Second Language Learning in an Undergraduate Population:

Applications of Psychoinguistic Theory

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Table of Contents

Abstract

A mini-lesson in Spanish vocabulary was taught to undergraduates unfamiliar with the language using one of two predominant L2 teaching methodologies, the grammar-translation approach or the communicative approach. Both experimental groups showed significant improvement in learning the target language over the baseline measure set by the control group, but no significant differences were observed between the two experimental groups. Working memory efficiency appeared to be related to L2 learning. Two weeks later, there were no significant differences between the performance of the any of the groups. A subset of participants who underwent a neuroimaging procedure while performing the experimental tasks showed higher overall cerebral blood flow velocities under the condition based on the grammar-translation approach compared to the condition based on the communicative approach. In the interview component of the present study, participants from the United States and Spanish-speaking countries were questioned about their experience with foreign language education, revealing a significant difference in age at which they learned their first second language and age of second language instruction in their countries. Taken as a whole, these results form a mosaic of the mechanisms and variables involved in second language learning, providing insight into the process of second language acquisition in undergraduate students.

Second language learning in an undergraduate population: Applications of psycholinguistic theory

Much research has been performed in the field of second language acquisition (SLA) in recent years. The burgeoning repertoire of professional literature related to the subject could be a byproduct of expanding interest in the interdisciplinary field of language learning and acquisition by theoretical linguists, cognitive and developmental psychologists, neuroscientists, and educators alike. This influx of interest and research is especially timely in the contemporary society of the United States, which is subject to growing immigration from Mexico and Latin America and increasing internationalization in the corporate and academic sectors. While it has been necessary to study the phenomenon of SLA through scientific and empirical methods since the birth of human language itself, it is arguably more essential than ever to understand it now. It is increasingly important that the neural mechanisms behind language learning are understood in order to gain the best opportunities for inter-linguistic and inter-cultural proficiency in today's world.

The purpose of this study was to provide a holistic view of the processes involved in second language acquisition in undergraduate university students. The experiment consisted of a main task in which the efficacy of two predominant hypotheses of SLA was compared under both short-term and long-term retention circumstances, an exploratory study of neurological hemispheric activation under both conditions as measured by cerebral blood flow velocity, and a multicultural component in which Spanish-speaking international students and American students of the Spanish language were interviewed about their experiences in learning a second language.

Overview of the hypotheses and other significant factors regarding second language acquisition

In order to fully understand the phenomenon of SLA, one must first gain a thorough knowledge of the hypotheses surrounding it. Although many hypotheses of SLA have arisen during the past century, two hypotheses dominate the field of second language acquisition and pedagogy today: the grammar-translation model (sometimes referred to as form-focused instruction (FFI)) and the communicative model.

The grammar-translation model is the older and more established of the two approaches to second language pedagogy. Until the rise of the audiolingual method in the 1940's, it remained effectively unquestioned by linguistic theorists and educators. Mitchell and Vidal (2001) point out that generations were taught Latin and Greek as well as modern languages in educational institutions using the grammar-first approach, and it remains thoroughly entrenched in many modern foreign language classrooms and lesson plans, especially at the novice level. Omaggio-Hadley (1993) explains that this approach to SLA is rooted in the belief that a syntactic framework is vital to language learning and that language acquisition cannot occur unless this framework is present. Thus, grammar instruction is provided first and foremost and specific emphasis is placed on the accuracy of output in the second language (L2). Proponents of the grammar-translation method believe that if the rules governing the grammar of the target language are well-acquired by the student, proficiency will occur of its own accord when enough knowledge of vocabulary and syntactic structures has been gained. The current trend in primary and secondary education, prompted by the call for teacher and student accountability at the local and federal levels and known informally as the "back to basics movement," is very much in accordance with the underlying tenets of the FFI model of L2 instruction. Although there is no indication that the assessment tools associated with this movement will be applied to foreign

language instruction in the near future, the author of the current study believes that few educators would dispute the fact that the principles, implications, and repercussions associated with this movement have reached beyond subject-area boundaries and affected theories of pedagogy in a broad and deep sense.

Mitchell and Vidal state that the communicative model arose from the monitor hypothesis of SLA, as originally proposed by Stephen Krashen. Krashen's (1982) monitor model is based on four main principles: the acquisition-learning distinction, the monitor hypothesis, the natural order hypothesis, and the input hypothesis (as cited in Omaggio-Hadley, 1993, p. 29). Omaggio-Hadley explains that Krashen emphasized the difference between second language *acquisition*, a metacognative process similar to the way that children develop proficiency in their native language, and *learning*, the conscious knowledge of grammatical rules of language. Acquisition and learning play distinct roles in L2 output. Acquisition stimulates output in the L2 while grammar serves as a "monitor" for output, comparing it to a checklist of rules and determining its correctness. Krashen also believed that the acquisition of grammar proceeds in a "natural" sequence and cannot be taught explicitly; therefore, the L2 should be taught by providing ample input in the target language that is "a little beyond" the proficiency level of the student (p. 29).

The communicative model states that proficiency in the target language (L2) occurs before explicit knowledge of the grammatical structure of the L2, in contrast with the sequence of SLA set forth by the grammar-translation model. Omaggio-Hadley (1993) notes that content-rich input is necessary for the development of proficiency in the L2 and that the maximum amount of input must be provided in order to attain the highest level of proficiency in the L2 possible. Practitioners of the communicative method are cautious not to force students to produce output in the L2 before they have gained a sufficient base of knowledge in the target

language and are ready to do so. This approach is largely based on the ideas of Krashen, as discussed above. Sigsbee (2002) states that many foreign language teachers have adopted the ideas associated with this hypothesis for practical use in their classrooms, and most notably, the American Council of Teachers of Foreign Languages (ACTFL) has developed a structured interview system that emphasizes the principles on which the communicative approach is based for the assessment of the proficiency of students in the target language, seemingly lending support to this theory of L2 instruction.

To the knowledge of the author of the current report, no controlled, systematic research comparable to that presented in this project has been published in the literature on SLA, education, experimental psychology, linguistics, or modern languages to date. While it's true that there are records of studies that have assessed the effectiveness of the grammar-translation and communicative models of SLA, most have been carried out by educators in real-life classroom situations, which, of course, cannot be as closely monitored and controlled as a true experimental environment of the type utilized in the current experiment.

Several studies suggest that an emphasis on form is an essential element for second language pedagogy programs, especially those designed specifically for older adolescents and adults. Klapper & Rees (2003) tracked the progress of two ability-matched groups of students enrolled in foreign language instruction programs through four years of undergraduate studies. The first group, referred to as the "specialist group," was taught according to an intensive program that included many aspects of the grammar-translation approach, whereas the second group, called the "non-specialist group," was taught using a program that emphasized skills associated with the communicative method. As measured by standardized assessment tests of grammar and proficiency, the former group made better overall progress, lending evidence for

the efficacy of the grammar-translation approach. Interestingly, however, the latter group improved substantially during the residency abroad period in which all of the students participated, almost equaling the scores of the grammar-translation group. This discrepancy could be explained by the observation that the promotion of communication and oral proficiency in real-life situations emphasized by the communicative approach often proves more useful in an informal immersion setting such as a study abroad program. Comparisons of the effects of explicit and implicit feedback on proficiency, which are associated with the grammar-translation and communicative approaches respectively, have also been made by some researchers, such as Soler (2005) and Rosa and Leow (2004). Their results suggest that explicit feedback, especially when presented in response to production of the target language, leads to a higher level of proficiency. The significance of these findings is related to the grammar vs. proficiency first question since the proficiency approach presents grammatical structures via an implicit route while the grammar approach teaches them explicitly. It is possible, however, that the results of these studies may be misleading if the intelligence and memory span of the subjects is taken into account, an issue that will be discussed in more depth later in this paper.

Surprisingly, there is comparatively little research that supports methods related to the communicative approach. Skala (2003), a secondary school French teacher who observed the progress of her own classes, found that methods that are theoretically related to the communicative approach, such as the total physical response approach (TPR) and the total physical response storytelling approach (TPRS) proved to be the most effective as measured on an objective level by student test grades and on a subjective level by student ratings of knowledge, proficiency, and motivation. Joiner (1977), who compared the achievement and proficiency of undergraduate students enrolled in a beginning French course taught using either

the communicative or the non-communicative (grammar-translation) method, observed that students in the former group showed superior performance in aspects of language use that emphasized the communication of a message in “realistic” situations similar to those found in everyday life whereas students in the latter group outperformed their counterparts when concrete lexical and syntactical knowledge of the language was tested. This pattern of results is not surprising since the performance of the students in each treatment group was superior in the aspects of the language that are emphasized by each methodology and, as such, are practiced more, which leads to better memory recall. An interesting finding from the same study were that students who received lower scores on the Modern Language Aptitude Test showed higher levels of overall achievement under the non-communicative condition. Also, students who scored high on a test of verbal creativity (Torrance Tests of Creative Thinking, Verbal From B) showed higher levels of overall achievement as members of the communicative treatment group whereas those who scored low on the same test achieved more under the non-communicative treatment. This correlation suggests that differences in style of thinking (highly creative vs. not highly creative) could serve as a predictor of which pedagogical methodology would be more effective for certain students.

Group and individual differences in ability and perception must not be overlooked when examining the effectiveness of L2 teaching and learning methods. Morris (2005) observed that the methodology (grammar-translation vs. communicative) used to teach foreign languages can vary according to whether foreign language classes are deemed honors or non-honors, with more communicative exercises presented in the honors classes and more form-focused exercises present in the non-honors sections. In this study, teachers who were interviewed felt more comfortable using communicative exercises with honors-level classes because such methods

allow a greater degree of freedom on the part of the students, who are perceived as being more able and focused in honors-level classes, whereas they tended to use form-focused exercises in non-honors classes given the assumption that students in these classes were less motivated and less able than their counterparts. These findings demonstrate that student vs. teacher perception is always an important consideration in any classroom situation. Similarly, Schulz (2001) documents a difference in teacher and student perceptions regarding the explicit teaching of grammar and error correction, where students favored the latter significantly over teachers. Major differences in perception between students and teachers such as this will invariably interfere with language instruction and learning, placing a psychological strain on both groups. In terms of individual differences in learning ability, Huang (2003) suggests that in order for L2 instruction to be most effective for all students involved, the instructor should devote time to teaching L2 learning methodology (that is, self-directed strategies to help the student learn and retain the target language to the greatest degree possible, such as oral repetition of vocabulary or, in this case, daily writing exercises using a journal), thus effectively eliminating any possible discrepancies due to ineffective student learning strategies and maximizing the student's capacity to learn the L2. This supplementary instruction may indirectly affect the student's level of proficiency in the L2 by facilitating the learning process, thus motivating him or her to learn the language, which in turn may translate into a higher proficiency level.

Another factor that must be considered when discussing the effectiveness of L2 pedagogy is the cultural component. Sigsbee (2002) points out that many students in the United States are unmotivated to learn a second language for a number of reasons, including the belief that it is unnecessary knowledge and their negative past experiences with foreign language classes. Foreign language teachers could attempt to remedy this problem by making a concerted effort to

include relevant and stimulating material in their classroom curricula. There are also cross-cultural differences in the methods used to teach L2's. Schulz (2001) conducted a survey of American and Columbian foreign language teachers and students and found that Columbians favored grammar instruction significantly over Americans. While the reasons behind this cultural difference are unclear, Schulz suggests that it may be attributed to the status quo of L2 pedagogy in both countries involved or possibly to the Columbians' lack of acquaintance with the current research in the area of L2 acquisition. In a comparative study of second language teaching methodology that spanned 17 countries, Pufahl, Rhodes, and Christian (2001) outlined some of the major differences between L2 instruction in these countries and the U. S., which included earlier L2 instruction, multiple language instruction (beyond the L2), and rigorous teacher training. The authors of this study urge American foreign language teachers to look beyond national borders and to consider what L2 teaching techniques have been effective in other countries in order to improve the quality of their own curricula.

The neural bases of language learning

Psychologists, neuroscientists, and linguists have looked to the human brain as the final arbiter of hypotheses concerning language acquisition and pedagogy. If an understanding of the neural processes underlying language learning is gained through science, it is believed that programs of instruction can be designed to facilitate language learning by taking advantage of the neural mechanisms involved.

Paul Broca (1824-1880) was arguably the first scientist to explore the neural basis of language learning. In 1861, when he performed an autopsy on an aphasic known as "Tan," Broca pinpointed the area in the brain devoted to language production, the inferior frontal gyrus (also known as Broca's Area and Brodmann area 44-45). A few years later, Karl Wernicke

(1848-1905) discovered the area in the brain responsible for language comprehension, the superior temporal gyrus (also known as Wernicke's Area or Brodmann area 22). The discoveries of these two physicians laid the groundwork for further investigation into the neural bases of language processing.

It is now known that the neural language network is much more complex than Broca and Wernicke imagined. In fact, the roles of Broca's and Wernicke's Areas in language processing are currently under investigation by neuroscientists such as Müller and Basho (2004), who have concluded that the linguistic functions of Broca's Area may arise from other seemingly unrelated specializations of the surrounding areas. Upon asking subjects to perform lexico-semantic decision, tone discrimination, and visuo-motor coordination tasks, the experimenters observed patterns of regional cerebral blood flow (rCBF) activation with functional magnetic resonance imaging (fMRI) that converged in Broca's Area, suggesting that these functions, which are of heightened importance in childhood, may be prerequisites for language processing. In addition to Broca's and Wernicke's Areas, previously unconsidered centers of neural language processing are being proposed, such as the dorsolateral prefrontal cortex (DLPFC). In a case study of two bilingual patients undergoing transcranial magnetic stimulation (TMS) treatment of the DLPFC for persistent major depression, Holtzheimer, Fawaz, Wilson, and Avery (2005) documented unexpected incidents of language switching between the L1 and L2, suggesting that this area may play a role in code-switching and inter-language interference prevention . Additionally, the work of neurosurgeon George Ojemann (2004, 2003, 1999) has shown that the neural network of language processing is so complex that it differs on an individual basis; for example, one person's primary cortical area for noun production may serve an unrelated function for another person. Ojemann has shown that this is also true for second language representation, with the

complexity, extensiveness, and concentration of the network varying greatly from person to person.

Recent research using neuroimaging techniques has provided a great deal of insight into the neural representation of second languages. One of the best known studies related to this subject is that of Kim, Relkin, and Hirsch (1997). Using fMRI technology, the experimenters concluded that native and second languages showed different patterns of neural activation for subjects who had acquired proficiency in the L2 after 10 years of age, whereas the patterns were comparable in childhood bilinguals. The results of this study are groundbreaking in that they show neural evidence that L2 acquisition in adults differs greatly than that in children, although it is not yet clear whether this places adults at a considerable disadvantage. On the other hand, Perani et al. (1998) observed a different pattern of activation when performing a similar experiment on bilingual subjects using positron emission tomography (PET). In this case, the experimenters found no noticeable differences in the neural representation between early and late bilingual subjects; however, significant differences were observed in high- and low-proficiency subjects. High-proficiency subjects showed attentive foci in the left temporal pole, middle and posterior temporal gyri, and bilaterally in the hippocampal structures whereas no similar activation was observed in the temporal poles or the left anterior and posterior parts of the middle temporal gyrus in low-proficiency subjects. The authors of this study suggest that the difference between these results and those of the former experiment may be due to a number of factors, including the content of the task (active translation vs. silent reading in the case of the first) or the neuroimaging method (PET vs. fMRI). At any rate, more research must be performed before a conclusion can be formed as to whether differences between the neural representation of the L1 and L2 exist, and if so, what their cause is.

It is generally assumed in the linguistic community that children learn second languages more easily and quickly than adults. This difference in ability has been traced back to the existence of what linguists term the "sensitive (or critical) period," which ends at around 8-10 years of age. It is thought that the pre-pubescent brain has a higher degree of neural plasticity than the post-pubescent brain and that this directly relates to the neural bases of second language acquisition. However, there is great disagreement about the extent to which adult second language learners are inhibited due to these neural differences. Zied et al. (2004) observed a significant difference in reaction time and accuracy rates of older (mean age = 71.33 years) vs. younger (mean age = 30.76 years) subjects in a bilingual version of the Stroop Task, suggesting that a deterioration of neural second language learning and retention capacity coincides with aging, especially in unbalanced bilingual subjects. From a broader standpoint, however, these results can be explained by the frontal lobe changes that accompany aging. Research has shown that elderly subjects exhibit slower reaction times than younger controls when faced with a variety of tasks, a measure that is directly related to the attentional control function of the frontal lobe (c.f. Madden, Whiting, & Huettel, 2005). On the other hand, the results of the experiment of McLaughlin, Osterhout, and Kim (2004) suggest that adult language learning may not be subject to as much neural impedance as some hypothesize. After only 14 hours of instruction in a previously unknown L2, event-related potentials (ERP's) similar to those of native speakers were observed in subjects who participated in a lexical discrimination task (word vs. non-word) in the target language. This observation shows that some information about words in the L2 is rapidly acquired by adult learners easily and subconsciously. These results also demonstrate the importance of research using neuroimaging techniques, which are sensitive to some aspects of L2 learning that behavioral tasks cannot accurately measure.

The role of laterality in language processing is another area of investigation that provides clues to the organization of language within the brain. It is generally accepted by psychologists and neuroscientists that the left hemisphere is specialized for language processing; however, it is not clear what role(s) (if any) the right hemisphere plays in language processing. Shrytov, Pihko, and Pülvermuller (2005) investigated the question of whether laterality in language processing can be explained by the physical or linguistic features of speech sounds by gauging the neural response of subjects to complex non-speech sounds, psuedowords, and words using magnetoencephalography (MEG). It was found that hemispheric dominance only emerged with words, suggesting that laterality in language processing derives from the processes of memory trace formation and learning rather than physical or phonological properties of speech sounds. Sundermeier, Virtue, and Marsolek (2005) investigated the involvement of the left and right hemispheres in inference generation. After reading brief inference-generating texts that described either familiar or less-familiar scenarios, subjects performed a lexical decision for a stimulus presented to either the left or right hemisphere. Facilitation was observed in the right hemisphere after familiar and less-familiar verbal conditions, whereas facilitation was only observed in the left hemisphere after familiar conditions. The results support the hypothesis of a separate-subsystems model of text comprehension, suggesting that the two hemispheres may play distinct roles in language comprehension; for example, it is possible that the left hemisphere (LH) could process language in a more constrained, specific environment while the right hemisphere (RH) could process in a more widespread environment. These findings are also in agreement with Elkhonon Goldberg's (1981) theory of hemispheric specialization in the processing of novel vs. routine information, which asserts that the former is directed by the right hemisphere whereas the latter is carried out in the left hemisphere and that, as input becomes

more familiar, the site of processing shifts from the right hemisphere to the left hemisphere (as cited in Goldberg, 2001). The results of some experiments suggest that the right hemisphere plays an integral, albeit less obvious, part in language processing, however. For example, Neininger and Pülvermuller (2003) found that subjects with lesions in different areas of the right hemisphere showed severe deficits in word processing as evidenced by their performance on a lexical discrimination task. These observations suggest that the right hemisphere is necessary for language processing and that trauma to this side of the brain could result in severe linguistic discrepancies. Not surprisingly, research has also shown that handedness has a direct effect on the lateralization of language processing. Using transcranial Doppler ultrasonography, Knecht et al. (2000) observed a variation in the use of the left hemisphere ranging from 4% in strongly right-handed participants to 15% in ambidextrous subjects to 27% in strongly left-handed participants.

In addition to the theory of laterality, the language localization hypothesis must be taken into account when discussing the neural substrates of language processing. Several researchers have recently found that specific parts of the brain are specialized for specific linguistic functions. Neininger and Pülvermuller's (2003) study of lesion patients lends support to the specialization hypothesis. The experimenters found that subjects with lesions in the right frontal lobe showed severe deficits in the processing of action verbs and subjects with lesions in the right inferior temporo-occipital lobe showed similar deficits in processing visually-related nouns. The findings of this study support a neurobiological model of language according to which language processing is based on cell assemblies distributed over both hemispheres that are specialized for specific word categories in certain parts of the brain, supporting both the laterality and localization hypotheses of language representation.

The role of working memory in language learning

It is generally agreed upon by linguists, psychologists, and neuroscientists that working memory is essential for learning of any new information, including language. On an individual basis, differences in working memory capacity can affect the difficulty of learning novel vocabulary and the recall of previously-learned lexical items, both of which are necessary skills in language learning. Thus, it is essential to gain an understanding of the concept of working memory in order to facilitate the learning of a second language from a practical perspective.

The functioning of the working memory was originally conceptualized by the cognitive scientists Alan Baddeley and Graham Hitch (1974), who proposed the division of the working memory into three components: the central executive, which is the attentional regulator of working memory and is responsible for coordinating two principal specialized slave system components, the visuo-spatial sketchpad (also referred to as visuo-spatial working memory), processor of visual and spatial information, and the phonological loop (also referred to as verbal working memory), processor of linguistic information. In 2000, Baddeley added a fourth element to his model of working memory, the episodic buffer, which is a limited-capacity system that is heavily dependent on executive processing but which differs from the central executive in being mainly involved in the storage of information rather than with attentional control. The episodic buffer is essentially the link between working and long-term memory, combining stimuli from several sources into a unified, multi-faceted code for long-term storage and later retrieval. Alternate conceptualizations of the functioning of the working memory exist, (c.f. Cowan, 2005; Ericsson & Kintsch, 1995), but the Baddeley-Hitch model is the most established and seems to have gained the most acceptance in the cognitive science research community to date.

In addition to theoretical conceptualizations, the working memory has been mapped anatomically using neuroimaging techniques. Research has identified the medial temporal lobe – specifically, the hippocampus – and the frontal lobe – specifically the prefrontal cortex – as key cerebral regions involved in the functioning of working memory (Buckner, Kelley, & Petersen 1999; Cohen & Eichenbaum, 1993; Squire, 1992). Not surprisingly, evidence of laterality contingent upon class of stimuli has been observed in the anatomical representation of working memory. The left frontal cortex shows activity in the encoding and processing of verbal material whereas the right frontal cortex is active with visual stimuli, and both sides show activity when mixed stimuli (containing verbal and visual associations) are present (Kelley et al., 1998). Additionally, the visuo-spatial sketchpad is sometimes conceptualized as activating the "where" pathway (from occipital to parietal lobe) whereas the phonological loop seems to deal more with activation of the "what" pathway (from occipital to temporal lobe). This explanation of the cerebral regions involved in the processing of visual and verbal stimuli suggests that differences in how the working memory handles the two classes of stimuli may transcend the traditionally-established right hemisphere/left hemisphere dichotomy.

The verbal working memory (VWM) has been conceptualized in a number of ways, but the most prevalent and accepted model is Baddeley's proposition of the phonological loop, which allows us to remember a series of distinct items (words, digits) using covert inner speech rehearsal and has been implicated in the acquisition of new words in children and adults. As originally proposed by Baddeley (1986), the phonological loop consists of two sub-components, a phonological store that can retain acoustic or speech-based information for one to two seconds and an articulatory control process, which can be understood as inner speech, that allows the retention of semantic information. According to Juffs (2006), two methods have mainly been

used to assess the capacity of the phonological loop in subjects: the repetition of nonsense words of varying syllable lengths and the ordered repetition of lists of varying lengths composed of distinct words. More recently, the neurological components of the phonological loop have been mapped. According to Paulesu (1993), the left supramarginal gyrus (Brodmann Area 40) has been identified as the cortical area associated with the phonological store and Brodmann areas 22 and 42 have been designated as primary locations of sub-vocal rehearsal. Baddeley (2003) points out that although activation is generally present in the left hemisphere, suggestions of homologous activity have occasionally been observed in the right hemisphere under especially strenuous conditions.

The role of the phonological loop is believed to be especially important in language acquisition. In fact, Baddeley, Gathercole, and Papagno (1998) have proposed that the primary function of the phonological loop is to facilitate the learning of novel words. Specifically in regard to second language learning, researchers have found that the accuracy of pseudo-word or non-word repetition predicts the acquisition of second-language vocabulary (Ellis, 1996; Service, 1992). The functioning of the phonological loop has also been linked to long-term memory through existing phonological knowledge of the native language, which assists in the learning of a second language. One piece of evidence for this connection comes from the results of studies that have examined the ability of English schoolchildren to repeat unfamiliar non-words contrived in accordance with the phonotactic rules of the French language, which was observed to be strongly correlated with the subjects' knowledge of French vocabulary (Gathercole & Thorn, 1997; Thorn & Gathercole, 1999). Furthermore, the form of verbal stimuli exerts an appreciable effect on the functioning of the phonological loop in language learning and processing. In discussions of the effect of suppression (that is, the prevention of the functioning

of the phonological loop), Baddeley and colleagues (1975, 1984) suggest that the presentation of purely verbal or purely visual stimuli is deleterious to the process of language learning. They assert that when verbal information is presented in auditory form (pure verbal), the supplementary visual code will be absent, and when it is presented visually, phonological recording is impaired. These speculations support the need for a signal rich in both verbal and visual content to ensure optimal functioning of the VWM in language acquisition.

Neuroimaging studies have suggested that many distinct parts of the brain are active in working memory processes associated with language acquisition. Working with neurosurgery patients, Johnson and Ojemann (2000) observed that electrical stimulation of different areas of the dominant (left) ventrolateral thalamus produces distinct linguistic deficits, suggesting that parts of the complex are active during language processing tasks. Specifically, they found that stimulation of the anterior segment causes production of a repeated incorrect word, stimulation of the medial segment evokes perseveration, and stimulation of the posterior segment and the anterior pulvinar result in misnaming and omission. They also observed that left ventrolateral thalamic stimulation during verbal memory input substantially decreased subsequent recall errors whereas stimulation during retrieval increased recall errors and that left pulvinar stimulation disrupted verbal memory processing while right pulvinar stimulation disrupted non-verbal memory processing, presenting evidence for lateralization. Halsband (2006) investigated the question of whether verbal memory processing in two unrelated languages is mediated by a common neural system or by distinct cortical areas using PET. The experimenter found that encoding was associated with prefrontal and hippocampal activation and that during retrieval, the precuneus showed a constant activation pattern for both languages for both abstract and highly imaginable words. Differential activations were observed in Broca's Area and in the cerebellum

as well as in the angular/supramarginal gyri according to the language used. Most notably, this study was the first to observe activation of the precuneus for foreign language processing as well as native language processing. The findings of this experiment demonstrate that many areas of the brain are involved in the encoding and retrieval of concrete and abstract words in native and foreign languages, and they reflect the diversity and interconnectedness of the areas in the brain used for the encoding and retrieval of verbal items in native and foreign languages. Moreover, they represent a specialized application of the generalized theory of some researchers that working memory processes are directly integrated with brain substrates in the long-term memory and are specialized according to the type of knowledge being drawn upon (c.f. Cowan, 1999; Moscovitch 2000).

Research examining the correlation between VWM capacity, attentional demands, and linguistic performance has confirmed that individual differences in VWM capacity can affect language processing. It is well-known that while online working memory capacity is limited, absolute capacity varies between individuals, and it has been suggested by several researchers that individual differences in absolute capacity are correlated with performance on complex tasks such as reading comprehension and reasoning items similar to those present in standardized intelligence exams (Carpenter, Just, & Shell, 1990; Daneman & Carpenter, 1984). Bornkessel, Fiebach, & Friederici (2004) observed differences in language processing between subjects with a high VWM span and those with a low span using event-related protocol (ERP) data. The results of the experiment demonstrated that low-span readers show a broadly distributed, sustained positivity whereas high-span readers show a shorter, topographically more focused negativity. A neural effect reflecting reanalysis in sentences disambiguated in a dispreferred way (P600) was observable only for high-span readers while the low-span group showed an N400-

like response, suggesting that when low-span readers encounter a syntactically ambiguous sentence, they are more likely to maintain multiple possible meanings in their verbal working memory whereas high span readers are able to quickly discard the irrelevant meaning and thus free up more memory needed to perform verbal tasks. Thus, people with a high VWM capacity process language more efficiently than those with a low capacity since they are able to quickly pinpoint the correct meaning of words and sentences. Jeffries et al. (2004) examined concurrent attentional demands on tasks containing different units of linguistic stimuli (words, unrelated sentences, and related sentences) to determine which stimuli elicited substantial demands on VWM and which were processed automatically without the assistance of VWM. It was found that words elicited a significant demand on VWM while related and unrelated sentence processing did not require much attention. These results concur with theories of VWM processes, which suggest that strategies such as chunking contribute to a decreased reliance on attention.

Without adequate VWM capacity, the learning and application of linguistic knowledge would be impossible. In addition to the study of normal VWM functioning, several investigators have examined subjects with brain trauma and pathologies that impair the functioning of processes controlled by the VWM. The differences in cerebral activation observed in these studies between pathological and normally-functioning participants have provided clues to which parts of the brain are involved in the processing of verbal stimuli. Dagenbach, Kubat-Silman, and Absher (2001) reported impairments in the performance of subjects with lesions in various parts of the thalamus compared to controls on a variety of tasks that are controlled by VWM processes, including the Daneman and Carpenter (1980) Reading Span Test, the Operation Span Test (which utilizes both VWM and VSWM), and a short-term word recall task, suggesting that

several regions of the thalamus play an integral role in VWM processes such as encoding and retrieval. Ravizza et al. (2006) found that VWM span was significantly lower in subjects with damage to the cerebellum than in controls but that rehearsal strategies and VSWM span did not show similar deficits. Given these results, they propose that the cerebellum may contribute to VWM during the initial phonological encoding and/or by strengthening memory traces rather than by directing covert articulatory rehearsal. Ellis Weismer, Plante, Jones, and Tomblin (2005) used fMRI to investigate the differences between adolescent specific language impairment (SLI) patients and controls in a verbal memory task. They observed that the SLI group displayed hypo-activation of the left parietal region and the precentral sulcus during encoding of stimuli as well as hypo-activation of the insular portion of the inferior frontal gyrus during the recognition phase. The results also suggested that SLI patients exhibit an atypical pattern of coordination of activation between several regions of the brain involved in the processing of verbal stimuli and VWM processes. Hypo-activation was observed between the superior temporal gyrus and frontal and parietal regions whereas hyper-activation was observed between the dorsolateral prefrontal cortex and inferior frontal region. No differences in laterality were observed. Similarly, Hugdahl et al. (2004) found that controls exhibited a small area of activation in the right inferior frontal lobe that was not present in SLI subjects. This activation is believed to play a role in working memory and attention processes used during language processing. Taken together, the outcomes of these studies of lesion and SLI patients confirm that there is an extensive network of cerebral areas that are involved in VWM processes and that damage to any one or combination of these regions can result in impairment of the processing of verbal information. In other words, dysfunction or damage to any part of the neurological system causes a breakdown of the entire network.

The current study

The purpose of the current study was to delve into the processes and applications of second language acquisition (SLA) using a holistic approach consisting of several lines of investigation. The main experimental task component was designed to investigate the effectiveness of two rival hypotheses prevalent in the field L2 acquisition: the grammatical framework approach and the communicative method. It was thought that the experimental condition derived from the communicative method would produce the best results as measured by a post-assessment due to a more comprehensive activation of the neural network produced by the varied stimuli associated with this methodology, leading to better comprehension and short- and long-term memory retention. The presence of a greater quantity of more diverse memory cues related to the lexical content presented in both conditions was also hypothesized to promote second language learning. The purpose of the follow-up sessions conducted two weeks after the main task had been performed was to investigate possible differences between short- and long-term retention of the target L2 material in the case of the experimental group and to provide a baseline measure for use in analysis in the case of the control group. As with the short-term post-exam, it was hypothesized that the visual/implicit experimental group would perform at a superior level on the long-term post-assessment given the comprehensiveness of the stimuli to which they were exposed.

In addition to the main task component of the present project, two supplemental segments were included to provide further insight into factors affecting second language acquisition. The purpose of the neuroimaging component, which used the same procedures as the main task portion, was to investigate the presence of lateralization due to stimuli used in the experimental pedagogical methodologies, and it was believed that heightened activation of both hemispheres

would be observed under the visual/implicit condition whereas heightened activation of the left hemisphere only would be observed under the verbal/explicit condition. In the multicultural component, international and American students were interviewed in order to ascertain the presence of cultural differences in foreign language education. It was hypothesized that significant differences would be observed with the factors of age at which the first second language was taught to participants, age at which the first second language is generally taught to residents of participants' country of origin, and number of languages known by participants.

Methods

Participants

All participants in the current experiment were undergraduate students at Washington College aged 18-23 years. Participants in the main task portion of the study consisted of a total of 33 students, all of whom were unfamiliar with Spanish, the target L2 presented in the task. Participants volunteered for the study in partial fulfillment of a requirement of the General Psychology course in which they were enrolled or who were otherwise recruited by the experimenter as volunteers due to their lack of knowledge of the target language. The original pool consisted of 35 participants, but the results of 2 were eliminated in analysis due to scores above the allowable level on the pre-test. In the experiment, participants were assigned to one of three conditions: the verbal/explicit experimental condition, which consisted of 9 participants; the visual/implicit condition, which consisted of 10 participants; or the control group, which consisted of 14 participants. A sub-sampling of 18 participants who had participated in the initial session of the experiment consisting of 10 members of the control group, 3 members of the verbal/explicit group, and 5 members of the visual/implicit group returned after a period of two

weeks for a follow-up session in which their long-term retention of the target language was assessed.

Seven participants, consisting of 3 males and 4 females, who were divided between the two experimental conditions in groups of 3 and 4, took part in the neuroimaging component of the experiment. All participants were right-handed native speakers of English. In addition to an independent analysis of cerebral hemodynamics, their results on the behavioral measures, which were identical to the assessments administered to the non-neuroimaging group, were included in the analysis of the main task portion of the study.

A total of 20 participants participated in the multicultural segment of the study, consisting of 11 Spanish-speaking international students and 9 American students of the Spanish language. International students were recruited through e-mail with the assistance of the Office of International Programs and the Chair of the Department of Hispanic Studies, and American students were recruited by means of a presentation by the experimenter at the beginning of two advanced-level Spanish classes. All interviews were conducted in Spanish and recorded by the experimenter. Responses were later transcribed and coded into numerical and categorical form in order to allow for statistical analysis.

Materials

A variety of measures were utilized in this experiment. Assessments widely available include the Edinburgh handedness inventory (Oldfield, 1971) and the software package *Laboratory in Cognition and Perception, Third Edition* (Levy & Ransdell, 1998), which includes a computerized version of the Sternberg working memory retrieval task (1966) that participants performed on IBM ThinkCentre computer terminals. All written measures other than the

Edinburgh handedness inventory were created by the experimenter for the purposes of this study and are included as appendices.

The videos utilized in the main task component of the experiment with the experimental groups were shot by the experimenter with a Sony camcorder, edited with Apple I-Movie software on a Macintosh G5 computer, and formatted in final form with a DVD interface. During experimental sessions, the videos were played back to participants using a Sony SLV D350P DVD/VHS combination player connected to an Epson PowerLite 7900p projector and an Extron MLS 406MA audio system.

In the neuroimaging portion of the experiment, cerebral blood flow velocity (CBFV) was measured using a functional transcranial Doppler (fTCD) apparatus and software manufactured by Elica, which were interfaced on a Gateway computer. This equipment provided dynamic measurements of blood flow through the middle cerebral arteries to each hemisphere of the brain using two ultrasound probes, which were applied to participants' left and right temples with the help of Aquasonic electrode transmission gel. Readings were averaged over a two-minute period of time during the experimental task (i.e. watching the video) to determine hemispheric activation.

A Radio Shack micro tape recorder was used to record the responses of participants in the multicultural component of this study. Responses were transcribed with Microsoft Word software, and codes derived from responses were input into SPSS software for statistical analysis. All analyses for the main task component of the experiment were also performed with SPSS.

Procedures

Main task initial session. To ensure that all participants had little to no knowledge of Spanish, the target language used in the experiment, the requisite that volunteers must have taken no more than one academic year of Spanish classes in middle or high school or no more than one semester of Spanish classes in college was clearly delineated on the sign-up sheet. When participants arrived at the experimental sessions, after giving their informed consent (Appendix A), they were asked to complete a pre-assessment which consisted of five items chosen from the vocabulary list to be used in the experimental component of the main task (Appendix B). Participants were instructed not to guess at the items and to only list the answer if they were sure that it was correct. Pre-assessments were then immediately scored by the experimenter. Only participants who showed minimal prior knowledge of the target vocabulary by scoring 0 or 1 correct were admitted to the next stage of the experiment, which consisted of two additional preliminary tasks. The first consisted of a detailed written demographic questionnaire (Appendix C) that served the purpose of measuring factors of interest, and in the second, participants performed a standardized computerized version of the Sternberg Task in order to measure their working memory capacity and efficiency. The main experimental task commenced after all participants had completed these two activities. In the experimental and control conditions, which were alternated according to session, participants were seated facing forward in an arrangement similar to that used in a typical classroom situation. Participants then watched a presentation of a pre-recorded lesson in which they were taught a fixed list of Spanish vocabulary words pertaining to the theme of sports and pastimes that had been extracted from an introductory-level Spanish textbook, *Puntos de Partida* (Knorre, Dorwick, Perez-Girones, Glass, & Villareal, 2004). The video shown to one experimental group featured a lesson taught

according to a methodology designed to encompass the essential components of the grammar-translation method using verbal stimuli and explicit instructions, whereas the video presented to the other experimental group featured the same lesson taught according to the tenets of the communicative method, using visual stimuli and implicit (i.e. non-existent) instructions. Participants were also given a vocabulary worksheet that contained the stimuli used in the video corresponding to the treatment methodology in print form so that they could follow along individually as they watched and listened to the video (Appendices D and E). After the content of the lesson had been taught, subjects completed review sheets pertaining to the conditions of their respective experimental group for purposes of reinforcement, which were not evaluated (Appendices F and G). The experimenter then played a second pre-recorded video in which the correct answers were reviewed with participants. After this video had ended, participants completed a metacognitive survey (Appendix H) and a stimulus-balanced written assessment of the vocabulary presented in the sample lessons designed to mimic a typical classroom exam (Appendix I), which was evaluated for accuracy and used for analytical purposes. After completing the post-assessment, participants were debriefed (Appendix J) and released.

The experimental procedure used for the control group was identical to that used for the experimental groups except that the video recording containing the experimental lessons was not played and subjects did not fill out a practice worksheet or a metacognitive survey. The purpose of this condition was to determine how guessable the items on the pre- and post-assessments were to participants with no exposure to the target language, making it possible to eliminate the covariance of random guessing from the results of the participants in the experimental groups. None of the sessions for the experimental groups or the control group lasted longer than 60 minutes.

Main task follow-up session. A sampling of participants from both experimental groups as well as the control group returned two weeks after the initial main task session to complete a long-term post-assessment which was similar, but not identical, to the post-test administered during the initial session. In the follow-up sessions, participants provided their informed consent a second time (Appendix K), took the long-term post assessment (Appendix L), and were then debriefed (Appendix M). None of the follow-up sessions lasted longer than 15 minutes.

Neuroimaging component. In addition to the main experimental task, in which performance was measured via behavioral data, the neural processes of SLA were examined using an fTCD, which made it possible to trace CBFV to the two hemispheres via the left and right middle cerebral arteries (LMCA and RMCA), in a supplemental segment of this study. After giving their informed consent (Appendix N), participants who volunteered for the neuroimaging portion of the study performed all tasks in the same sequence as participants in the experimental groups of the main task component; the only differences in procedure were that participants could only be run one at a time due to the capacity of the fTCD and that the CBFV of participants in the neuroimaging group was measured during the learning segment of the trial, in which the pre-recorded lesson was presented. Through the use of alternation, half of the participants in the neuroimaging component were assigned to the verbal/explicit condition and half were assigned to the visual/implicit condition. After completing the experimental tasks, participants were debriefed (Appendix O) and released. None of the neuroimaging sessions lasted for longer than 75 minutes. Like those who participated in the main task portion of the study, participants in the neuroimaging segment were asked to return after two weeks for a follow-up session that was identical to the follow-up session of the main task component. Since

behavioral data was also collected from participants in the neuroimaging component using the same assessments that were administered to participants in the main task segment, this data was included in the analysis of the data from the main task.

Multicultural component. In addition to the segments discussed, the current project also included an exploratory study of inter-cultural differences between Spanish-speaking international students and American students of the Spanish language. After providing their informed consent (Appendix P), participants in this portion of the study were interviewed about their experiences learning an L2 in their native countries via a structured question and answer format (Appendix Q), and afterwards, they were debriefed (Appendix R) and released. All responses were recorded on audiotape and later transcribed and coded by the experimenter for statistical analysis.[1]

Results

Main task component

A univariate between-subjects analysis of variance (ANOVA) confirmed that both of the experimental groups (verbal/explicit and visual/implicit) performed at a significantly higher level than the control group on the short-term post assessment administered at the end of all initial experimental sessions, $F(2, 29) = 15.196$, $p < .001$ (Figure 1). However, Bonferroni post-hoc tests revealed that there were no significant differences between the composite scores obtained by the participants in the verbal/explicit and visual/implicit experimental groups on the short-term post assessment, and that experimental group had no bearing on sub-scores obtained on the verbal or visual segments of the test. For the experimental groups, higher scores on the short-term post-test were obtained by participants who obtained a score of 1 than by participants who

[1] The primary reason for the inclusion of the interview component in the current study is the requisite of the Department of Hispanic Studies that all Senior Capstone projects include a cultural element.

obtained a score of 0 on the pre-test, $t(22) = 22.687$, $p < .001$. Further analysis revealed no significant differences between the scores of the experimental groups and the control group on the long-term post assessment, $F(2, 17) = .105$, $p = .901$.

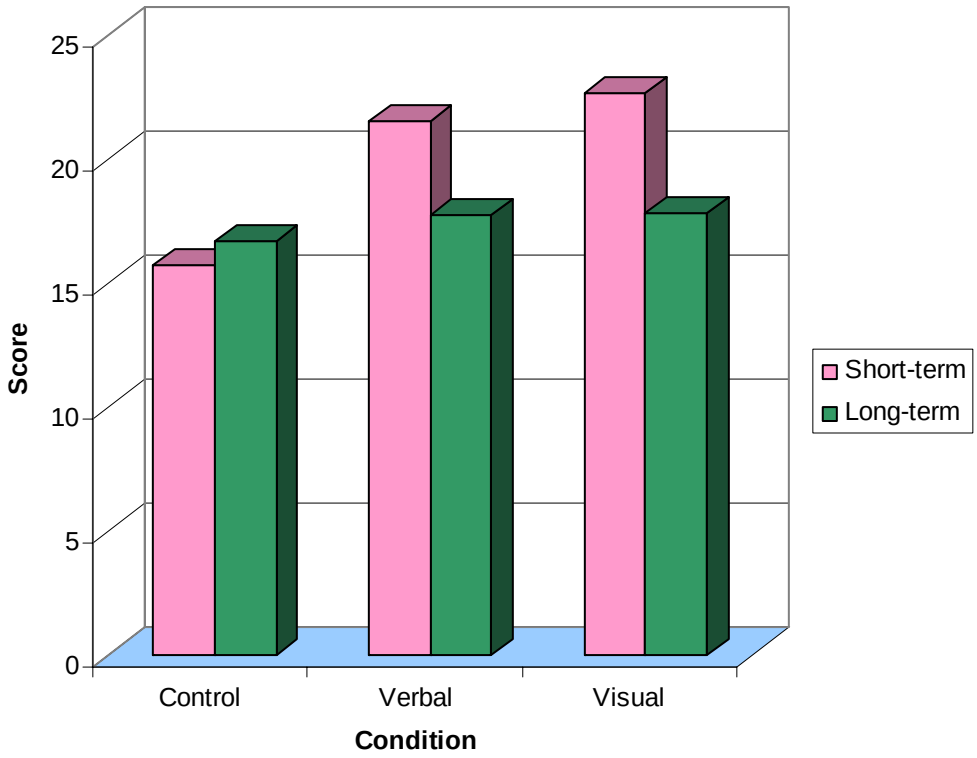

Figure 1. Mean scores achieved on short- and long-term post-assessments by participants in control, verbal/explicit, and visual/implicit groups.

In addition to the main hypothesis, several additional factors were examined using only the results of the experimental groups, but only one trend was observed. Correlational analysis revealed a relationship between working memory efficiency (as measured by reaction time on the Sternberg Task) and novel language learning (as measured by scores on the short-term post assessment), $r(33) = .328$, $p = .068$.

Neuroimaging c omponent

A univariate ANOVA indicated no significant differences between the left and right CBFV's of participants in the verbal/explicit and visual/implicit conditions, $F(1,5) = 1.659$, $p = .254$, and $F(1,5) = .738$, $p = .430$, respectively. However, upon closer examination, the means reveal a pattern that is partially consistent with the research hypothesis, showing a higher degree of blood flow on both sides for participants in the visual/implicit group (Figure 2). It is also worth noting that the standard deviations are greater for the visual/implicit group, suggesting that there is more variance in CBFV under this condition.

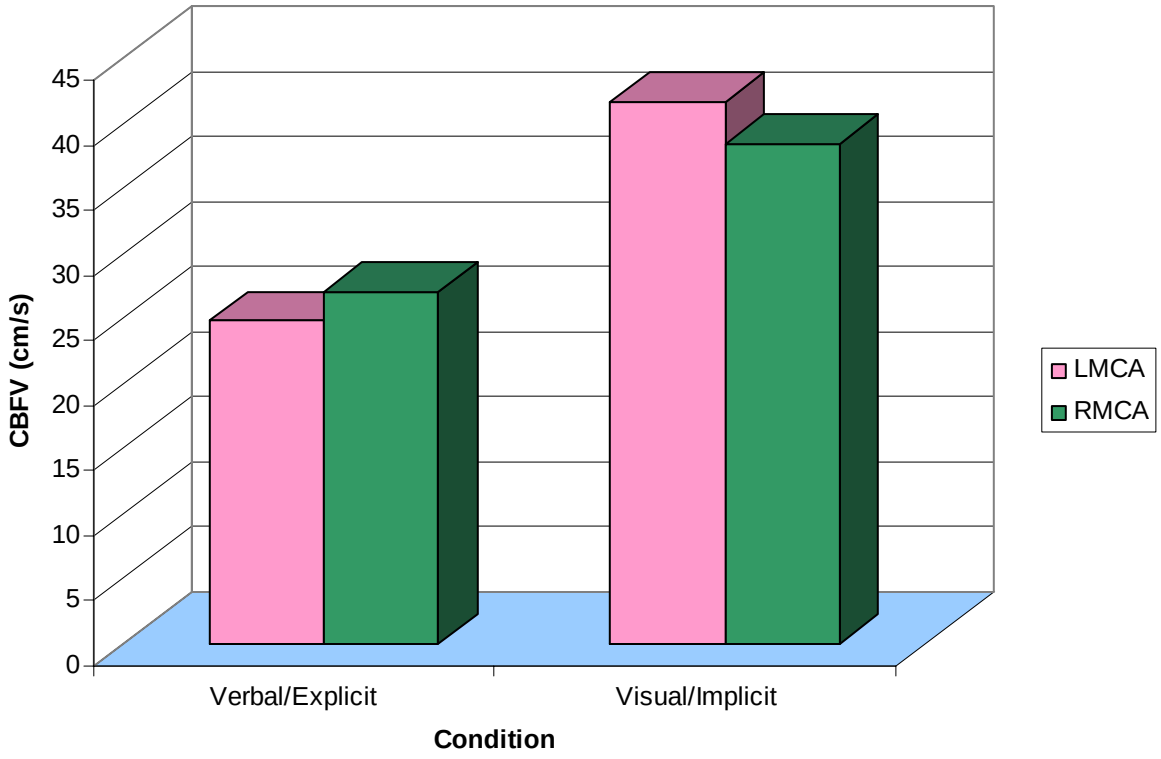

Figure 2. Mean hemispheric CBFV for verbal/explicit and visual/implicit groups.

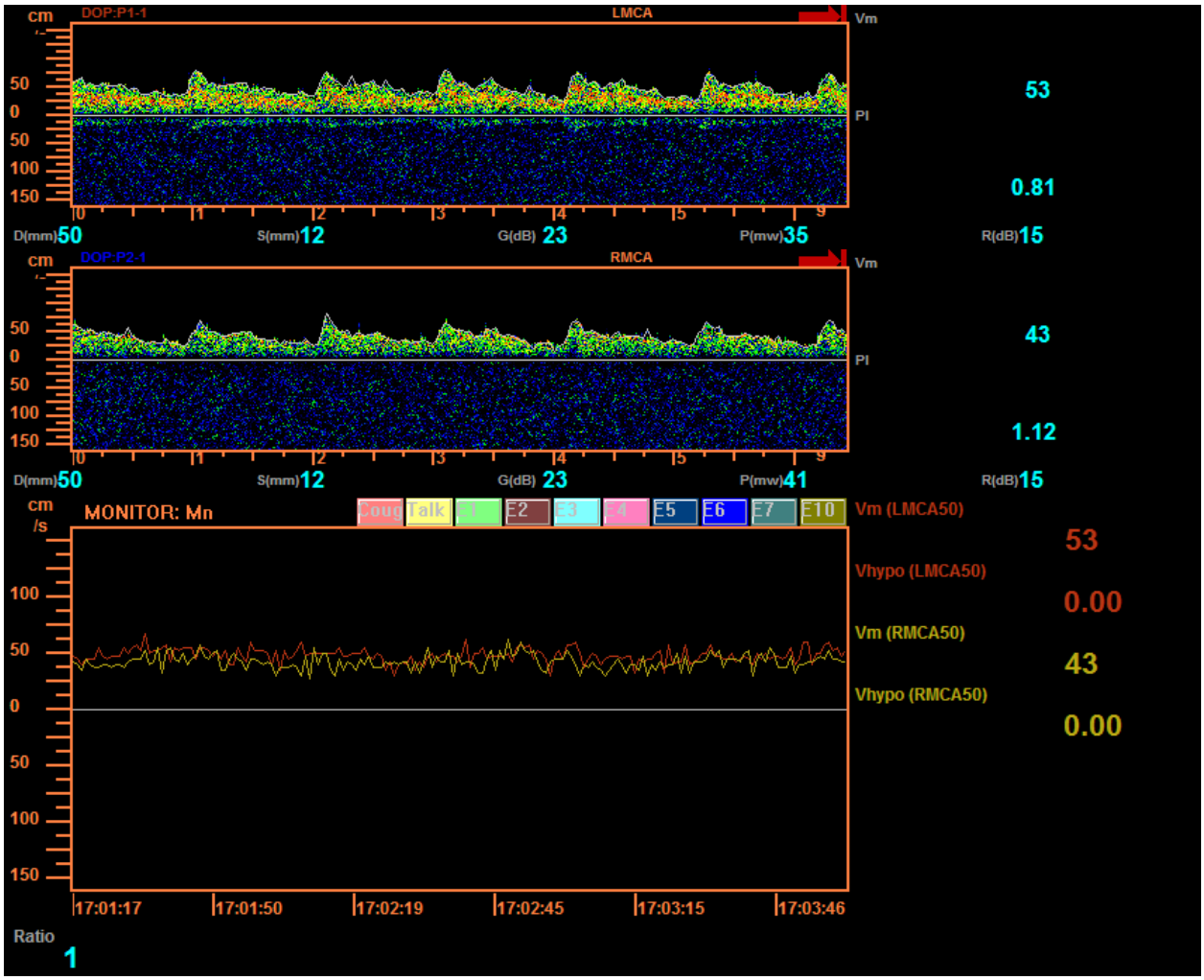

Figure 3. Representative CBFV output for the LMCA (top) and RMCA (middle) and graph of CBFV in both arteries (bottom) of a participant in the verbal/explicit condition.

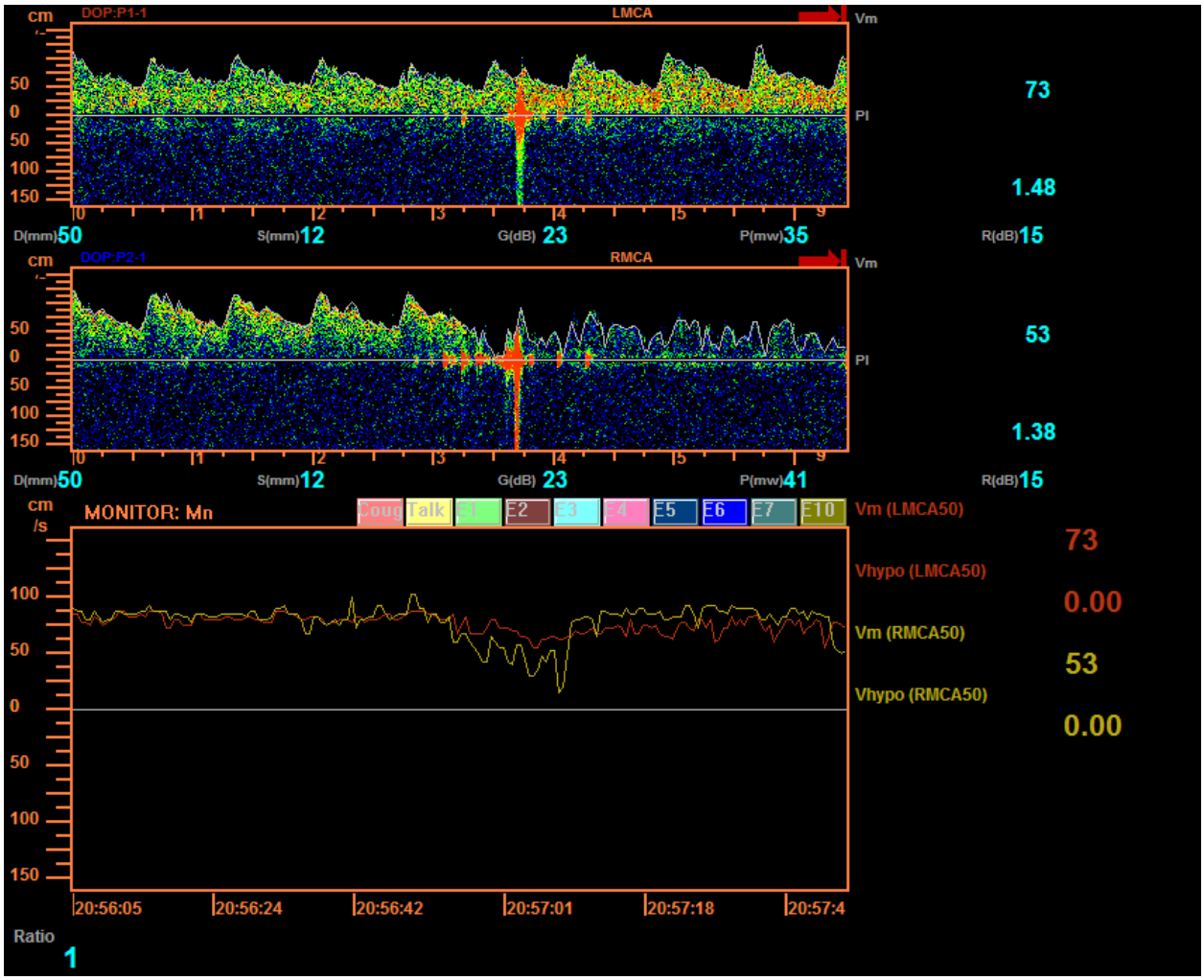

Figure 4. Representative CBFV output for the LMCA (top) and RMCA (middle) and graph of CBFV in both arteries (bottom) of a participant in the visual/implicit condition.

Multicultural component

Significant differences were observed between international and American participants for age at which participants began to learn their first second language, $t(17) = 8.157$, $p < .001$, and age at which foreign languages are first taught in the participants' respective countries, $t(16) = 3.266$, $p = .005$ (see Table 1 for descriptive statistics). Although no significant differences between American and international participants were found regarding number of languages known, examination of descriptive statistics revealed a noticeable difference between the means (2.444 and 3.222, respectively) and standard deviations (.726 and 1.093, respectively) of the two groups.

Group	American			International		
Factor	*N*	*Mean*	*SD*	*N*	*Mean*	*SD*
Personal age of 1st 2nd language	8	12.500	.756	11	6.000	2.145
National age of 1st 2nd language	8	12.000	1.069	10	7.100	.4220
Number of 2nd languages known	9	2.444	.726	9	3.222	1.093

Table 1. Factors of interest related to second language education differing between American and international participants.

Discussion

Main task component

The results of the main task component of the current study demonstrate that instruction, whether in accordance with the tenets of the grammar-translation or communicative approach, is an important part of the acquisition of a novel second language. For the majority, this goes without saying, and the outcome of this experiment suggest a reason why many people seek active instruction in their attempt to learn a novel language rather than attempt to learn on their

own. Thus, it came as no surprise that a highly significant difference was observed between the scores of the experimental groups, which was instructed, and those of the control group, which was not instructed, on the short-term post-assessment used in this experiment to measure the learning of an unfamiliar language by unexposed participants.

However, the results of this experiment do not confirm the hypothesis that participants exposed to the visual/implicit experimental condition, which was designed to be in accordance with the communicative method and which included a greater variety of stimuli (verbal *and* visual), would show a level of learning and achievement superior to that of the verbal/explicit experimental treatment, which was formulated in keeping with the tenets of the grammar-translation approach and which included only verbal stimuli. The lack of significance observed could be explained by the briefness of the lessons, which were about five minutes in length. Perhaps a longer period of exposure is necessary for any differential effects in learning and achievement such as those observed by Skala (2003) and Klapper & Rees (2003) to emerge given the fact that their findings were based on long-term observations made over the course of a semester and four years, respectively, whereas the results of the current experiment were based upon a one-time, short exposure to the target linguistic stimuli. Of course, it may also be the case that any differences due to type of instruction may be inexistent or so negligible that they will not become apparent under any circumstances. At any rate, further research must be performed on the effects of different types of instruction on the process of second language acquisition before a concrete conclusion can be reached.

Additionally, no significant relationship was observed between experimental condition and verbal or visual subset score on the short-term post assessment. This finding is especially interesting due to the fact that many of the questions on the post-test were almost identical in

form to those on the practice worksheets for each experimental condition. The logical – and assuring – conclusion that can be drawn from these observations is that the additional memory cues of syntax or item length were not used to answer test questions since, if that were the case, a strong correlation between condition and subset score would have been apparent. The implication that these observations entail is that there is an ordering of memory cues according to perceived relevance to the task at hand and that, specifically in regard to novel language learning, so-called shallow processing cues are of minimal importance. This finding is an extension of the observations of Craik and Lockhart (1972), who, in a well-known study, found that only deep processing cues, which are related to semantics, promote the memorization of familiar words. Taken together, the findings of this study and the current experiment make it clear that successful language instruction must emphasize semantic association in order to promote the processes of encoding and retrieval in working and long-term memory that are an essential part of language acquisition.

The lack of significance observed with all other factors, with the sole exception of working memory efficiency as measured by the Sternberg task, may also be attributable to the briefness of the exposure used in the experiment. As with instructional methodologies, effects due to other factors related to second language acquisition and learning, including memory techniques used, affective factors, past experience, scholastic achievement and aptitude, and field of study, may gain an appreciable impact with lengthened exposure to a learning paradigm such as that used in the present study. It is not surprising, however, that a trend was observed between working memory efficiency and immediate achievement in learning a novel second language (as measured by the short-term post assessment) due to the fact that both tasks involve retrieval from working memory. It is worth noting, however, that individual differences in working memory

may be exacerbated by the briefness of the lesson presented in this experiment, and it's possible that extended exposure to the stimuli presented in the lesson over a longer period of time (such as that encountered in many foreign language classes) may partially compensate for individual differences in working memory capacity, intelligence, and creativity since techniques for learning complex cognitive skills are developed over time with practice. Several other past experiments involving the learning of complex cognitive skills (e.g. Bornkessel, Fiebach, & Friederici, 2004 (language processing); van den Noort, Bosch, & Hugdahl, 2006 (second language acquisition); Pena & Tirre, 1992 (algebraic word problem solving)) have shown a strong relationship between working memory capacity and skill acquisition; thus, as with other factors under consideration in this study, working memory capacity and efficiency may show a heightened relationship with achievement in accordance with a lengthening of exposure.

In summary, a pronounced difference was observed between the achievement of the experimental groups and the control group, but no noticeable differences were seen between the two experimental groups. Additionally, a trend was observed between working memory efficiency and achievement, but no other factors were found to be significant. While it's true that the participant pool of the present study was not of the ideal size, analysis suggests that even if the sample size were increased, the observed differences would be comparable in nature. An interesting idea for future study would be to create a longitudinal version of the current experiment in which the target stimuli presented in the first session are reinforced through subsequent trials and in which novel stimuli related to the stimuli of the initial session are presented in each follow-up trial, building upon an already-established base of knowledge. The results of such a study would be even more relevant than those of the present experiment to language pedagogy since the proposed structure is more similar to the structure of real-world

language classes, which meet over an extended period of time and use previously-acquired knowledge of the target language as a base to facilitate the teaching of novel aspects of the language. Also, the results of the proposed experiment may reveal stronger correlations and more profound differences between test factors and achievement in the target language.

Neuroimaging component

Information about CBFV during the main experimental task gained using the fTCD partially confirmed the hypothesis in that a high CBFV average was observed in both the LMCA and RMCA under the visual/implicit experimental condition. However, data was inconsistent with the hypothesis under the verbal/implicit condition; in fact, a pattern opposite the predicted findings was observed in this case, with the RMCA exhibiting a higher CBFV average than the LMCA. Additionally, a significantly larger standard deviation emerged under the visual/implicit condition, showing a greater degree of variance between participants in the visual/implicit group as compared to participants of the verbal/explicit group. While the findings for the visual/implicit group were unsurprising, the data of the verbal/explicit group proved to be a surprise to the experimenter given the consistent observations of many past studies that the left hemisphere is more active in the processing of purely verbal stimuli (see Beeman & Chiarello, 1998, for a review).

While the slightly higher CBFV average for the RMCA in participants exposed to the verbal/explicit condition was not expected, it may be an indication that the verbal stimuli were processed visually. Unfortunately, self-report information from the metacognitive survey pertaining to this point does not confirm that this is the case. Due to the small size of the participant pool, it is also possible that the observed effects could be attributed to a lack of sufficient data. Although the standard deviation was smaller for this treatment group, there was

one less participant in the verbal/explicit group than the visual/implicit group, and in such a small group, the data of one case (or the lack thereof) can greatly skew the observed results. It is possible that the results of the neuroimaging segment reflect the processing of novel information (Goldberg & Costa, 1981), but the data could also have been skewed by a non-representative sample or experimental error. Whatever the case, more experimentation and an increase in the size of the participant pool are necessary to determine the significance and validity of the observations gleaned from this portion of the study.

The higher hemispheric CBFV means of participants exposed to the visual/implicit experimental condition in both the LMCA and RMCA indicate the comprehensiveness of the stimuli used in this condition on a neurological level. Given the fact that this condition contained both verbal and visual stimuli, it is not surprising that high activation was observed in both hemispheres via CBFV. The high averages observed in both hemispheres under the visual/implicit treatment relative to the lower averages observed under the verbal/explicit treatment confirm that the former activates a more extensive network of neural areas, which was a key component of the hypothesis that the verbal/implicit group would show a higher level of achievement on the post-assessment, which measured acquisition of the target language behaviorally. Although this hypothesis was not borne out in the main task component of this experiment, the results of the neuroimaging component suggest that if the experimental design were modified in such a way to better capture the nuances of the differences in second language acquisition caused by exposure to each of the pedagogical methods represented by the two experimental conditions of this study, participants in the visual/implicit group would display learning superior to that of the verbal/explicit group.

Multicultural component

Results obtained from interviews of American and international participants show that personal and national age of second language learning and number of languages known are two of the most fundamental differences in second language education between the countries represented by the two groups. Statistical analysis provided strong empirical support for the hypotheses that these age-related factors would show the greatest difference between the two groups interviewed; however, the results did not strongly confirm that there is a significant difference between the number of languages known by American and international participants. Despite the relatively small sample size, the large discrepancy between the responses of the members of the American and international groups in age-related aspects clearly indicates great differences in the nature of foreign language education in the United States and Spanish-speaking countries, with non-Americans tending to learn a second language at a substantially younger age than Americans.

The difference between both variables related to age of acquisition of the first second language in American and international participants is not surprising given the fact that the national age of the learning of the first second language is a generalization which is no doubt based upon the personal experience of the participants, which is more specific. The reported answer to the national age question is also likely influenced by the social circles of the participants – that is, if the participants have many friends and family members who learned their first second language at a certain age, they would be likely to report that age. Of course, it goes without saying that the members of the social circles of the participants probably learned their first second language at around the same age as the participants given the fact that most people tend to associate with people of a similar social class and educational level, so the similar

experiences of the participants' acquaintances probably confirmed the experiences of the participants, rendering them more confident in making a generalization based primarily upon personal experience. Furthermore, the sample of participants who were interviewed was fairly selective, so replication of the findings is necessary in a more randomized sample that is representative of the general population.

The descriptive data is in accordance with the research hypothesis for this segment of the study, which states that a difference should be observed between the two groups for the number of languages known. Given the difference observed between the means and standard deviations of the American and international groups for this factor, the lack of a statistically significant difference between the two groups suggests that a difference is indeed present but that more participants are necessary to broaden the gap to the point of statistical significance. Neither the group mean, which was higher for international participants, nor the breadth of the standard deviation, which was greater for international participants, were surprising as other research has shown that on average, people of other countries know more languages than Americans (Sigsbee, 2002), and it is common sense that the number of languages known by citizens of the United States is less variable than the number of languages known by the citizens of countries around the world given the comparative sample sizes and ranges of socio-economic circumstances of the two representative groups. For these reasons, it is difficult to compare samples from one country with samples from a vast group of other countries, as this study attempts to do. The results are further complicated by the fact that the sample of participants was fairly selective, and replication with a less selective, more randomized sample is necessary. At any rate, the difference observed between the number of languages known by American and international participants is worthy of consideration by the people of the United States in the sense that the

habitants of the countries represented in the sample, many of which have lower overall socio-economic standards of living than the United States, know a greater number of languages than their American counterparts.

The findings obtained from the interviews conducted in the present study confirm the observations that foreign language education specialists have made for years: that residents of the United States begin to learn second languages at a later age and know fewer languages than the citizens of many countries around the world. It is the hope of the author that the strong empirical evidence demonstrated in the multicultural component of the current study will encourage Americans to begin second language education at a younger age and to make a concerted effort to learn more languages, thus placing themselves on par with people from countries around the world and paving the way for international cooperation and mutual understanding.

Overall conclusions

This study represents a first step in understanding the effect of instruction on language acquisition, breaking the ground for future experimenters to delve headfirst into an under-explored – yet extremely important – field of research in cognitive and educational psychology and applied linguistics. It is the hope of the author that further research will be conducted on this topic using an experimental paradigm similar to that utilized in the current study in addition to the few field studies that already exist. The two conditions used in this experiment should be separated out into their respective components in a four square experimental design in order to clarify the effects on language learning caused by each factor. Additionally, longitudinal research should be conducted since working memory limitations place an upper-bound limit on one-time performance, exaggerating individual differences between participants. The

applications of experimentally-conducted teaching research to the proving ground of everyday life are all too often overlooked despite their obvious utility. It is hoped that the multicultural component of the current study will lend further insight into additional characteristics often overlooked in experimental research into the processes of second language acquisition. The results of the present project will begin to form a mosaic of the mechanisms and variables involved in the process of second language learning and serve as a starting point from which to explore the numerous applications of psycholinguistic theory.

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Appendix A
Informed consent: Main experimental task

Second language learning in an undergraduate population: Applications of psycholinguistic theory

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The purpose of this study is to determine the most effective pedagogical method to facilitate the learning of a second language in an undergraduate population. This experiment, although highly controlled, has intentionally been designed to imitate a normal classroom setting in order to ensure that the results are applicable to similar situations outside the laboratory. It is asked that only those with no prior exposure to Spanish in an academic or everyday situation participate in this experiment in order to ensure consistency of results.

In this session, you will first be asked to take a pre-test of your knowledge of the vocabulary used in the experimental task. Admission to the study will be contingent on your performance on the pre-test. If you are permitted to continue, you will then fill out a demographic form, providing general background information as well as specific information pertaining to your experience in learning foreign languages, and perform a standardized version of the Sternberg Task, which will be used to measure your working memory capacity (that is, how much you can readily remember in a short time-span). Next, you will proceed to the experimental task, in which you will be taught a lesson using a particular methodology in a foreign language (Spanish) that is completely novel to you. After the lesson, you will individually complete a worksheet for review purposes (which will NOT be evaluated) and afterwards, the experimenter will provide the correct answers to the entire experimental group. You will then be asked to fill out a post-experimental survey regarding your opinions about your performance on the experimental task. Finally, you will take an "exam" over the material covered in the lesson (which WILL be evaluated and used as a measure of performance). This session of the experimental task will last no more than two hours and you will receive two experimental credits as compensation for your

participation if you are a student in the General Psychology course. All components of this experiment will be completed by the end of the spring 2007 semester.

In this experiment, you will be identified only by a random number assigned to you by the experimenter (NOT your experimental credit ID); thus, no record will exist associating your name with this number. For this reason, it is asked that you take note of the number assigned to you in the event that you decide to exclude your results from the study. All individual results will be kept strictly confidential by the experimenter.

I, the undersigned, affirm that I have read this form in its entirety and that any questions that I have had regarding the current experiment have been answered at this time. I understand that my participation is completely voluntary and that, should I refuse to participate in this task, I am free to leave with compensation and without penalty. I am also aware that I reserve the right to decline to complete any part of the experiment and that I may leave the experiment at any point with compensation and without penalty. Thus, by signing this form, I am indicating my agreement to participate in the current experimental study, *Second language learning in an undergraduate population: Applications of psycholinguistic theory*.

_____

Print Name

_____ _____

Signature Date

Appendix B
Pre-experimental assessment
Morett/Littlefield/Noetzel, FA06-20

Preuba sobre los deportes

Instructions: Write the English equivalent of the Spanish word on the line next to each item. Please do not *guess; only write the English translation if you are confident that it is correct. It is okay if you do not know any of the answers.*

1. El baloncesto _____
2. Patinar _____
3. El equipo _____
4. La pelota _____
5. Ganar _____

Appendix C
Pre-experimental demographic survey
Morett/Littlefield/Noetzel, FA06-20

Instructions: Please answer the following questions to the best of your knowledge. If you choose not to answer or do not know the answer to an/some item(s), please indicate so by writing "Decline to answer" or "Don't know" next to the item(s). To ensure accuracy of analysis, please do not leave any questions blank.

Part A: General Background Information

1. What is your sex? Female Male

2. What is your age? _____

3. What year are you in college?

First (Freshman)	Third (Junior)	Not applicable
Second (Sophomore)	Final (Senior)	

4. What is/are your major(s) or what are you planning to major in?

5. What is/are your minor(s) or what are you planning to minor in, if anything?

6. What is your cumulative college G.P.A.?

3.5-4.0	2.5-3.0	1.5-2.0	_____ Not applicable
3.0-3.5	2.0-2.5	< 1.5	

7. What were your S.A.T. and/or A.C.T. scores?
(Please fill in both sections if you have taken both exams.)

S.A.T.		A.C.T.	
Reading	_____	English	_____
Math	_____	Math	_____
Writing	_____	Reading	_____
Total	_____	Science	_____
		Writing	_____
		Total	_____

_____ Not applicable/Don't know

Part B: Topic-Related Background Information

Please Note: For the purposes of this study, American Sign Language (ASL) is not considered a foreign language. When answering all grade-related questions, please use the Washington College grading scale, as outlined below:

A+: 97-100%	*A: 93-97%*	*A-: 90-92%*
B+: 87-89%	*B: 83-86%*	*B-: 80-82%*
C+: 77-79%	*C: 73-76%*	*C-: 70-72%*
D+: 67-69%	*D: 63-66%*	*D-: 60-62%*
F: 60% and below		

1. Please list all foreign languages that you have studied/learned, the age at which you started studying each one, the amount of years that you have studied each one, and the average grades that you generally receive(d) in classes for each one.

I.	Language	_____	Age	_____
	Years studied	_____	Grade	_____
II.	Language	_____	Age	_____
	Years studied	_____	Grade	_____
III.	Language	_____	Age	_____
	Years studied	_____	Grade	_____

_____ I've never learned a foreign language.

2. If you took the foreign language placement test when you matriculated at Washington College, please indicate the language that you were tested on and the level (class) into which you were placed (e.g. FRS 102, GRS 300+).

French _____ German _____

Level of placement _____

_____ I did not take a foreign language placement test

3. Are you studying any foreign language(s) right now? If so, please list them below with the corresponding course number (e.g. ITA 102, JPN 201) and your approximate grade in the class to date.

I.	Course number	_____	Grade	_____
II.	Course number	_____	Grade	_____

_____ I am not taking any foreign language classes right now.

4. If you took any Advanced Placement foreign language courses in high school, please list the language, your year in school when you took them (e.g. junior, senior), and the score that you received on the A.P. test.

I. Language _____ Year _____
Score _____
II. Language _____ Year _____
Score _____

_____ I never took any A.P. foreign language courses in high school.

5. If you took any honors level or accelerated foreign language classes in high school, please list them here along with your year in school when you took them.

I. Class _____ Year _____
II. Class _____ Year _____

_____ I never took any honors level or accelerated foreign language courses in high school.

6. Please rate the difficulty of learning each foreign language that you have studied and of learning foreign languages in general using the following five-point Likert scale:

1	2	3	4	5
Extremely difficult	Moderately difficult	Neutral	Moderately easy	Extremely easy

Overall rating _____

I. Language _____ Rating _____
II. Language _____ Rating _____
III. Language _____ Rating _____

_____ I've never learned a foreign language so I have no basis to judge.

7. Please rate the difficulty of the following language-related skills in English and foreign languages in general using the following five-point Likert scale:

1	2	3	4	5
Extremely difficult	Moderately difficult	Neutral	Moderately easy	Extremely easy

Native language Foreign language(s)

Reading	_____	Reading	_____
Writing	_____	Writing	_____
Speaking	_____	Speaking	_____
Listening	_____	Listening	_____

8. What is the average grade that you (have) generally receive(d) in English classes?

9. Do you consider yourself stronger at visual- or verbal-related tasks?

Visual Verbal Both/Neither

10. Please list any foreign language study abroad experiences that you have participated in to date in chronological order, specifying the country(ies) visited, language(s) spoken, and duration of visit(s). (Please Note: English-speaking programs in non-English speaking countries, such as the environmental studies trip to Ecuador or the anthropology trip to Peru, do not qualify for this question but should be recorded in the answer to the next question.)

I. Country _____ Duration _____
Language _____
II. Country _____ Duration _____
Language _____

_____ I have never participated in a foreign language study abroad program.

11. Please list any vacations that you have taken to countries where a language other than English is spoken in chronological order, specifying the country(ies) visited, language(s) spoken, and duration of visit(s).

I. Country _____ Duration _____
Language _____
II. Country _____ Duration _____
Language _____
III. Country _____ Duration _____
Language _____

_____ I have never vacationed in a country where English is not spoken.

Part C: Topic-Specific Interest Inventory

Please rate your agreement with the following statements using the five-point Likert scale outlined below:

1	*2*	*3*	*4*	*5*
Strongly disagree	*Disagree*	*Neutral*	*Agree*	*Strongly agree*

1. I enjoy watching sports and physical activities. _____
2. I enjoy participating in sports and physical activities. _____
3. I enjoy most sports and physical activities in general. _____

When you have completed the survey, please notify the experimenter that you are ready to proceed.

Appendix D
Bilingual vocabulary list

Los deportes
Sports

I. Los deportes del equipo	Team sports
1. El béisbol	Baseball
2. El vólibol	Volleyball
3. El baloncesto	Basketball
4. El fútbol	Soccer
5. El fútbol americano	Football
6. El lacrosse	Lacrosse
II. Los deportes individuales	Individual sports
1. Correr	To run
2. Caminar	To walk
3. Patinar	To skate
4. Saltar	To jump
5. Esquiar	To ski
6. La natación	Swimming
7. El ciclismo	Bicycling
8. Montar a caballo	To ride a horse
9. Bucear con oxígeno	To SCUBA dive
III. Las personas que participan en los deportes	People who participate in sports
1. El/La jugador(a)	Player
2. El equipo	Team
3. El/La entrenador(a)	Coach
4. El/La aficionado/a	Fan
5. El/La árbitro/a	Referee
IV. Los objectos que se usan para jugar los deportes	Objects used to play sports
1. La bola	Golf ball
2. El balón	Soccer ball
3. La pelota	Tennis ball
4. El bate	Baseball bat
5. El palo	Stick (for hockey, lacrosse)
6. Los zapatos	Sneakers
V. Otras palabras asociadas con los deportes	Other words associated with sports
1. El tanteo	Score (noun)
2. Ganar	To win

3. Perdir	To lose
4. El campo	Field
5. El uniforme	Uniform

Appendix E
Graphic vocabulary list

Los deportes

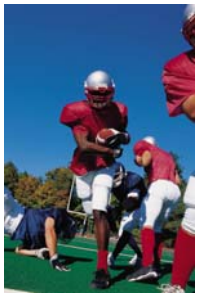
I. Los deportes del equipo


El béisbol


El vólibol


El baloncesto


El fútbol


El fútbol americano


El lacrosse

II. Los deportes individuales


Correr


Caminar


Patinar


Saltar


Esquiar


La natación


El ciclismo


Montar a caballo


Bucear con oxígeno

III. Las personas que participan en los deportes


El/La jugador(a)


El equipo


El/La entrenador(a)


El/La aficionado/a


El/La árbitro/a

IV. Los objectos que se usan para jugar los deportes


La bola


El balón


La pelota

El bate

El palo

Los zapatos

V. Otras palabras asociadas con los deportes

El tanteo

Ganar

Perdir

El campo

El uniforme

Appendix F
Bilingual lesson worksheet

Los deportes

Part I: Matching

Match the Spanish term in the left column with the corresponding English definition in the right column.

1. _____	El baloncesto	A. Score
2. _____	Caminar	B. Team
3. _____	El equipo	C. Ski
4. _____	El balón	D. Walk
5. _____	El tanteo	E. Ball
6. _____	El fútbol	F. To lose
7. _____	Esquiar	G. Soccer
8. _____	El árbitro	H. Basketball
9. _____	Perdir	I. Referee

Part II: Multiple Choice

For each Spanish term, choose the letter of the most closely related item in English to form a sentence that makes sense.

10. Se usan el palo _____.
    A. in hockey
    B. in basketball
    C. in soccer
    D. in volleyball

11. La natación _____.
    A. takes place on a field
    B. takes place in the pool
    C. takes place on the ice
    D. takes place in the air

12. _____ el fútbol.
    A. The fans cheer on
    B. The player kicks
    C. The referee penalizes
    D. The players play

13. La aficionada _____.
    A. plays the game

B. cheers on the team
C. calls the shot out of bounds
D. formulates a winning strategy

14. El campo _____.
A. is pitched at the batter
B. is worn by the players
C. is flat and grassy
D. is a team sport

15. Una persona famosa del ciclismo es _____.
A. Nancy Kerrigan
B. Jason Giambi
C. Lance Armstrong
D. The Incredible Hulk

Appendix G
Graphic lesson worksheet

Los deportes

Part I: Matching

Match the following pictures with the letter of the corresponding word in Spanish in the word bank below.


1. _____


2. _____


3. _____


4. _____

5. _____


6. _____


7. _____


8. _____


9. _____

Word Bank

A. El tanteo
B. El equipo
C. Esquiar
D. El balón
E. Perdir
F. El fútbol
G. Caminar
H. El árbitro
I. El baloncesto

Part II: “Quick draw”

Sketch a basic picture depicting the following Spanish terms in the spaces below.

10. El palo

11. La natación

12. El fútbol

13. La aficionada

14. El campo

15. El ciclismo

Appendix H
Post-experimental metacognitive survey
Morett/Littlefield/Noetzel, FA06-20

Instructions: Please answer the following questions honestly. Write the letter that corresponds with the answer with which you are most in agreement in the blank next to each question. In addition, please circle the letter that corresponds with the answer that you have chosen from the choices offered in order to minimize confusion in scoring.

1. _____ How well do you think you learned the words presented in the experimental lesson?
   A. Extremely well
   B. Fairly well
   C. So-so
   D. Not very well
   E. Hardly at all

2. _____ How many of the words would you estimate that you have learned?
   A. Almost all (24-30)
   B. Most (18-24)
   C. About half (12-18)
   D. Relatively few (6-12)
   E. Close to none (0-6)

3. _____ How would you rate the effectiveness of the teaching style used in the experimental lesson?
   A. Very effective
   B. Fairly effective
   C. So-so
   D. Not very effective
   E. Totally ineffective

4. _____ How well do you think the teaching style matched your learning style?
   A. Extremely well
   B. Fairly well
   C. So-so
   D. Not very well
   E. Hardly at all

5. _____ Please rate the level of interest that you felt during the experimental lesson.
   A. Extremely high
   B. Fairly high
   C. Neutral
   D. Fairly low
   E. Extremely low

6. _____ Please rate your enjoyment of the lesson.
    A. Extremely high
    B. Fairly high
    C. Neutral
    D. Fairly low
    E. Extremely low

Appendix I
Short-term post-experimental assessment
Morett/Littlefield/Noetzel, FA06-20

Examen sobre los deportes

Part A: Verbal Definition Matching

Match the word in Spanish on the left with the corresponding translation in English on the right. Some definitions will not be used.

1.	_____ El baloncesto	A.	To ski
2.	_____ Caminar	B.	To jump
3.	_____ La natación	C.	Bicycling
4.	_____ Patinar	D.	Lacrosse
5.	_____ Montar a un caballo	E.	Volleyball
6.	_____ Esquiar	F.	Soccer
7.	_____ Bucear con oxígeno	G.	Baseball
8.	_____ El vólibol	H.	To skate
9.	_____ Correr	I.	To walk
10.	_____ El futból	J.	Football
		K.	Basketball
		L.	To run
		M.	To ride a horse
		N.	To SCUBA dive
		O.	Swimming

Part B: Multiple Choice Bilingual Sentence Formation

For each Spanish term, choose the letter of the most closely related item in English to form a sentence that makes sense.

11. El jugador _____.
    A. judged the shot to be out of bounds.
    B. cheered from the stands.
    C. kicked the ball into the goal.
    D. called a timeout and explained a new strategy.

12. _____ el campo.
    A. The player bats
    B. The team members wear
    C. The player hits the ball with
    D. The game is played on

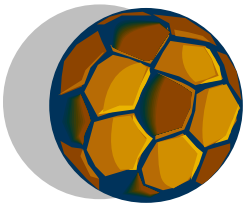
13. La entrenadora _____.
    A. formulates a winning strategy.
    B. cheers on the home team.
    C. pitches the ball at the batter.
    D. calls the player “safe.”

14. ____ gana el partido.
    A. The ball
    B. The referee
    C. The sports fan
    D. The team

15. El árbitro _____.
    A. wins the game.
    B. blocks the attempt to score a goal.
    C. calls the shot valid.
    D. cheers on the home team.

Part C: Visuo-Verbal Association Matching

Write the letter of the matching Spanish word from the word bank on the following page underneath the picture of the corresponding object. Some words will not be used.

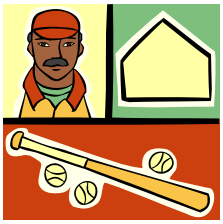


16. _____

17. _____

18. _____

19. _____



20. _____

21. _____

22. ___ 23. ___ 24. ___

Word Bank for Part C:

A. El bate
B. El uniforme
C. Los zapatos
D. La bola
E. El balón
F. El béisbol
G. Ganar
H. El palo
I. El equipo
J. Saltar
K. Las corbatas
L. Perdir

Part D: Visual Production

Draw a quick, basic sketch of the following Spanish terms in the space below.

25. La pelota 26. El palo 27. El ciclismo

28. El tanteo 29. La aficionada 30. El fútbol americano

Appendix J
Debriefing: Main task component

Second language learning in an undergraduate population: Applications of psycholinguistic theory

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The purpose of the project in which you have participated is to determine the most effective method of teaching a foreign language to novice-level undergraduate students and to shed light on the process of second language acquisition in general. During the experimental task, you were taught a mini-lesson in Spanish vocabulary using either the direct translation method or the communicative method. It is hypothesized that the communicative method will be shown by this experiment to be the more effective method in concordance with the conclusions of several other similar experiments. Prior to the experimental task, you performed the Sternberg Task, which is used primarily for the purpose of determining a possible correlation between working memory span and performance on the experimental task. It is hoped that the results of this study will be far-reaching in their implications and applications and that they will prove useful in the structuring and teaching of foreign language courses at Washington College and elsewhere in the future.

Your individual results on all components of this experimental task will be kept strictly confidential. This experiment will compose the experimenter's Senior Capstone Experience, partially fulfilling the requirements for the Bachelor of Arts degree in Experimental Psychology from Washington College. If you have any further questions, would like to exclude your results from the experiment, or are interested in the results of this study, please contact the experimenter or the faculty advisors listed above. Thank you very much for your participation in this project.

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Appendix K
Informed consent: Long-term memory recall component

Second language learning in an undergraduate population: Applications of psycholinguistic theory

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In this component of the present experiment, you have been asked to return two weeks after performing the main experimental task and take the post-experimental assessment that was originally administered to you after completing the main task a second time. The purpose of this component of the experiment is to gauge long-term memory retention of the material presented in the main experimental task. This task should take no longer than 15 minutes and you will receive one experimental credit as compensation for your participation if you are a student in the General Psychology course. You will be identified only by the random number given to you at the beginning of the main experimental task so that your results for this portion can be associated with your information from the previous session. As in the main task, your individual results for this component will remain strictly confidential and you reserve the right to withdraw at the present time or leave at any point during the task with compensation and without penalty.

I, the undersigned, affirm that I have read this form in its entirety and that any questions that I have had regarding the current experiment have been answered at this time.

_____
Print Name

_____ _____
Signature Date

Appendix L
Long-term retention post-assessment
Morett/Littlefield/Noetzel, FA06-20

Prueba sobre los deportes

Part A: Verbal Definition Matching

Match the word in Spanish on the left with the corresponding translation in English on the right. Some definitions will not be used.

1. _____ Ganar
2. _____ El balón
3. _____ El uniforme
4. _____ Saltar
5. _____ El equipo
6. _____ La bola
7. _____ El bate
8. _____ Los zapatos
9. _____ El béisbol
10. _____ La pelota

A. To run
B. Baseball bat
C. Team
D. Stick
E. Tennis ball
F. To win
G. (The) Score
H. Soccer ball
I. Referee
J. Team
K. Sneakers
L. Golf ball
M. To jump
N. Baseball (sport)
O. Uniform

Part B: Multiple Choice Bilingual Sentence Formation

For each Spanish term, choose the letter of the most closely related item in English to form a sentence that makes sense.

11. Una persona famosa del fútbol americano es _____.
    A. Jackie Robinson
    B. Lance Armstrong
    C. Mia Hamm
    D. Donovan McNabb

12. _____ el palo.
    A. The player bats
    B. The team members wear
    C. The player scores a goal using
    D. The game is played on

13. La aficionada _____.
    A. formulates a winning strategy
    B. cheers on the home team
    C. pitches the ball at the batter
    D. calls the player “safe”

14. Una persona famosa del ciclismo es _____.
    A. Jackie Robinson
    B. Lance Armstrong
    C. Mia Hamm
    D. Donovan McNabb

15. _____ el tanteo.
    A. The scorekeeper keeps track of
    B. The players play the game using
    C. The team wears
    D. The team wins

Part C: Visuo-Verbal Association Matching

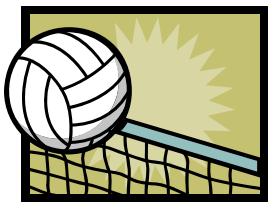
Write the letter of the matching Spanish word from the word bank on the following page underneath the picture of the corresponding object. Some words will not be used.

16. _____

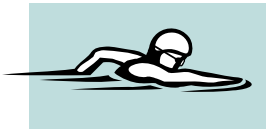
17. _____

18. _____

19. _____



20. _____



21. _____

22. _____

23. _____

24. _____

Word Bank for Part C:

A. Correr
B. Caminar
C. Saltar
D. La natación
E. El fútbol
F. El baloncesto
G. Esquiar
H. Bucear con oxígeno
I. Montar a un caballo
J. El vólibol
K. Patinar
L. Perdir

Part D: Visual Production

Draw a quick, basic sketch of the following Spanish terms in the space below.

25. Montar a un caballo

26. El árbitro

27. El jugador

28. Ganar

29. El campo

30. La entrenadora

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Appendix M
Debriefing: Long-term memory recall component

Second language learning in an undergraduate population: Applications of psycholinguistic theory

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The purpose of the project in which you have participated is to determine the most effective method of teaching a foreign language to novice-level undergraduate students and to shed light on the process of second language acquisition in general. During the experimental task in the previous session, you were taught a mini-lesson in Spanish vocabulary using either the direct translation method or the communicative method. It is hypothesized that the communicative method will be shown by this experiment to be the more effective method in concordance with the conclusions of several other similar experiments. Prior to the experimental task, you performed the Sternberg Task, which is used primarily for the purpose of determining a possible correlation between working memory span and performance on the experimental task. It is hoped that the results of this study will be far-reaching in their implications and applications and that they will prove useful in the structuring and teaching of foreign language courses at Washington College and elsewhere in the future.

During this session, your long-term recall of the material taught during the experimental task was tested using a topic-specific test similar (but not identical) to the test taken at the end of the previous session. It is hypothesized that long-term memory will be facilitated best by the communicative method, leading to higher rates of recall in participants exposed to this method.

If you have any further questions or are interested in the results of this study, please contact the experimenter or the faculty advisors listed above. This experiment will compose the experimenter's Senior Capstone Experience, partially fulfilling the requirements for the Bachelor of Arts degree in Experimental Psychology from Washington College. Thank you very much for your participation in this project.

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Appendix N
Informed consent: Neuroimaging version of main task

Second language learning in an undergraduate population: Applications of psycholinguistic theory

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The purpose of this component of the present experiment is to analyze the neurological processes involved in second language acquisition. The procedure of this component is essentially identical to that of the main experimental task with the exception that during the task, your regional cerebral blood flow (rCBF) will be measured using Transcranial Doppler (TCD) equipment. TCD is a non-invasive psychometric apparatus consisting of a "reader" approximately the size of a small appliance that will be applied to your temple using electrocondcutive gel connected to a computer that tracks and compiles signals received from the reader, showing the pattern of blood flow in the cerebral cortex. While in operation, the reader receives outgoing signals from your rCBF, transmitting them to the computer. No waves or signals are emitted from the apparatus at any point.

In this session, you will first be asked to take a pre-test of your knowledge of the vocabulary used in the experimental task. Admission to the study will be contingent on your performance on the pre-test. If you are permitted to continue, you will then fill out a demographic form, providing general background information as well as specific information pertaining to your experience in learning foreign languages, and perform a standardized version of the Sternberg Task, which will be used to measure your working memory capacity (that is, how much you can readily remember in a short time-span). Next, you will proceed to the experimental task in which you will be taught a lesson using a particular methodology in a foreign language (Spanish) that is completely novel to you. During this time, measurements of regional cerebral blood flow will periodically be taken using the TCD. After the lesson, you will complete a worksheet for review purposes (which will NOT be evaluated) and afterwards, the experimenter will provide the correct answers. You will then be asked to fill out a post-experimental survey regarding your opinions about your performance on the experimental task. Finally, you will take an "exam"

over the material covered in the lesson (which WILL be evaluated and used as a measure of performance). This session of the experimental task should last no more than two hours and you will receive two experimental credits as compensation for your participation if you are a student in the General Psychology course. All components of this experiment will be completed by the end of the spring 2007 semester.

In this experiment, you will be identified only by a random number assigned to you by the experimenter (NOT your experimental credit ID); thus, no record will exist associating your name with this number. For this reason, it is asked that you take note of the number assigned to you in the event that you decide to exclude your results from the study. All individual results will be kept strictly confidential by the experimenter.

I, the undersigned, affirm that I have read this form in its entirety and that any questions that I have had regarding the current experiment have been answered at this time. I understand that my participation is completely voluntary and that, should I refuse to participate in this task, I am free to leave with compensation and without penalty. I am also aware that I reserve the right to decline to complete any part of the experiment and that I may leave the experiment at any point with compensation and without penalty. Thus, by signing this form, I am indicating my agreement to participate in the neuroimaging component of the current experimental study, *Second language learning in an undergraduate population: Applications of psycholinguistic theory*.

_____

Print Name

_____ _____

Signature Date

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Appendix O
Debriefing: Neuroimaging version of main task

Second language learning in an undergraduate population: Applications of psycholinguistic theory

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The purpose of the project in which you have participated is to determine the most effective method of teaching a foreign language to novice-level undergraduate students and to shed light on the process of second language acquisition in general. During the experimental task, you were taught a mini-lesson in Spanish vocabulary using either the direct translation method or the communicative method. It is hypothesized that the communicative method will be shown by this experiment to be the more effective method in concordance with the conclusions of several other similar experiments. Simultaneously with the experimental task, you underwent one or more scans using the Transcranial Doppler (TCD) apparatus to measure regional cerebral blood flow (rCBF) and gauge which areas of the brain are actively involved in second language acquisition. It is hypothesized that the occipital visual cortex will be active in the communicative condition only whereas Wernicke's Area and the pre-frontal lobe will be active in both conditions. It is hoped that the results of this study will be far-reaching in their implications and applications and that they will prove useful in the structuring and teaching of foreign language courses at Washington College and elsewhere in the future.

If you have any further questions or are interested in the results of this study, please contact the experimenter or the faculty advisor listed above. This experiment will compose the experimenter's Senior Capstone Experience, partially fulfilling the requirements for the Bachelor of Arts degree in Experimental Psychology from Washington College. Thank you very much for your participation in this project.

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Appendix P
Informed consent: Multicultural component

Second language learning in an undergraduate population: Applications of psycholinguistic theory

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The purpose of this component of the current study is to analyze cultural differences between American and international students that may influence the processes of second language acquisition and learning. You have been selected to participate in this study due to your background as an international student or an American student majoring in a foreign language. After you have signed this form, you will be interviewed about your personal experience in learning foreign languages and the way that foreign languages are taught in your country. Your responses will be recorded on audiotape for transcription, translation, and synthesis at a later date. The interview will last no more than 30 minutes and the entire study will be realized in less than a semester's time. Your individual responses will be kept in confidence by the experimenter in the case that you indicate that you do not wish that they be made public. In the documentation and discussion of results, a pseudonym will be used in place of your name to ensure maximum confidentiality and anonymity.

By signing this form, I am indicating my consent to allow the experimenter to interview me about my experience of learning (a) foreign language(s) and I am affirming that any questions that I have regarding the content or structure of the interview have been answered at this time. I understand that I have the right to withdraw at the present time and that I may decline to answer any question(s) or stop the interview at any time without penalty. I am aware that my responses will be recorded on audiotape and later transcribed for use in the experimenter's senior thesis project; thus, I grant the experimenter permission to quote and/or paraphrase any statement(s) that I make in this interview.

Print name

Signature

Date

Appendix Q
Interview questions

1. When did you begin to learn your second language? How many years old were you?
2. What methods were used to teach you your second language?
3. When did you travel to a country where your second language is spoken for the first time if you have done so?
4. How do you learn foreign languages best?
5. How many languages do you know overall?
6. In your native country, at what age is the second language generally first taught?
7. (For teaching assistants and tutors) What are the most effective methods of teaching your students foreign languages?

Appendix R
Debriefing: Multicultural component

Second language learning in an undergraduate population: Applications of psycholinguistic theory

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The purpose of the project in which you have participated is to determine if there are profound differences between the way that second languages are taught in the United States and other countries, specifically Spanish-speaking countries. It is hypothesized that major differences lie in the age at which second languages are taught, the method by which they are taught in academic settings, and the exposure of second language students to countries in which the target language is spoken. It is thought that these differences may arise from the underlying internalized domestic perception that is characteristic of the citizens of the United States as compared to the global perspective that is characteristic of many other countries.

Your taped responses to the interview questions will be transcribed, analyzed for content, and compared to the responses of international Spanish-speaking students as well as American students who are majoring in Hispanic language and culture. All responses will be compiled into a report highlighting the similarities and differences in the field of second-language teaching and learning that will become a component of the experimenter's Senior Capstone Experience for the Bachelor of Arts degree in Hispanic Studies from Washington College.

Your individual responses to all questions will be kept strictly confidential. If you have any further questions, would like to exclude your responses from the project, or are interested in the outcome of this study, please contact the experimenter or the faculty advisors listed above. Thank you very much for your participation in this project.