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Abstract

In bilinguals, both languages are always active and competition for retrieval is greater than it is in monolinguals. Though bilinguals have control over their use of language and rarely make mistakes in choosing which language to speak in, competition remains. Language production is a challenging process in and of itself but even more so for bilinguals. A notable difference between monolingual and bilingual speech production is that bilingual speech requires that the speaker choose the language they wish to speak in before articulation. Thus, increased competition is hypothesized to differentially affect the selection process for bilinguals. The current study investigated word production in Chinese-English bilinguals and English monolingual speakers using a simple picture naming task in which pictures were presented in list contexts that were either semantically blocked by category (i.e., all animals or vegetables) or mixed randomly. All participants named the pictures in English. For the monolinguals, this was their first language (L1) but for the Chinese-English bilinguals, this was their second language (L2). Previous studies have shown that picture naming in the context of the semantically blocked categories produces longer naming latencies than picture naming in the context of mixed semantic categories. The hypothesis is that semantically blocked lists increase the presence of competition among the words that are possible picture names. Replicating previous findings, the experiment found that pictures of objects were slower to be named in same-category blocks than in mixed-category contexts. However, the results also revealed larger effects of semantic blocking for the bilinguals in L2 than for the monolinguals in L1. Taken together, the results support the hypothesis that lexical retrieval is a competitive process and that competition is greater for bilinguals than for monolinguals because bilinguals are required to juggle the competition across both of their languages even when speaking one language alone.

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Chapter 1

Introduction

In today's world knowing more than one language is becoming more and more important; technological advancements and innovations are making communication with other countries important and many people grow up learning two languages simultaneously in bilingual homes. Cognitive research on bilingualism has shown that there are many benefits to knowing more than one language (e.g., Caramazza, 1997). Bilinguals appear to be advantaged relative to monolinguals on tasks that require attentional control, particularly when irrelevant information must be ignored or conflict must be resolved (e.g., Bialystok, Craik, Klein, &Viswanathan, 2005).

One hypothesis about the source of bilingual advantages in cognition comes from research that shows that bilinguals are able to control the language they intend to use although both languages are always active (e.g., Kroll, Sumutka, & Schwartz, 2005). A major focus of research on bilingual production concerns the way in which the competition across alternatives in each of the bilingual's two languages is negotiated (e.g., Belke, Meyer, & Damian, 2005; Damian, Vigliocco, & Levelt, 2001; Kroll & Stewart, 1994; Maess, Friederici, Damian, Meyer, & Levelt, 2002). If bilinguals are continually resolving cross-language competition when they are required to speak in one language alone, they may eventually acquire more general expertise in the resolution of competition and conflict (Bialystok, 2005).

Speech production itself is complex for monolinguals but for bilinguals, the requirement to choose a single word in one language alone, places another set of demands on planning

spoken utterances. Lexical selection involves several stages before an intention is translated into the sounds to be spoken (see Figure 1). The planning of speech begins with recognition (Maess et al., 2002). Then the speaker enters the conceptual stage where depending on the situation and context it must be decided what concept the speaker wishes to convey (Levelt, Roelofs, & Meyer, 1999). Once the speaker decides how to refer to the object they then must retrieve a lemma corresponding to the concept. A lemma represents a word's abstract lexical information and syntax (e.g., gender in languages that represent grammatical gender) and how the word can be used, but has no information regarding about the word form or phonology. This occurs in between the semantic level where meaning is applied to words and the phonological level where sounds of a word are produced. This is the stage of speech production that is hypothesized to generate competition; the co-activated lemmas now compete in order to be retrieved. The speaker must choose a word from their mental lexicon that best corresponds to what it is that they wish to convey. The retrieval for that word is in competition with semantically related items and concepts for they too become activated; this stage is known as lexical selection (Levelt et al., 1999). Another concept might become directly activated based on what was seen and in turn other related concepts also become activated; this then, increases the choices the speaker has to choose from within their mental lexicon and thus becomes more prone to errors and delay (Rahman & Melinger, 2009). This again causes competition. Once the lemma of choice has been selected it is phonologically encoded, and the word is composed through its string of segments (Levelt et al., 1999). Spoken word is then produced through articulation of these gestures (Levelt et al., 1999).

This same effect is magnified in a bilingual when they need to choose a single word from two languages. First they must understand what the object to be named is and then choose the

language to name it in. Bilinguals will always have two names to choose from for one single object, the name in one language and its equivalent in the other language. Within bilinguals, the second and usually less dominant language, often presents more difficulty when it comes to activation. The L1 is normally more active and more difficult to suppress than the L2 (Hoshino, 2006). But it is more difficult to switch back to an L1 when the L2 has been active for a long period of time, than it would be to switch from L1 to L2 (Hoshino, 2006).

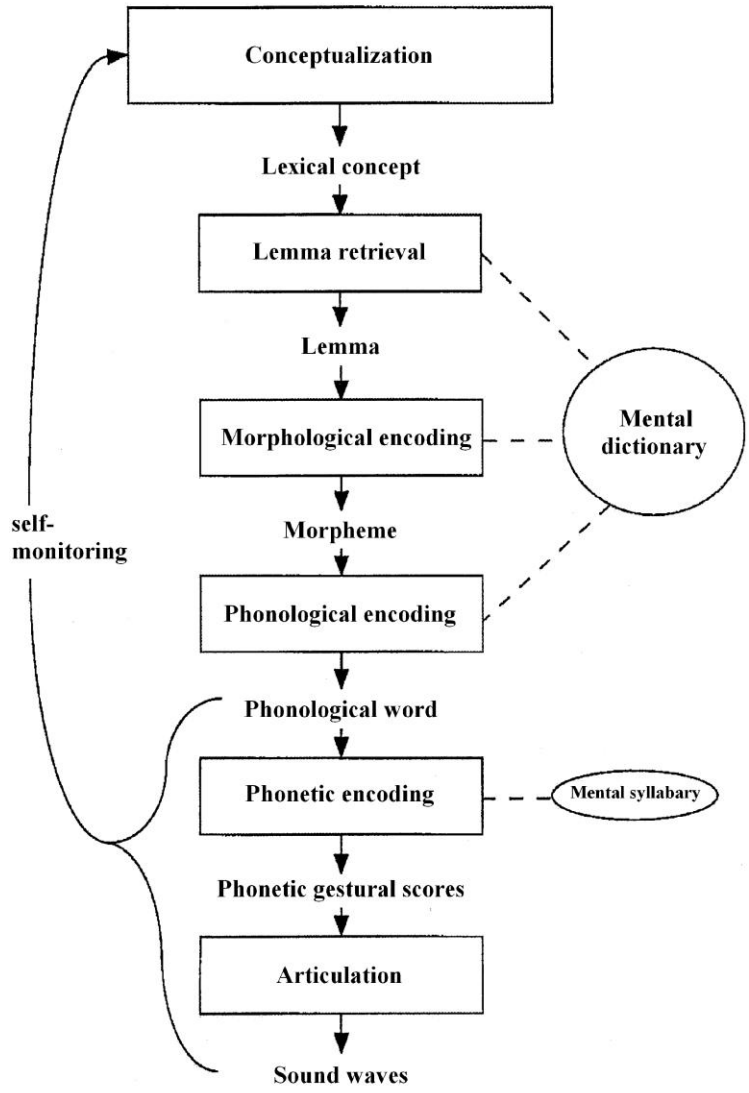

Figure 1. Stages of lexical access (adapted from Levelt et al., 1999)

A semantic blocking paradigm has been commonly used to examine the lexical selection process; it is an interference effect that is repeatedly observed in behavioral studies (Maess et al., 2002). In the blocking paradigm, participants repeatedly name sets of objects from blocked or from mixed semantic categories and their naming latencies are then recorded (Belke, Brysbaert, Meyer, & Ghyselinck, 2005). Picture naming is slower in the context of semantically blocked lists than in semantically mixed contexts (e.g., Damian et al., 2001; Kroll & Stewart, 1994). In addition to semantic blocking, there have also been a number of different experimental paradigms, such as naming pictures in the presence of a word distractor, generating words in response to a definition, and translating words from one language to another, that have been used to examine lexical production and the potential competition among lexical candidates in choosing a single word out of one's mental lexicon to speak (e.g., Costa, Miozzo, & Caramazza, 1999; Hermans, Bongaerts, De Bot, & Schreuder, 1998; Meuter & Allport, 1999; Miller,2001).

Previous studies have focused on spoken production in monolinguals and the semantic context effect in order to gain a better understanding for language production by using both picture-naming tasks and picture-word naming tasks. Both are used to examine the competition that occurs at the lexical selection stage of speech production. Again participants are shown either pictures of objects or words of objects that are grouped into blocked semantic categories or mixed semantic categories and then asked to name them aloud. However, some studies have reported that instead of observing a semantic interference effect, they have found an effect of facilitation. If this is in fact true, then it can be said that lexical selection is not a matter of competition. According to Mahon, Costa, Peterson, Vargas, and Caramazza (2007) semantic

facilitation would then be an indicator for lexical priming and interference effects would be said to occur post-lexically.

In reviewing the evidence for the semantic blocking effect, there has been an even stronger focus in literature on the interference effect which indicates that there is co-activation that occurs during the lexical selection. Studies focusing on this effect have found that categorically blocked words tend to be named slower than categorically mixed words (e.g., Damian et al., 2001; Kroll & Stewart, 1994). These studies have examined the naming of pictures grouped into blocks of semantically categorized and non-categorized objects. Results have shown that participants named objects in same category blocks at much slower rates than with non-categorized blocks. These same findings were found to be true with studies of picture-word naming tasks (e.g., Belke et al., 2005; Damian et al., 2001). These results indicate that there is in fact competition that occurs at the lexical selection stage of language production. Maess et al. (2002) found that fifteen out of twenty participants produced longer response times when naming pictures of objects in same-category (blocked) vs. mixed-category conditions. Kroll and Stewart (1994) found a similar interference effect when they observed English speakers do the same. They too found that these speakers were slower at naming pictures of objects within same-category blocks of items that were semantically related, compared to those from different-category block, not semantically related to one another. Kroll and Stewart (1994) also found the effect to be similar for English-Dutch bilinguals in a single-word translation task. Damian et al. (2001) too found similar results in a picture-naming task using ten native German speakers and twenty-five white line drawings on black backgrounds. This semantic blocking effect has been interpreted to reflect competition for retrieval that occurs during lexical selection. The semantic relatedness across items is thought to increase competition and the rate which words can be

retrieved. Co-activated lemmas and co-activated lexical concepts, semantically related words, compete amongst one another in the same-category blocked conditions for retrieval. This is not the case when it comes to mixed-category conditions. Belke et al. (2005) set out to test whether the semantic context effect would be greater for same-category blocked sets of late-acquired words or for same-category blocked sets of early-acquired words using both picture naming and word reading with the help of thirty-six undergraduate students. They found that the context effect was greater for late-acquired picture names than for early-acquired picture names. Pictures were more difficult to name than were words within semantically related block than in mixed blocks; they also found picture naming to result in a larger age of acquisition effect than did word naming. They found that as they had thought, the context effect was stronger for late-acquired object names. This demonstrates that the semantic naming context that arises at the lemma level also interacts with the age of acquisition effects (Belke et al, 2005).

Rahman and Melinger (2009) propose a swinging lexical network in which both a facilitative and inhibitory effect occur in process of speech production. They argue that there is both a conceptual facilitation effect and one of lexical competition. They note that lexical entries are selected from among competitors and concepts simply receive more or less activation. Still the increase in co-activated concepts produces a stronger effect on lexical interference than on conceptual facilitation (Rahman & Melinger, 2009). Rahman and Melinger (2009) hypothesize that facilitation is induced by semantically related distracter words, not part of the target's semantic category, rather than interference. The whole semantic category becomes more active and results in this blocking effect. They propose that interference occurs when a cohort of lexical candidates is active and/or when conceptual facilitation is absent or greatly reduced. Facilitation then occurs when neither is satisfied.

The present study aims to investigate word production in Chinese-English bilinguals and English monolingual speakers using a simple picture naming task. We ask whether bilinguals speaking in their second language (L2) would suffer more interference than monolinguals speaking in their first language (L1). To examine this issue we compared semantically blocked and mixed picture naming for the Chinese-English bilinguals and native English speaking monolinguals all naming the pictures in English. If non-native English speakers are more sensitive to competition in their L2 than the native English speakers are in their L1, then we would expect to see a larger blocking effect. We expect that picture naming in L2 will be longer than picture naming in L1. We hypothesize that same semantically blocked categories produce longer naming latencies and are slower to be named than picture naming in the context of mixed semantic categories due to the interference thought to arise from increased competition among semantically related alternatives; thus, making it harder to choose one correct name. The magnitude of the blocking effect should also be larger if L2 is more vulnerable to competition. Lexical retrieval is a competitive process and even more so for bilinguals.

Chapter 2

Method

Participants

Twenty-two English monolingual and ten Chinese-English bilingual students from The Pennsylvania State University participated in the experiment in exchange for course credits or payment. The average age of the English monolingual participants was 20.3 yrs. and the average age for the Chinese-English bilingual participants was 21.0 yrs.

Materials

Twenty-five black and white line drawings of common objects were selected from five semantic categories (animals, clothing, furnishing, kitchen items, and vehicles- see Appendix A) for the picture naming task. These drawings were arranged in a 5x5 matrix, forming blocked (homogeneous) and mixed (heterogeneous) sets of five items (see Figure 2). Each homogeneous set contained five items from the same category (e.g, dolphin, bear, horse, dog, monkey) whereas each heterogeneous set included one item from each of the five semantic categories (e.g. dolphin, bike, dress, vase, spoon). The pictures, 300 x 300 pixels, were presented at the center of the screen on a white background.

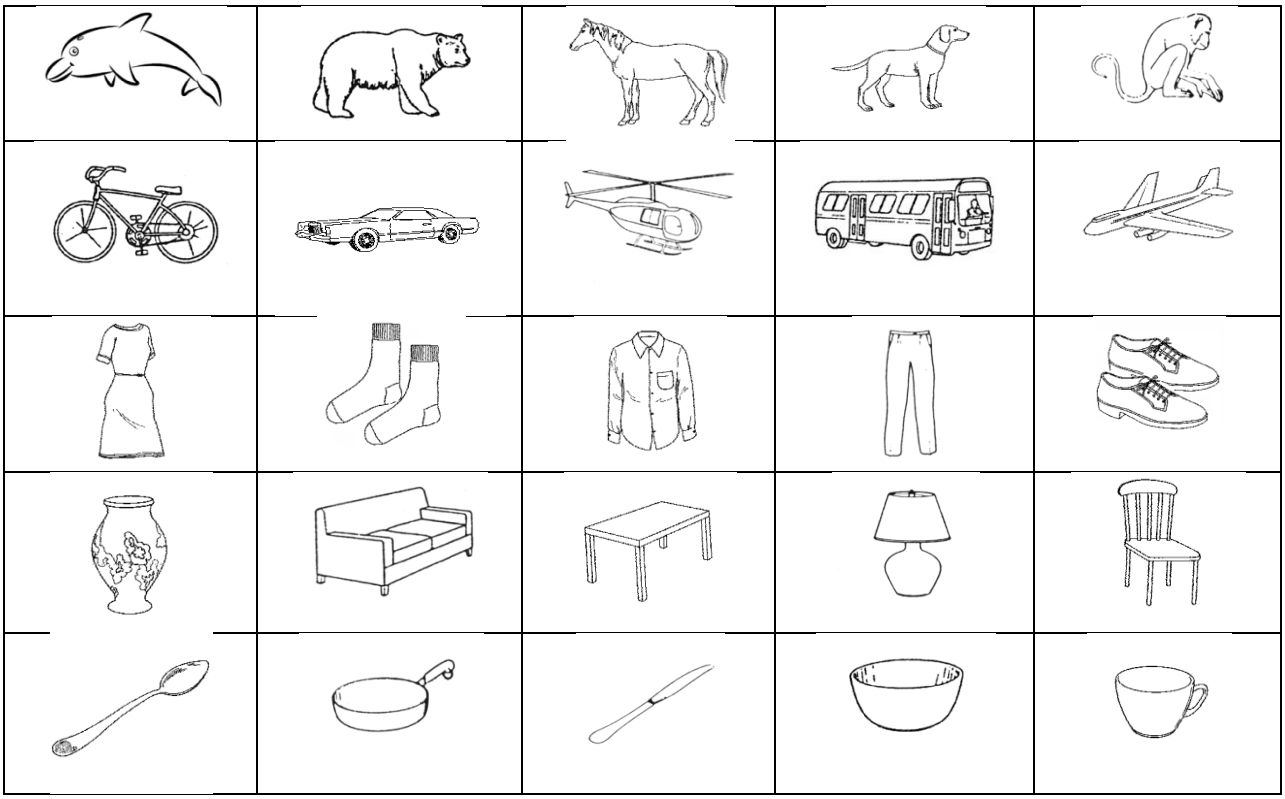

Figure 2. The picture stimuli used in the experiment, consisting of five semantic categories with five exemplars each. Stimuli were repeatedly presented in small sets corresponding either to rows (blocked category/ semantically homogeneous) or to the columns (mixed category/ semantically heterogeneous) of the matrix.

In addition, both English-monolingual and Chinese-English bilingual participants were asked to complete a Simon task (Simon & Rudell, 1967) and an Operation Span task (Turner & Engle, 1989). The Simon task was used to assess the ability to suppress irrelevant information. Blue and red squares were presented at three different locations during the task. Participants were asked to attend to the color of the square and ignore its location. Performance on the Simon task appears to be sensitive to the consequences of bilingualism (e.g., Bialystok et al., 2004). The Operation Span task (OSpan) task was used to measure individual differences in cognitive resources. Performance on the OSpan task is hypothesized to measure working memory. It

appears to predict the efficiency of language processing as well as reading and speaking span measures but again minimizing the contribution of language-specific processing. Participants were asked to solve simple arithmetic equations and decide whether the presented equation was correct or incorrect while memorizing a series of presented words. The words were presented in the native language of the participants, so in English for the English monolinguals and in Chinese for the Chinese-English bilinguals.

Chinese-English participants were also given a lexical decision task, used as an additional proficiency measure, in which they were instructed to decide if the given string of letters was a real word or non real word in English. Non-words were pseudo-homophones, non-words that sound like real words. This task has been used in previous studies as a measure of L2 lexical proficiency and has been shown to be a valid test in measuring the size of vocabulary in L2 (Huibregtse, Admiraal, & Meara, 2002).

Apparatus

The pictures were presented on a computer screen, using the E-Prime program to time the presentation of the stimuli. Reaction time to the onset of articulation was measured to the nearest millisecond. Responses were also recorded using a microphone and a MiniDisc recorder to enable a later check for the accuracy of spoken names.

Design

The experimental blocks were presented in a sequence of ABBA or BAAB, having the blocked or mixed list appear first. The order was counterbalanced across participants. Each of the

five target pictures was presented five times in a pseudorandom order such that the same picture never appeared on consecutive trials. Each testing session lasted about 50 minutes.

Procedure

Before beginning the experimental blocks, participants were given practice to complete. The pictures presented in the practice block were different from the pictures in the experimental session. The pictures were always to be named in English, even for the Chinese-English participants.

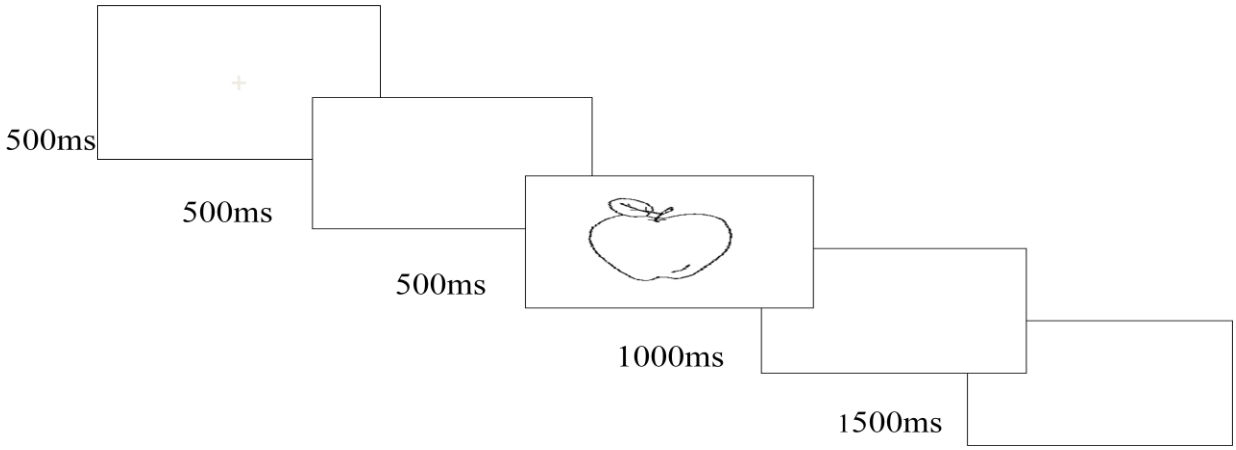

Figure 3. Picture naming task used in experiment

On each trial, participants were first presented with a fixation point for 500 ms (see Figure 3). It was then followed by a blank slide for 500 ms. The image itself was then presented for 500ms. Participants named the object here, or more often during the next blank slide that appeared on the screen for 1000 ms. Latencies were measured from the onset of the target picture. An inter-trial interval of 1500 ms followed and concluded each trial. Another fixation

point began the next trial. Participants were instructed to name the objects as quick and as accurately as possible. Three optional breaks were available for participants during the study if they wished to utilize it. The Simon task, Operation Span task, lexical decision task, and the language history questionnaire followed the picture naming task.

Chapter 3

Results

Data analyses were first performed on the lexical decision task. Reaction times (RTs) for correct responses less than 300 ms or greater than 3000 ms and RTs that were 2.5 standard deviations above or below the mean were identified as outliers separately for words and non-words; these were then excluded from the analyses. The final mean accuracy and RTs for correct responses were then calculated for each condition. For non-words response times were longer, but the participants were just as accurate as with real words. Three Chinese-English bilingual participants were excluded from the subsequent analyses. These three participants scored below a 70% criterion on the lexical decision task and as a result are believed to have been guessing and not sufficiently proficient in English. The language profile for the included Chinese-English bilinguals is shown in Table 1.

Participants were given a comprehensive language history questionnaire to complete in order to assess proficiency in their native language and to obtain information regarding their second language learning experiences (see Table 1). Chinese-English bilinguals reported themselves to be Chinese-dominant but very proficient in English; having approximately equal proficiency in Chinese and English. Chinese-English bilingual participants reported themselves to be just as proficient in English as were the native monolingual English speakers. Monolingual speakers of English reported to have had no or limited proficiency in other languages, but were very proficient in English. Self rating of their proficiency was based on the four language skills of reading, spelling, writing, speaking, and speech comprehension. The self-rated proficiency measure was on a 10-point scale with 1 being not proficient and 10 being very proficient.

The Simon effect was calculated by subtracting the mean reaction time for the congruent trials from the mean reaction time for the incongruent trial (see Table 1). Trials whose responses were incorrect or whose responses were correct but reaction times were over 1500 ms were considered as errors and excluded from both reaction time and accuracy analyses. The mean reaction time and accuracy was calculated for three conditions- where the color and location were the same (congruent), where the color and its location were different (incongruent), and when the box appeared at the center of the screen (neutral). Chinese-English bilinguals had a greater Simon difference score than the English monolinguals; however, the analysis of variance (ANOVA) did not find this to be significant. Both Chinese-English bilinguals and English monolinguals were equally good at suppressing irrelevant information, the Simon task did not show to be sensitive to the consequences of bilingualism.

In the Operation Span task the mean reaction times for correct decisions were calculated separately for "yes" and "no" answers. Reaction times that were 2.5 standard deviations above or below the mean were identified as outliers and excluded from the analysis. The number of words that were recalled correctly among correct responses to the equations was then counted. This number was then used as an index of the participant's operation span (see Table 1). Chinese-English bilinguals averaged a greater score on the OSpan task than did English monolinguals recalling more words, being quicker and making fewer errors; an analysis of variance (ANOVA) showed these results to be significant. This shows that bilinguals have a greater working memory than monolinguals and appear to have greater processing resources than monolinguals.

	#	Age (yrs)	Mean L1 Rating	Mean L2 Rating	Simon Difference Score	O-Span (out of 60)
English monolinguals	22	20.3	9.0	3.2	41 ms	45.2
Non-native English Speakers (L1 = Chinese)	7	21.0	8.8	8.0	52 ms	50.9

Table 1. Profile of monolingual and bilingual participants.

In the picture naming task, recorded picture naming responses were transcribed and coded for accuracy. A liberal criterion was used for measuring accuracy such that synonyms of the expected name of a given picture (e.g., bike for bicycle) were considered correct responses. Responses that deviated from the expected picture name and synonyms, responses that started with hesitation, and "don't know" responses were scored as incorrect. Responses that the microphone did not pick up were eliminated as technical errors. RTs for correct responses that were less than 300 ms or greater than 3000 ms and reaction times that were 2.5 standard deviations above or below the mean were identified as outliers and excluded from the analyses. Reaction times and accuracy were then again calculated for only correct responses (see Figures 4 and 5).

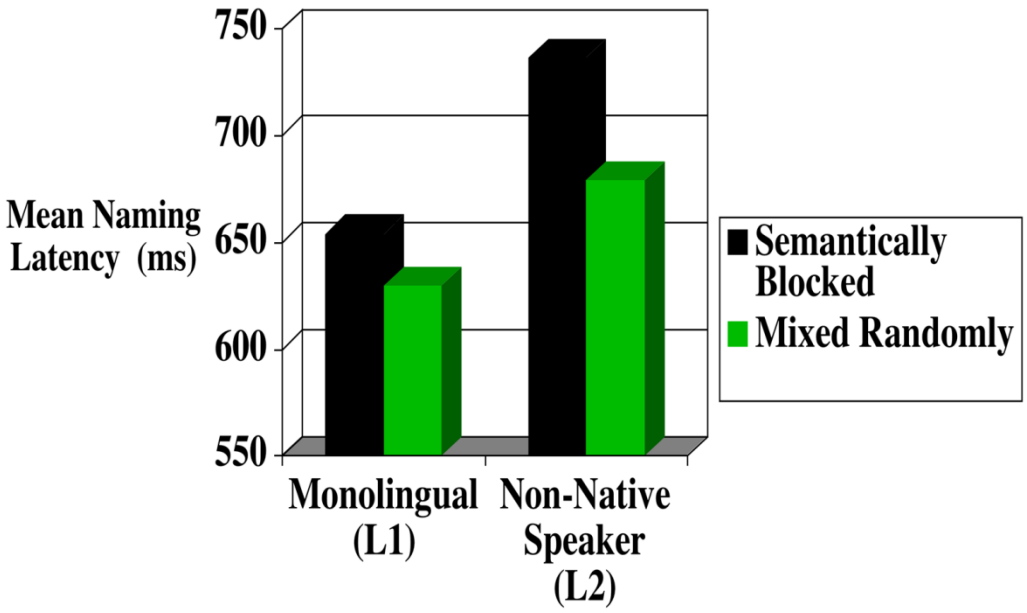

Figure 4. Mean response time to name pictures (in milliseconds).

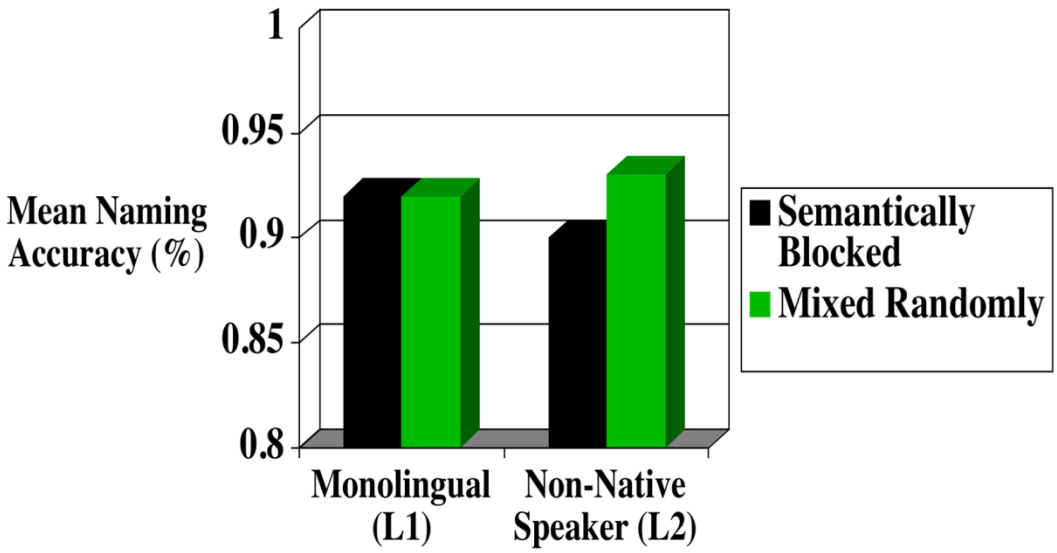

Figure 5. Accuracy of picture naming.

Analyses of variance (ANOVAs) were conducted on both accuracy and RT data with subjects as a random factor. The RT ANOVA revealed a significant main effect of list type, i.e., whether naming occurred in a blocked vs. mixed context [$F(1, 27) = 44.20$, $p < .001$]. Participants were slower to name the objects in the blocked context than in the mixed context. Picture naming latencies were longer in blocked than mixed lists for both groups but the effect was significantly larger for the bilingual Chinese-English speakers in L2 (see Figure 4). Relatively proficient L2 speakers were more sensitive and vulnerable to the blocked competition in their L2 than native speakers in their L1.

Although both groups were relatively accurate to name pictures, there was a significant interaction between group and list with only the Chinese-English bilingual speakers showing a blocking effect in accuracy as well as in response time (see Figure 5). The accuracy ANOVA also revealed a significant main effect of list type [$F(1, 27) = 6.27$, $p < .02$]. Chinese-English participants were less accurate at naming objects in a blocked context than in a mixed context. L2 speakers produced more errors under the blocked conditions; the Chinese-English bilingual speakers were more likely to make an error in the blocked context. Monolinguals showed to be just as accurate at picture naming in a blocked context as they were in a mixed context. The results suggest that spoken production in the second language is more vulnerable to competition, presumably because alternative candidates in both languages compete for selection. Results indicate that bilinguals speaking in their L2 suffer more interference than monolinguals speaking in their L1.

A significant, unexpected interaction was also found within group effects of order and will have to be examined in future research. An analyses of variance (ANOVA) revealed an effect of order of the list in the reaction time analyses [$F(1, 27) = 5.10$, $p < .03$] and accuracy [$F(1, 27) = 5.13$, $p < .03$].

Discussion

The primary goal of the present study was to investigate word production and determine whether bilinguals speaking in their L2 suffer more interference than monolinguals speaking in their L1. Previous studies have shown bilinguals to have better inhibitory control and more cognitive resources than monolinguals controls (e.g., Bialystok, 2001; Bialystok et al., 2004; Kroll, Michael, Tokowicz, & Dufour, 2002). To address this question we compared semantically

blocked and mixed picture naming in Chinese-English bilinguals and native English monolingual speakers. Using a semantic blocking paradigm, the results replicated previous findings showing that speakers were slower to produce single word names in semantically blocked conditions compared to mixed conditions. This indicates that the interference thought to arise because the blocked context increases competition among semantically related alternatives makes it more difficult to select a single correct name for the object. Though semantically blocked lists produced interference in picture naming for both monolinguals and bilinguals, the effect was also significantly larger for the bilinguals. Thus, results of the simple picture naming task suggest that both languages are always active and compete for selection within a bilingual. More words are activated and the consequence appears to be to increase the choices the bilingual speaker has to choose from for selection and production of spoken word.

Bilinguals are relatively advantaged compared to monolinguals; they have a greater ability to suppress irrelevant information when attentional control is required due to their ability to control the language that they tend to use. Because bilinguals are continually resolving the cross-language competition, they acquire expertise in resolution of competition and conflict. It is difficult for bilinguals to suppress their L1 completely when speaking in their L2 instead, co-activation occurs and the L1 remains active. Hence, lexical selection is a matter of competition.

Future Direction

In future research we will investigate the time course of these differences for first and second language speakers and their neural basis using even related potentials.

Appendix A

Picture Stimuli Used In Experiment

Practice CMMC	**Practice MCCM**	**Animals**	**Clothing**	**Furnishing**	**Kitchen Items**	**Vehicles**
Apple	Key	Bear	Dress	Chair	Bowl	Bicycle
Banana	Leaf	Dog	Pants	Lamp	Cup	Bus
Lemon	Pencil	Dolphin	Shirt	Sofa	Knife	Car
Pineapple	Star	Horse	Shoes	Table	Pan	Helicopter
Strawberry	Umbrella	Monkey	Socks	Vase	Spoon	Plane

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-Trained for 180 hours as a short term crisis counselor in emotional support, crisis intervention, alcohol, tobacco, other drugs, and basic needs.
-Volunteered on the hotline for over 200 hours
-Deal with situations relating to crisis intervention, short term counseling, information and referrals, emergency food, temporary emergency shelter placement, and drug and alcohol intervention and information
-Answer phones for the Gay Lesbian hotline, Women's Resource Center, Aids Project, Senior Resource Center, Alcoholics Anonymous, and Counseling Alternatives
-Train new volunteers

Research Experience (Fall 2008-Spring 2010) with Judith F. Kroll (Purple Lab)

Awards:

Dean's List
Thompson Award
The Community Foundation:
Walter and Adi Blum Scholarship
The David Yanis Scholarship

Presentations/ Activities:

Summer 2008, CIEE: Study abroad in St. Petersburg, Russia
Spring 2009, Mortar Board Senior Honors Society Member and Alumni Chair
April 2010, Presented thesis findings at the Undergraduate Research Exhibition