 126.52$, $p < .01$.

An interaction effect between sentence change type and proficiency level also

emerged, $F(2, 37) = 5.16$, $p < .05$. Paired t tests that were corrected for Type I error using the Bonferroni procedure confirmed that the low proficiency group did significantly worse at detecting meaning changes than both the mid-level and high-level proficiency groups, $t(27) = -2.17$, $p < .05$, and $t(11) = -4.58$, $p < .01$ respectively. Means are listed in Table 1 and a graphical display is featured in Figure 6.

Table 1 *Mean Number of Inaccurate Responses* for Types of Sentence Change Across Language and Proficiency Level*

Type of Sentence Change		English		Spanish		Mean Total
		Mean	Std. Dev.	Mean	Std. Dev.	
Meaning	High	.83	1.33	1.67	1.03	2.50
	Mid	1.80	1.40	2.25	1.44	4.05
	Low	2.07	1.59	4.36	2.73	6.43
Total		**4.70**		**8.28**		**12.98**
Form	High	6.83	3.54	7.17	3.06	14.00
	Mid	7.70	2.52	8.05	2.89	15.75
	Low	7.14	2.80	5.71	2.05	12.85
Total		**21.67**		**20.93**		**42.60**

* Maximum number of inaccurate responses is 15

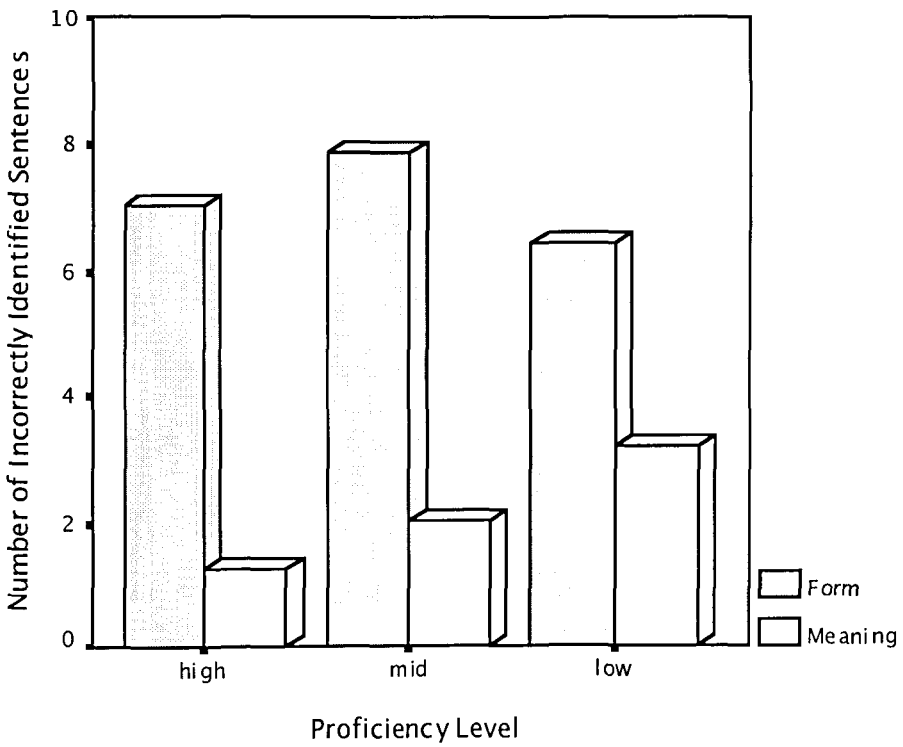

Figure 6. Number of incorrectly identified sentences based on L2 proficiency level and sentence change type. The low proficiency group did significantly worse at detecting meaning changes than the high and mid-level proficiency groups.

Language and sentence change type created a just marginally significant interaction, $F(1, 37) = 4.08, p = .051$. Collapsed across all proficiency levels there was a significant difference between English meaning change accuracy scores and Spanish meaning change accuracy scores, $t(39) = -.58, p < .01$. Participants were more accurate at detecting English meaning changes than Spanish meaning changes. The same was not true for form change sentences however.

Finally, the anticipated three-way interaction reached significance, $F(2, 37) = 3.59, p < .05$. One-way ANOVAs were used to test for specific group differences. There was a marginally significant effect for Spanish form change question accuracy, $F(2, 37) =$

3.19, p =.053. Post hoc tests determined that the low proficiency and moderate proficiency groups performed significantly differently. Low proficiency participants were more accurate at detecting Spanish form changes (M = 5.71) than moderately proficient participants (M = 8.05). There was also a significant difference in accuracy for detecting Spanish meaning changes according to proficiency level, $F(2, 37) = 6.15$, $p <$ .01. Post hoc tests determined that the low proficiency individuals were significantly worse at detecting meaning changes in Spanish than both the moderately and highly proficient individuals.

Looking at the graph in Figure 7, the moderately and highly proficient participants show a large discrepancy in Spanish meaning and Spanish form accuracy. The same is not true for less proficient individuals. Compared to students who have reached at least a moderate level of Spanish proficiency, those who are less proficient show drastically less of a difference between their Spanish form and Spanish meaning accuracy scores.

Finally, it should be noted that when verbal SAT score was used as a covariate, the three-way interaction actually became more significant (p value changed from .038 to .035).

High Spanish Proficiency

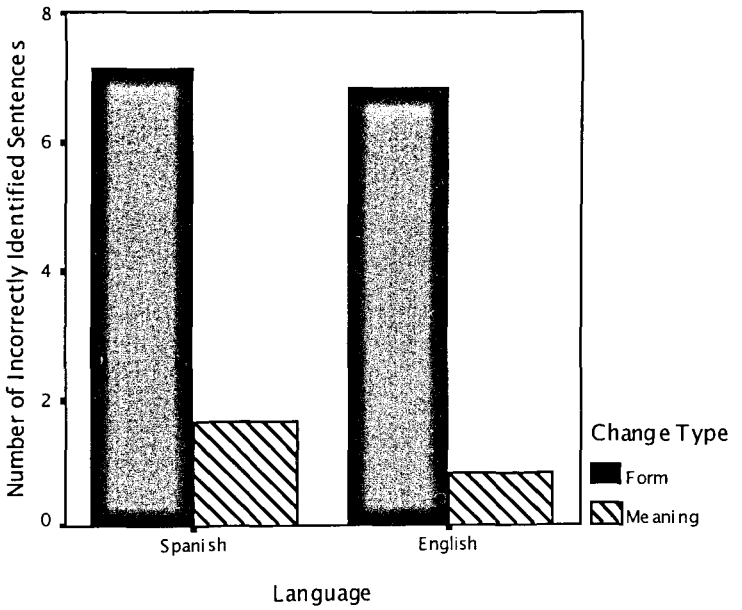

Figure 7a. Number of incorrectly identified sentences based on language and sentence change type for high Spanish proficiency group.

Moderately Proficient Spanish

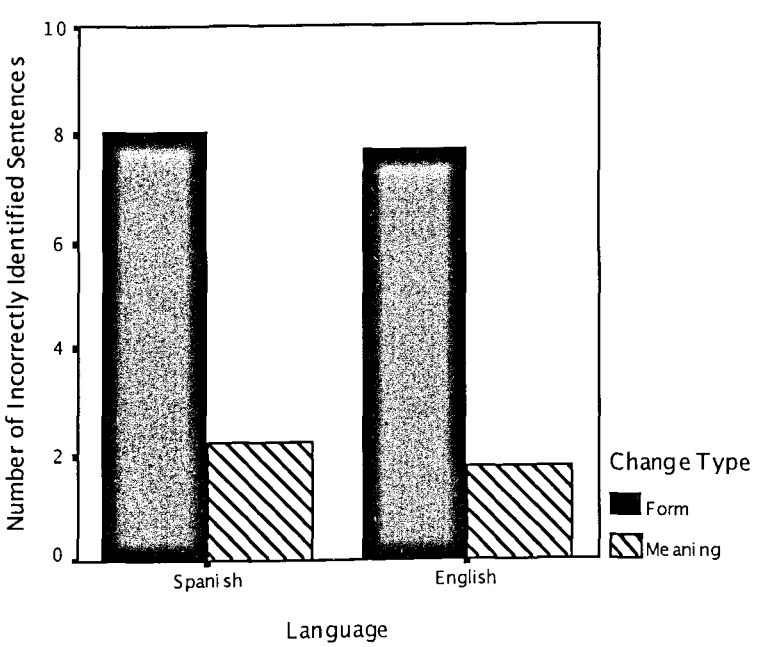

Figure 7b. Number of incorrectly identified sentences based on language and sentence change type for moderately proficient Spanish group.

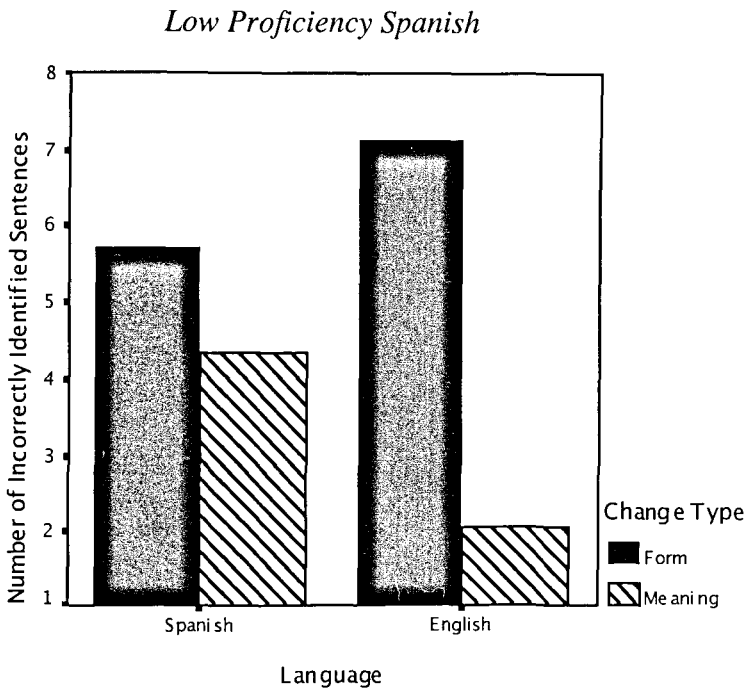

Figure 7c. Number of incorrectly identified sentences based on language and sentence change type for low Spanish proficiency group. Compared to the mid-level and high proficiency groups, the low proficiency group was significantly better at detecting meaning change sentences in English than Spanish.

Reaction Time Data

To analyze reaction time scores, a 2 (language: English, Spanish) x 2 (type of sentence change: form, meaning) x 3 (proficiency: low, middle, high) mixed-subjects ANOVA was conducted using reaction time as the dependent variable. Box's *M* test highlighted significant differences in the variance between groups, $F(20, 882.5) = 2.04$, $p = .005$. Because homogeneity of variance is an underlying assumption of ANOVA (Green & Salkind, 2003), data transformations were performed to correct this error. After taking the square root of reaction time scores, no significant differences between group variances were detected by Box's *M* test, $F(20, 882.5) = 1.51$, $p > .05$.

There was a significant difference in type of language on reaction time.

Participants were faster at responding to English sentences ($M = 4594.68$ ms) than they were at responding to Spanish sentences ($M = 6114.01$ ms), $F(1, 37) = 52.35$, $p < .01$. Additionally, participants were faster at responding to meaning change sentences ($M = 4922.73$ ms) than form change sentences ($M = 5785.95$ ms), $F(1, 37) = 55.97$, $p < .01$. See Table 2 for a complete list of means.

Table 2 *Mean Reaction Times (in milliseconds) for Types of Sentence Change Across Language and Proficiency Level*

Type of Sentence Change		English		Spanish	
		Mean	Std. Dev.	Mean	Std. Dev.
Meaning	High	3269.10	405.58	5015.17	525.73
	Mid	4143.84	1204.86	5806.39	1549.46
	Low	4689.48	1435.71	6612.41	3207.55
Form	High	4710.51	1024.42	6485.03	1614.72
	Mid	5036.70	1593.64	6378.49	1992.01
	Low	5718.42	2205.36	6386.55	2024.51

An interaction effect between sentence change type and proficiency level also emerged, $F(2, 37) = 5.35$ $p < .01$. Follow-up paired samples t tests using the Bonferroni procedure to correct for Type I error determined that both the high proficiency and middle proficiency groups showed significant differences in their reaction times to form and meaning change sentences, $t(5) = -5.73$, $p < .01$, and $t(19) = -4.62$, $p < .01$

respectively. Both the high and middle proficiency groups responded significantly faster to meaning change questions than form change questions. Although the low proficiency group showed the same trend (M_{form} = 6052.5 ms, M_{mean} = 5650.9 ms), the difference between form change and meaning change reaction times was not significant for the low proficiency group. Refer to Figure 8 for a graph of this interaction.

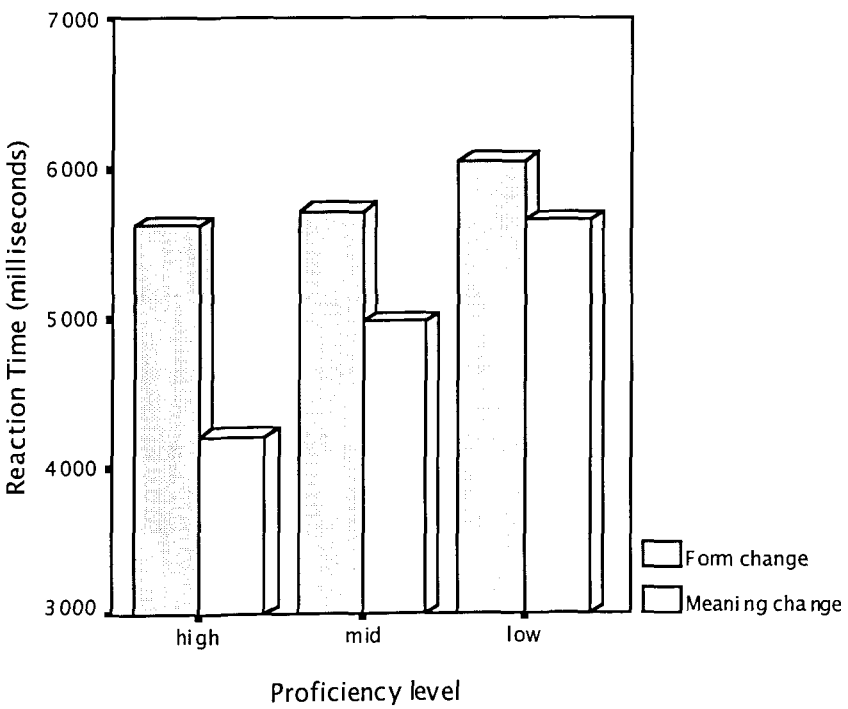

Figure 8. Reaction times (in milliseconds) assessed across L2 proficiency level and sentence change type. Though the high and moderate proficiency groups showed significant differences in their reaction times to form and meaning change sentences, the low proficiency group did not.

Language and sentence change type created a significant interaction, $F(1, 37) = 5.88$, $p < .05$. Paired samples t tests determined that reaction times to Spanish form change sentences and reaction times to English form change sentences were significantly

different, $t(39) = 5.05$, $p < .01$. Participants were faster at responding to English form changes ($M = 5226.4$ ms) than to Spanish form changes ($M = 6397.3$ ms). Reaction times to English form and English meaning change sentences were also significantly different, $t(39) = 6.52$, $p < .01$. Participants were faster at responding to English meaning changes ($M = 4203.6$ ms) than to English form changes ($M = 5226.4$ ms). Finally, reaction times to Spanish meaning and English meaning change sentences were significantly different, $t(39) = 6.99$, $p < .01$. Participants were faster at responding to English meaning changes ($M = 4203.6$ ms) than to Spanish meaning changes ($M = 5969.8$ ms).

Regression Analyses Applied to the Covariate

In order to understand the influence of verbal intelligence on sentence recognition accuracy, regression analyses were applied to the data. Interestingly, accuracy at detecting English meaning change sentences was the only variable significantly predicted by verbal SAT score. 22.4% of the variance in accuracy at detecting English meaning changes could be accounted for by verbal SAT score ($r = -.473$).

Similar to the sentence identification accuracy data, an individual's verbal SAT score predicted his/her reaction time for English sentences involving meaning changes. 24.6% of the variance in reaction time to English meaning change sentences could be accounted for by verbal SAT score ($r = -.496$).

Discussion

Sentence Identification Accuracy

The main effect of accuracy at identifying types of sentence changes supports the claim that people focus more on meaning than form when reading sentences. In this respect, the research fully sustains Sachs' 1967 work. In both languages, participants were more accurate at detecting meaning changes in sentences than detecting form changes.

The novelty of this study lies in its three-way interaction between proficiency level, sentence change, and language. Participants with low Spanish proficiency levels were significantly different from participants who had reached at least a moderate level of Spanish proficiency. Follow-up tests of the significant three-way interaction confirmed that accuracy depends on language and type of sentence change.

Students who have less experience with Spanish make more form-related recognition errors in Spanish than do students at a moderate level of reading proficiency. Curiously, the low and high proficiency groups did not differ significantly in their abilities to detect Spanish form changes. In fact, the high proficiency group was slightly more accurate at detecting Spanish form changes than the moderately proficient group. The reason for this is debatable. Perhaps in the shift from attention to form to attention to meaning, the importance of structural properties reaches a minimum. Once proficiency in a language is achieved however, a more practical balance is reached. Interestingly, moderately proficient individuals show a similar trend in their accuracy scores for English form change sentences. Although they are by no means significantly different

from the other groups, moderately proficient individuals are the least attuned to form in both English and Spanish.

Participants who were least proficient in Spanish also differed from the other proficiency groups in their ability to detect Spanish meaning changes. The least proficient individuals did significantly worse than the other individuals at detecting meaning changes in Spanish.

Finally, moderately and highly proficient bilinguals showed a large discrepancy in their Spanish meaning and Spanish form change accuracy scores. In contrast, the least proficient group had similar accuracy scores for Spanish meaning change sentences and Spanish form change sentences. Thus, while the more proficient groups shared similar accuracy ratios, the least proficient group differed significantly in the relationship of L2 form and meaning accuracy. There were no differences in accuracy scores for the different types of English sentences across the various proficiency levels.

Reaction Time

As would be expected, there was a main effect of language and a main effect of sentence change on reaction time. Participants responded faster to English sentences than Spanish sentences and faster to meaning change sentences than form change sentences.

Participants were faster at responding to English form change sentences than Spanish form change sentences. They were faster at responding to English meaning change sentences than to Spanish meaning change sentences. Finally, they were faster at responding to English meaning change sentences than English form change sentences. However, there was no difference in reaction time to Spanish meaning change sentences

and reaction time to Spanish form change sentences.

The most relevant finding from the reaction time data concerns the relationship between type of sentence change and proficiency level. While the high and mid-level proficiency groups showed significant differences in their reaction times to form and meaning change questions, the low proficiency group did not. In both languages, both the high and moderate proficiency groups were significantly faster at detecting meaning change sentences than form change sentences. Though the low proficiency group showed a similar trend, the difference between meaning change and form change reaction times was not significant.

Assessing the Influence of Verbal Intelligence

Regression analyses indicated that a person's verbal SAT score significantly predicts his/her ability to recognize meaning changes in English and his/her speed at responding to these types of sentences. However, neither accuracy nor speed for any other *language x sentence change* combinations could be predicted by verbal intelligence.

Thus, verbal intelligence plays at least some role in a person's ability to perform on this task, but that role seems largely due to the impact of verbal intelligence on detecting English (L1) meaning changes. This finding brings a fascinating point to light. According to Hannon and Daneman (2001), at the beginning stages of reading, word recognition and lexical access account for the majority of variance in predicting a person's reading comprehension ability. However, after a person gets beyond the beginning stage, these variables account for relatively little of the variance in predicting reading comprehension ability. Instead, higher level, knowledge-based variables take

over as the most predictive factors. For example, highly skilled readers use semantic, syntactic, and referential relationships to make sense of a text. These readers are better at integrating newly encountered information with information encountered earlier in the text.

If this is the case, second language proficiency may come into play at the beginning stages of learning to read L2, but not to the same degree after a person reaches a moderate level of reading achievement. In other words, a person's approach to reading depends on familiarity with the language only up to a certain point; after that point, more individual, knowledge-based factors come into play. At the beginning stages of reading, vocabulary knowledge and phonology to print mapping are important. However, after reaching a certain level of reading ability, knowledge-based strategies rather than language specific abilities are consequential.

This could explain why verbal intelligence predicts an individual's ability and speed at detecting English meaning changes, but does not predict any other *language x sentence change* scores. Being native English speakers and college students, all participants were beyond any beginning stages of learning to read L1. Therefore, these higher level, more individualized variables (verbal SAT) acted as the best predictors in determining comprehension in L1. In contrast, there were two sets of predictor variables that could account for reading comprehension in L2, depending on proficiency level. For the least proficient students, even though they may have honed their abilities to abstract meaning and integrate information in English, the fact that they are still new to Spanish prevents them from accessing these skills in L2. Not until they reach a certain level of

basic familiarity with Spanish can they tap into their higher-level reading skills. This contrasts with the moderately to highly proficient bilinguals. These people are familiar enough with Spanish to be able to use higher-level processes in reading comprehension.

Thus, it makes sense that verbal SAT would not influence anything other than a person's ability to manipulate English semantics when reading. Manipulation of Spanish semantics is dependent on a person's proficiency level to a point, then on his/her higher-level cognitive abilities. Thus, even if a person has a high verbal intelligence, if he/she has not reached a certain point of familiarity with L2, this verbal intelligence cannot be tapped into for help with reading comprehension.

The current findings for bilingual sentence processing seem to require a different model than those outlined in the bilingual word processing literature. Less proficient L2 learners are far more attuned to the structural properties of discourse in their second language than in their first language. The same is not true for more proficient bilinguals. Indeed, these preliminary findings seem in line with the bilingual word processing studies. However, L2 proficiency does not appear to be the only contributing factor. To some degree, verbal intelligence is related to memory for sentences. Thus it seems that fluency in a language influences how a person attends to and remembers reading material, but only to an extent. After a certain L2 proficiency threshold is reached, higher-level cognitive variables come into play.

If this theory is correct, mere exposure to the second language is the most effective tool for boosting comprehension ability in the initial stages of L2 reading. Thus, even if a person has highly refined knowledge-based reading strategies in his/her

first language, they may not be accessible in the second language. In order to tap into these resources, a person must first have an adequate knowledge of word forms or vocabulary. This is intuitively appealing, as a person who does not recognize any words in a passage cannot begin to use semantic elaboration or text integration techniques.

This theory provides adequate explanation as to why SAT verbal score was not related to one's proficiency level in a second language.

Limitations

It is important to recognize that although the distinct population selected for this study allows for control of several second language learning variables, it also translates to a lack of generalizability. Students at the University of Richmond are high achieving individuals with advanced skills in L1 reading. Furthermore, information provided on the Language History Questionnaire suggests that these participants form a relatively homogenous subset of second language learners. Although age of exposure to Spanish differed, other language variables were relatively consistent. For example, only one student had a parent who was fluent in Spanish. Granted, the experiment aimed to control for these immersion variables; however, in order to understand the true range of second language learners, it will be necessary to recruit a more diverse sample of English-Spanish bilinguals. In addition, other combinations of languages need to be examined. For example, while the orthography of English and Spanish is similar, languages like English and Chinese might show quite a different relationship between structural and semantic elaboration in embedded discourse. Regardless of the results of

this experiment, several more studies are required prior to building an adequate model of bilingual sentence recognition.

Although the university's registrar office was contacted about releasing SAT information to the primary investigator, confidentiality laws actually prohibit SAT scores to be released, even with a student's consent. Therefore, self-report had to suffice. There are two potential drawbacks to students reporting their own SAT scores. First, students took the test more than a year prior; thus, memory may not serve perfectly. Secondly, score inflation is a possibility, especially for those students who may feel their scores were inadequate. The combination of poor memory and a desire to present the best self may have skewed SAT score data.

Methodologically speaking, power is of concern in this study. Although the original intent was to divide participants into only two proficiency groups, this became impractical upon inspection of the language history data. Therefore, the sample size of 40 was smaller than desired for a 2 x 2 x 3 mixed subjects ANOVA.

Implications and Future Directions

Overall, these results suggest that a low level of proficiency in a second language attunes a person to greater focus on structure than semantics. Interestingly, the same cannot be said for moderately to highly proficient Spanish learners, whose form to meaning accuracy ratio in L2 is similar to that of L1. It appears that after attaining a certain level of reading proficiency, a person switches to more meaning-based processing. The present study provides the first indication that the shift from focus on form to focus on meaning extends beyond the word processing level. As this is the first

experiment of its kind to assess bilingual sentence processing, future studies are required to verify its effects.

Though this research has been largely exploratory, the preliminary conclusions provide direction for a number of future inquiries. Results support bilingual word processing studies in which less proficient bilinguals do in fact pay more attention to form than meaning. However, this initial conclusion raises several questions. First, is there a natural progression from focus on form to focus on meaning when learning to read a second language? Or is this progression simply an artifact of the learning environment? It seems that attention to form at an early stage of reading is necessary for achieving later fluency and comprehension. If this is the case, then perhaps it is possible to make current classroom strategies for teaching second languages more effective. Students who have not reached an adequate level of L2 proficiency should not be expected to use context clues for meaning abstraction but should instead be exposed to more word forms in the language. Once L2 learners overcome the proficiency threshold, structure should take a backseat to semantic understanding and interventions for more top-down processing should be considered. Holistic approaches to reading might be the most useful once a moderate level of reading proficiency is achieved.

Another future direction requires that researchers look into phonological representations during reading. Using a group of English monolinguals, Baddeley (1966) found that similar-sounding words made for poorer recall than similar meaning words. Even when presented with words visually, participants seemed to be forming a mental

representation of the information acoustically. Since reading involves using an internal voice, this phonological variable could provide a fascinating route for exploration.

There is further evidence that phonological components of a language are associated with short-term memory capacity. As individuals read, they subvocally rehearse the material. Research has found that memory span is equal to the amount of material that can be subvocally rehearsed in a certain time interval. It is highly likely that speakers in the beginning stages of second language learning are slower at articulating words (Brown & Hulme, 1992), consequently, not holding as many in memory. If so, retention and comprehension in the second language may be at a disadvantage.

In a recent study, researchers found that second language learners' performance on word identification tasks was best predicted by the working memory system, which is language-independent (Swanson et al., 2004). Because working memory contributed unique variance to L2 word identification tasks, researchers concluded that factors beyond phonological awareness in L1 should be considered when predicting literacy in L2. According to this research both L1 phonological knowledge and working memory are important in predicting L2 reading abilities.

With this in mind, a closer inspection of higher-level cognitive factors could provide increased understanding of bilingual sentence processing. For example, working memory capacity can influence one's ability to acquire meaning from context (Cain et al., 2004), to integrate new information with old information (Hannon & Daneman, 2001), and to recognize words (Dixon et al., 1988), thereby resulting in better reading comprehension. Thus, although this study controlled for intelligence, a variable highly

correlated with L1 reading comprehension (Hannon & Daneman, 2001), the influence of working memory across languages and proficiency levels remains to be understood.

If second language reading comprehension is dependent on proficiency in that language, then various individual differences should be assessed within rather than across the different proficiency levels. Word recognition and lexical decision tasks should predict how well less proficient individuals comprehend L2 reading passages, whereas memory and intelligence should predict how well proficient bilinguals comprehend L2 reading passages (Hannon & Daneman, 2001). It is important not to treat bilinguals as a homogenous group when it comes to reading. Less proficient bilinguals seem to be using different processing techniques than more proficient bilinguals. Even working memory might be used in different capacities depending on a person's level of L2 understanding.

Overall, this study provides fascinating preliminary insight into a largely unexplored area of inquiry. It opens up a novel pathway for understanding bilingual processing, reading strategies, and perhaps eventually, more effective second language teaching methods. In the meanwhile, a great deal more research is required prior to building a sound model of bilingual sentence recognition.

References

Altarriba, J. (2003). Does *carino* equal "liking"? A theoretical approach to conceptual nonequivalence between languages. *International Journal of Bilingualism, 7*(3), 305-322.

Baddeley, A.D. (1966). The influence of acoustic and semantic similarity on long-term memory for word sequences. *Quarterly Journal of Experimental Psychology, 18,* 302-309.

Barcroft, J. (2002). Semantic and structural elaboration in L2 acquisition. *Language Learning, 52,* 323-363.

Bialystok, E., & Miller, B. (1999). The problem of age in second-language acquisition: Influences from language, structure, and task. *Bilingualism: Language and Cognition, 2,* 127-145.

Birdsong, D., & Millis, M. (2001). On the evidence for maturational constraints in second-language acquisition. *Journal of Memory and Language, 44,* 235-249.

Brown, G.D.A., & Hulme, C. (1992). Cognitive psychology and second language processing: The role of short-term memory. In R.J. Harris (Ed.), *Cognitive processing in bilinguals* (pp. 105-121). New York: Elsevier Publishing.

Cain, K., Oakhill, J., & Lemmon, K. (2004). Individual differences in the interference of word meanings from context: The influence of reading comprehension, vocabulary knowledge, and memory capacity. *Journal of Educational Psychology, 96*(4), 671-681.

Chen, H. (1990). Lexical processing in a non-native language: Effects of language proficiency and learning strategy. *Memory and Cognition, 18,* 279-288.

Craik, F.I.M., & Lockhart, R.S. (1972). Levels of processing: A framework for memory research. *Journal of Verbal Learning and Verbal Behavior, 11,* 671-684.

de Groot, A. M. B., Dannenburg, L., & van Hell, J.G. (1994). Forward and backward word translation by bilinguals. *Journal of Memory and Language, 33,* 600-629.

de Groot, A.M.B., & Kroll, J.F. (1997). Lexical and conceptual memory in the bilingual: Mapping form to meaning in two languages. In A. de Groot & J. Kroll (Eds.), *Tutorials in bilingualism: Psycholinguistic perspectives* (pp.169-199). Mahwah: Lawrence Erlbaum Associates.

Dixon, P., LeFevre, J.-A., & Twilley, L.C. (1988). Word knowledge and working memory as predictors of reading skill. *Journal of Educational Psychology, 80,* 465-472.

Durgunoglu, A.Y., & Roediger, H.L. (1987). Test differences in accessing bilingual memory. *Journal of Memory and Language, 26,* 377-391.

Graesser, A.C., Millis, K.K., & Zwaan, R.A. (1997). Discourse comprehension. *Annual Review of Psychology, 48,* 163-190.

Green, S.B., & Salkind, N.J. (2003). *Using SPSS for Windows and Macintosh (3rd ed.).* Upper Saddle River, NJ: Prentice Hall.

Hakuta, K., Bialystok, E., & Wiley, E. (2003). Critical evidence: A test of the critical-period hypothesis for second-language acquisition. *Psychological Science, 14,* 31-38.

Hannon, B., & Daneman, M. (2001). A new tool for measuring and understanding individual differences in the component processes of reading comprehension. *Journal of Educational Psychology, 93*, 103-128.

Harley, B., & Wang, W. (1997). The critical period hypothesis: Where are we now? In A. de Groot & J. Kroll (Eds.), *Tutorials in bilingualism: Psycholinguistic perspectives* (pp. 19-51). Mahwah: Lawrence Erlbaum Associates.

Harrington, M. (1992). Working memory capacity as a constraint on L2 development. In R.J. Harris (Ed.), *Cognitive processing in bilinguals* (pp. 123-135). New York: Elsevier Publishing.

Johnson, J.S., & Newport, E.L. (1989). Critical period effects in second language learning: The influence of maturational state on the acquisition of English as a second language. *Cognitive Psychology, 21,* 60-99.

Kroll, J.F., & Curley, J. (1988). Lexical memory in novice bilinguals: The role of concepts in retrieving second language words. In M.M. Gruneberg, P.E. Morris, & R.N. Sykes (Eds.), Practical aspects of memory: Current research and issues (pp.389-395). New York: John Wiley & Sons.

Kroll, J.F., & Stewart, E. (1994). Category interference in translation and picture naming: Evidence for asymmetric connections between bilingual memory representations.*Journal of Memory and Language, 33,* 149-174.

Lenneberg, E. (1967). *Biological foundations of language.* NY: John Wiley & Sons Inc.

Magiste, E. (1984). Stroop tasks and dichotic translation: The development of interference patterns in bilinguals. *Journal of Experimental Psychology: Learning, Memory and Cognition, 10*, 304-315.

McClelland, J.L., & Rumelhart, D.E. (1981). An interactive activation model of context effects in letter perception: Part 1. *Psychological Review, 88,* 375-407.

Moskovsky, C. (2001). The critical period hypothesis revisited. In C. Allen (Ed.), *Proceedings of the 2001 Conference of the Australian Linguistic Society.* Retrieved October 19, 2003, from http://linguistics.anu.edu.au/ALS2001/proceedings.html.

Potter, M. C., So, K.F., Von Eckardt, B., & Feldman, L.B. (1984). Lexical and conceptual representation in beginning and proficient bilinguals. *Journal of Verbal Learning and Verbal Behavior, 23,* 23-38.

Psychological Software Tools (2001). *E-Prime* [Computer software; version 1.0].

Sachs, J. (1967). Recognition memory for syntactic and semantic aspects of connected discourse. *Perception and Psychophysics, 2,* 437-442.

Sepanski, S. E., & Li, P. (in press). Language history questionnaire for L2 research: A survey and a one-size-fit-all version. *Bilingualism: Language and Cognition.*

Sholl, A., Sankaranarayanan, A., & Kroll, J.F. (1995). Transfer between picture naming and translation: A test of asymmetries in bilingual memory. *Psychological Science, 6,* 45-49.

Silverberg, S., & Samuel, A.G. (2004). The effect of age of second language acquisition on the representation and processing of second language words. *Journal of Memory and Language, 51,* 381-398.

Swanson, H.L., Saez, L., Gerber, M., & Leafstedt, J. (2004). Literacy and cognitive functioning in bilingual and nonbilingual children at or not at risk for reading disabilities. *Journal of Educational Psychology, 96,* 3-18.

Talamas, A., Kroll, J.F., & Dufour, R. (1999). From form to meaning: Stages in the acquisition of second-language vocabulary. *Bilingualism: Language and Cognition, 2,* 45-58.

Townsend, D.J., & Bever, T.G. (1988). Knowledge representations during reading depend on reading skill and reading strategy. In M.M. Gruneberg, P.E. Morris, & R.N. Sykes (Eds.), *Practical aspects of memory: Current research and issues: Vol. 2* (pp. 309-314). New York: John Wiley & Sons.

Zwaan, R.A. (1994). Effects of genre expectations on text comprehension. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 20,* 920-933.

Appendix A.

Language History Questionnaire (Sepanski & Li, in press)

Please answer the following questions to the best of your knowledge.

1. Age (in years):

2. Sex (circle one): Male/Female

3. Country of origin:

4. How long have you lived in this country?

5. What is your native language? (If you grew up with more than one language, please specify)

6. Is English your second language?

YES/NO (if you answered NO, you need not to continue this form)

7. If you answered YES to question 6, please specify the age at which you started to learn English (check only one situation).

At home _____
In school _____
After arriving in this country _____

8. How did you learn English as a second language up to this point? (check all that apply)

Mainly through formal classroom instruction _____
Mainly through interacting with people _____
A mixture of both _____

9. What language do you usually speak to your mother at home? (If not applicable for any reason, write N/A)

10. What language do you usually speak to your father at home? (If not applicable for any reason, write N/A)

11. What languages can your parents speak fluently? (If not applicable for any reason, write N/A)

Mother: _____
Father: _____

12. What language or languages do your parents usually speak to each other at home? (If not applicable for any reason, write N/A)

13. Write down the name of the language in which you received instruction in school, for each schooling level:

Primary/Elementary School _____
Secondary/Middle School _____
High School _____
College/University _____

14. Estimate, in terms of percentages, how often you use your native language and other languages per day (in all daily activities combined):

Native language _____%
English _____%
Other languages _____% (specify: _____)
(Total should equal 100%)

15. Estimate, in terms of hours per day, how often you watch TV in your native language and other languages per day.

Native language _____ (hrs)
English _____ (hrs)
Other languages _____ (specify the languages and hrs)

16. Estimate, in terms of hours per day, how often you read newspapers, magazines, and other general reading materials in your native language and other languages per day.

Native language _____ (hrs)
English _____ (hrs)
Other languages _____ (specify the languages and hrs)

17. Estimate, in terms of hours per day, how often you use your native language and other languages per day for work or study related activities (e.g., going to classes, writing papers, talking to colleagues, classmates, or peers).

Native language _____ (hrs)
English _____ (hrs)
Other languages _____ (specify the languages and hrs)

18. In which languages do you usually:
Add, multiple, and do simple arithmetic? _____
Dream? _____
Express anger or affection? _____

19. List all languages you know in order of most proficient to least proficient. Also provide the age at which you were first exposed to each language and the number of years you have spent on learning each. Rate your ability on the following aspects in each language. Please rate according to the following scale (write down the number in the table):

very poor poor fair functional good very good native-like
1 _____ 2_____3_____4_____5_____6_____7_____

Language	Reading proficiency	Writing proficiency	Speaking fluency	Speech comprehension ability	Age first exposed to language	Number of years learning

20. If you have taken a standardized test of proficiency for languages other than your native language (e.g., TOEFL or Test of English as a Foreign Language), please indicate the scores you received for each.

Language	Scores	Name of the Test
_____	_____	_____
_____	_____	_____
_____	_____	_____

21. In which language (your best two languages) do you feel you usually do better?

	At home	At work
Reading	_____	_____
Writing	_____	_____
Speaking	_____	_____
Understanding	_____	_____

22. Among the languages you know, which language is the one that you prefer to use?

At home	_____
At work	_____
In a party	_____
In general	_____

23. If you have lived or traveled in other countries for more than three months, please indicate the name(s) of the country or countries, your length of stay, and the language(s) you learned or tried to learn.

24. If there is anything else that you feel is interesting or important about your language background or language use, please comment below.

Appendix B.

Example English testing material

PASSAGE:

I have a friend who must be the sweetest, shyest person in the world. His name is brittle and ancient, Luke. His age is modestly intermediate, forty. He is rather short and skinny, has a thin moustache and even thinner hair on his head. Since his vision is not perfect, he wears glasses. They are small, round, and frameless.

In order not to inconvenience anyone, he always walks sideways. Instead of saying 'Excuse me', he prefers to slide by a person. If the gap is so narrow that it will not allow him to pass, Luke waits patiently until the obstruction moves by itself. Stray dogs and cats panic him and in order to avoid them Luke constantly crosses from one side of the road to the other. If you saw Luke on the street you might think he is a bit bizarre. Maybe he is, but I feel proud to call Luke a friend.

TEST QUESTIONS: Did you read the following sentence in the passage?

1. In order not to inconvenience anyone, he always walks sideways. (identical)
2. He always walks sideways in order not to inconvenience anyone. (form change)
3. He wears glasses since his vision is not perfect. (form change)
4. He prefers to slide by a person instead of saying 'Excuse me'. (form change)
5. In order not to incapacitate anyone, he always walks sideways. (meaning change)
6. Since his vision is perfect, he does not wear glasses. (meaning change)
7. Instead of saying 'Excuse me', he prefers to slam into a person. (meaning change)

Appendix C.

Example Spanish testing material

PASSAGE:

Me llamo Ilia Rolón y tengo 25 años. Nací en Nueva York, de padres puertorriqueños. Mi pasatiempo favorito es bailar.

Cuando estoy bailando, ¡se me olvida casi todo! No me gusta bailar en pareja porque me es difícil coordinar mis pasos con los pasos de mi pareja. Tengo mi propio estilo de baile con influencia latina y africana. A todo el que me ve bailar le impresiona la sensualidad de mi baile.

Como puede imaginar, esto a veces causa malentendidos. Pero yo no bailo para impresionar a nadie. El baile me alegra porque me permite una libertad física de la que falto en mi vida diaria.

Did you read the following sentence in the passage?

1. Cuando estoy bailando, ¡se me olvida casi todo! (identical)

2. ¡Se me olvida casi todo! cuando estoy bailando. (form change)

3. La sensualidad de mi baile le impresiona a todo el que me ve bailar. (form change)

4. El baile me permite una libertad física de la que falto en mi vida diaria y por eso me alegra. (form change)

5. Cuando estoy bailando, ¡muevo casi todo mi cuerpo! (meaning change)

6. A todo el que me ve besar le impresiona la sencillez de mi beso. (meaning change)

7. El viaje me alegra porque me da la oportunidad de vivir en una manera diferente que mi vida diaria. (meaning change)