EFFECTS OF LANGUAGE DEVELOPMENT ON BILINGUALS' CONCEPT SELECTIONS: A CASE STUDY OF LANGUAGE SPEECH PRODUCTION TASK IN THE KHMER-ENGLISH BILINGUAL CONTEXT

SOKSAN DAM

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE MASTER DEGREE OF MEASUREMENT AND TECHNOLOGY IN COGNITIVE SCIENCE

COLLEGE OF RESEARCH METHODOLOGY AND COGNITIVE SCIENCE
BURAPHA UNIVERSITY, THAILAND

AUGUST 2015

The thesis of Soksan Dam has been approved by the examining committee to be partial fulfillment of the requirements for the Master Degree of Measurement and Technology in Cognitive Science of Burapha University.

Advisory Committee

..... Advisor
(Assistant Professor Dr. Suchada Kornpetpanee)

Examining Committee

..... Chairperson
(Assistant Professor Dr. Malee Nitsaisook)

..... Member
(Assistant Professor Dr. Suchada Kornpetpanee)

..... Member
(Assistant Professor Dr. Arnon Chaisuriya)

..... Member
(Dr. Pratchaya Kaewkaen)

This thesis has been approved by the College of Research Methodology and Cognitive Science to be partial fulfillment of the requirements for the Master Degree of Measurement and Technology in Cognitive Science of Burapha University.

..... Dean of College of Research Methodology and Cognitive Science
(Assistant Professor Dr. Suchada Kornpetpanee)

....., 2015

ACKNOLEDGEMENTS

I would like to firstly express my deepest and whole-hearted gratitude to Her Royal Highness Princess Mahachakri Sirindhorn who provided me full supports for my study, accommodation and etc. during my academic life in Thailand.

Secondly, I would like to show my sincere thanks to Asst. Prof. Dr. Suchada Kornpetpanee, the Dean of the College of Research Methodology and Cognitive Science, Burapha University for her advices, constructive feedbacks, and supports on my study and thesis. Without her orientations, I would not be able to punctually complete my thesis and my study. Meanwhile, I would like to appreciably thank Prof. Remo Job, the chair and dean of the Department of Psychology and Cognitive Science, University of Trento for his warm welcome, guidance, advices, and feedbacks on my research proposal during my academic mobility in Italy.

Thirdly, I am extremely grateful to Dr. Pratchaya Kaewkaen, Asst. Prof. Dr. Arnon Chaisuriya, Asst. Prof. Laphatrada O'Donnell and Dr. Suchada Sakolkijrungroj for being the experts to evaluate my research instruments. I really appreciate their constructive feedbacks.

Fourthly, I would like to sincerely thank to BELTEI International University rector, lecturers, students and staff who actively involved in my experiment and gave assistances to my data collections. Without their presence, my experiment would not be succeeded.

Finally, I would like to faithfully thank people who have offered their help especially RMCS lecturers, staff, friends, and classmates. Most importantly, I would like to specially and gratefully thank my parents who always give me all sorts of supports which words could not describe. Their unconditional love is priceless for me.

Soksan Dam

56910039: MAJOR: MEASUREMENT AND TECHNOLOGY IN COGNITIVE SCIENCE
M. Sc. (MEASUREMENT AND TECHNOLOGY IN COGNITIVE SCIENCE
KEYWORDS: CONCEPT SELECTION/ SEMANTICALLY RELATED & UNRELATED CONTEXT DISTRACTERS/ BILINGUALS

SOKSAN DAM: EFFECTS OF LANGUAGE DEVELOPMENT ON BILINGUALS' CONCEPT SELECTIONS: A CASE STUDY OF LANGUAGE SPEECH PRODUCTION TASK IN THE KHMER-ENGLISH BILINGUAL CONTEXT. ADVISORY COMMITTEE: SUCHADA KORNPETPANEE, Ph.D. 172 P. 2015.

การวิจัยนี้มีวัตถุประสงค์เพื่อ 1) ศึกษาผลของตัวลวงที่มีต่อการเรียนรู้ภาษาของบุคคลสองภาษา และ 2) เปรียบเทียบวิธีการรับรู้ที่ใช้ในการเรียนรู้ภาษาระหว่างกลุ่มที่มีความสามารถสูงกับกลุ่มที่มีความสามารถต่ำ กลุ่มตัวอย่างประกอบด้วยกลุ่มที่มีความสามารถสูงจำนวน 24 คน และกลุ่มที่มีความสามารถต่ำจำนวน 24 คน แบ่งระดับความสามารถด้วยผลการทดสอบจากแบบทดสอบความสามารถทางด้านภาษาของ Gollan, Montoya and Werner (2002) การทดลองในการวิจัยนี้ชื่อว่า Language Speech Production ดำเนินการโดยให้กลุ่มตัวอย่างแปลคำศัพท์จากภาษาอังกฤษเป็นภาษาเขมร โดยคำศัพท์ที่กำหนดให้มีบริบทของตัวลวงเป็นคำหรือรูปภาพที่มีและไม่มีความหมายสัมพันธ์กับคำศัพท์ที่กำหนดให้ ระหว่างการทดลอง ผู้วิจัยบันทึกเวลาการตอบสนอง และความถูกต้องของคำตอบโดยใช้โปรแกรม DMDX วิเคราะห์ข้อมูลด้วยค่าเฉลี่ย ส่วนเบี่ยงเบนมาตรฐาน และ three-way ANOVA

ผลการวิจัยปรากฏว่า ผู้เข้าร่วมการวิจัยสามารถใช้เวลาการตอบสนอง ในบริบทของตัวลวงที่เป็นคำศัพท์ได้เร็วกว่าตัวลวงที่เป็นรูปภาพ นอกจากนี้พบว่าตัวลวงที่เป็นคำซึ่งมีความหมายสัมพันธ์กับคำศัพท์ ที่กำหนดให้ส่งผลรบกวนการเรียนรู้ภาษา ขณะที่ตัวลวงรูปภาพที่มีความสัมพันธ์กับคำศัพท์ที่กำหนดให้ช่วยส่งเสริมการเรียนรู้ภาษา กลุ่มที่มีความสามารถต่ำถูกรบกวนจากตัวลวงที่เป็นคำซึ่งมีความหมายสัมพันธ์กับคำศัพท์ที่กำหนดให้มากกว่ากลุ่มที่มีความสามารถสูง นอกจากนี้ตัวลวงรูปภาพที่มีความสัมพันธ์กับคำศัพท์ ที่กำหนดให้ช่วยส่งเสริมการเรียนรู้ภาษาในกลุ่มที่มีความสามารถต่ำได้น้อยกว่ากลุ่มที่มีความสามารถสูง ดังนั้นบุคคลสองภาษาที่มีความสามารถต่ำควรเรียนรู้คำศัพท์ใหม่ในภาษาที่สองด้วยการคิดเชื่อมโยงกับคำศัพท์ในภาษาที่หนึ่ง (เช่น เรียนรู้ภาษาอังกฤษโดยเชื่อมโยงกับภาษาเขมรที่เคยเรียนรู้ มาก่อน) ในขณะ ที่บุคคลสองภาษาที่มีความสามารถสูงสามารถเรียนรู้คำศัพท์ใหม่ในภาษาที่สองได้โดยตรง (เช่น เรียนรู้คำศัพท์ภาษาอังกฤษจากรูปภาพที่มีความหมายสัมพันธ์กับคำศัพท์นั้น)

56910039: MAJOR: MEASUREMENT AND TECHNOLOGY IN COGNITIVE SCIENCE
M. Sc. (MEASUREMENT AND TECHNOLOGY IN COGNITIVE SCIENCE
KEYWORDS: CONCEPT SELECTION/ SEMANTICALLY RELATED & UNRELATED CONTEXT DISTRACTERS/ BILINGUALS

SOKSAN DAM: EFFECTS OF LANGUAGE DEVELOPMENT ON BILINGUALS' CONCEPT SELECTIONS: A CASE STUDY OF LANGUAGE SPEECH PRODUCTION TASK IN THE KHMER-ENGLISH BILINGUAL CONTEXT. ADVISORY COMMITTEE: SUCHADA KORNPETPANEE, Ph.D. 172 P. 2015.

The purposes of this study were 1) to find out the effects of context distracters on bilinguals' language speech productions and 2) to compare the locus of concept selections between less-proficient and high-proficient bilinguals. The subjects comprised a less-proficient group (n=24) and a high proficient group (n=24) classified by the language production test of Gollan, Montoya and Werner (2002). This experiment was called language speech production where individual subjects were asked to translate the presenting target word from English (L2) into Khmer (L1) under semantically related and unrelated context picture and word distracters. During the experiment, the reaction times (RTs) and accuracy were recorded into the DMDX software program. Mean, standard deviation and three-way ANOVA were used for data analyses.

The results showed that the reaction times of language speech productions under context word distracters were faster than that of context picture distracters. Semantically related context words caused semantic interference while semantically related context pictures increased semantic facilitation. Less-proficient bilinguals experienced more interference by semantically related context word distracters than high-proficient bilinguals. However, less-proficient bilinguals were less facilitated by semantically related context picture distracters than high-proficient bilinguals. Thus, the locus of concept selections of less-proficient bilinguals was at the lexical level where they needed to rely on lexical link from L1 in their language speech production. The locus of concept selections of high-proficient bilinguals, on the other hand, was at the conceptual level where they could directly conceptualize from semantically related context pictures.

CONTENTS

CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (Continued)

CHAPTER 1

INTRODUCTION

Statement and Significant of the Problem

English is a global language and one of the most spoken languages throughout the world. As Cambodia is one of the ASEAN members and its integration will be officially implemented in the late 2015; therefore, article 34 of ASEAN approved that every nation has agreed to use English as an official language for international communication between countries in ASEAN region (ASEAN, 2008). In other words, English will mainly influence economic development, business, educations, tourism and international-relations in the ASEAN region. Consequently, after ASEAN integrations, the member with poor human resources in English competences will become inferior to the country that possesses better English and it will be hard for them to keep up with challenges within the membership countries (ASEAN, 2008).

To acquire English skills which are not one's native language is usually very difficult and a huge barrier for second language learners since it requires learners' high efforts, motivations, and attentions in order to produce good outcomes and become proficient in English. It is very important that language educators regarding specifically to the teachers need to understand the language process of monolinguals and bilinguals so that they can plan and apply their lessons and teaching techniques effectively and efficiently. Obviously, monolinguals who have fewer lexical activations in their brain could name an object with two or more alternative names in their native language very easily and naturally with less anxiety, tension and especially without any interference from their second language, so there is fewer problems for them to response in their native language (Jescheniak & Schriefers, 1998; Peterson & Savoy, 1998; Levelt, 1989). However, bilingual's language production is more complex because words in one language have translation equivalent in another language which has been known as cross-language synonyms as they could easily interfere in bilinguals' language speech productions. Therefore, bilinguals typically need more time and efforts for planning and practicing in

language productions since they possess more complex lexical activations in their brain (Costa, Miozzo, & Caramazza, 1999; Hermans, Bongaerts, De Bot & Schreuder, 1998).

The model of bilingual language production adapted from Poulisse and Bongaerts (1994) along with Hermans (2000) described the process which bilinguals had to go through when naming the picture. This model explained that bilinguals need to involve in three sequential levels such as conceptual, lemma and phonological level in order to produce the right words in second language (L2). Firstly, it is the conceptual levels which the semantic features related to the meaning of the pictured objects are activated in first language (L1) and second language (L2). The next level is called lemma which the abstract lexical representations for each of the lexical alternatives in both L1 and L2 occurred in the language production process. Finally, phonological level refers to the articulation of the right target word. For example, when the Spanish-English bilinguals were asked to name the picture of chair in English, they firstly try to semantically conceptualize the picture of *chair* in English and *silla* in Spanish, and then the abstract lexical representation occurred in both language at lemma level such as *table* in English and *mesa* in Spanish and so on. Finally, the phonological level occurs which the bilinguals could produce the sound (chair) specifying the picture. The lemma level has been considered as the "hard problem" for bilinguals as they mostly come up with difficulty to select the correct word in response to the target concept, and also at this level both target and non-target lexical representations compete for activation. How could bilingual deal with this challenge? Also, how could bilinguals deal with the hard problem? The answers to those questions were varied and controversial among linguists.

La Heij (2005) introduced Concept Selection Model (CSM) to provide solutions to the hard problem. This model argued the problem of lexical selections by supporting that the hard problem would not cause the huge barriers for bilinguals because the problem was already solved at the conceptual level. The basic assumption of this model explained that the target language selections occurred before lexical level basically at the conceptual level and especially taking place during the pre-verbalization where the target language to be responded was already activated for bilinguals. For instance, when the bilinguals of English Spanish were asked to name

the picture in English, the English word would be considered and strongly activated in the lexical process during the preverbal speech although some Spanish words could also be activated. Enough evidences from the Stroop translation tasks supported that bilinguals' hard problem could be solved at the conceptual level (Bloem & La Heij, 2003; Bloem, Van Den Boogaard, & La Heij, 2004). However, this Concept Selection Model evidently in favor of high- proficient bilinguals to deal with the hard problem. What about the less-proficient bilinguals? How could they deal with such a hard problem? Could less-proficient bilinguals be able to conceptualize at the conceptual level?

Based on Revised Hierarchical Model (RHM), Kroll and Stewart (1994) explained the lexical and conceptual representation in accordance to L2 proficiency. This model showed the independent lexical representation of L1 from L2. Bilinguals could access directly to L1 word and its semantic while words in L2 relied on L1 language translation equivalent in order to access its meaning. This model demonstrated that word-to-concept connection was stronger for L1 while word-to-concept connection for L2 could be increased positively correlated to L2 language proficiency level. In other words, if L2 English learners of Spanish were asked to name the picture of dog in English and Spanish, the word *dog* had higher correlation to L1 while the word *perro* in Spanish would depend on translation equivalence or lexical link from L1 so that L2 word could be produced.

Green (1998) firstly introduced Inhibitory Control Model (ICM) where the process of bilinguals' language production was significantly depended on inhibition of the non-target language so that the target language had priority to be more activated. Generally, both L1 and L2 had possibility to be activated. However, due to the language task schemas together with their inhibitory connection and suppression, the non-target language was inhibited. Then, the target language was regulated and activated; as a result, the language to be responded was ready for activation. However, as this language production occurred at the lemma level, ICM similarly inhibited the non-target words known as lemma in the same language. As a result, the target word could be activated and produced correctly. According to ICM, less-proficient bilinguals relied more on lexical inhibition of the non-target words.

Schwieter and Sunderman (2008) introduced the new model in bilinguals' language production entitled Selected by Proficiency (SbP) Model. This model supported the ideas that less-proficient bilinguals depended on lexical link from L1 known as language translation equivalent in order to produce L2 responses. Also, word-to-concept was stronger in L1 than in L2. However, for high-proficient bilinguals, this model showed very slight lexical link from L1 in language production and word-to-concept in L1 and L2 was almost equal. Thus, high-proficient L2 could produce language responses without relying on L1. However, there was a possibility that high-proficient bilinguals could switch back to rely on procedures adopted by less-proficient bilingual for language productions.

Bloem and La Heij (2003) expanded their research study with different stimulus onset asynchrony (SOA) at three different time frames at -250 ms of SOA, 0 ms of SOA, and +150 ms of SOA with Stroop translation tasks. The stimulus to be presented was in L2 (Dutch) while the context distracters were presented in L1 (English) the most dominant language. Subjects were asked to response in backward translation from L2 to L1 as quickly as possible by ignoring the context distracters. The intention of running this experiment at various SOA was to find out if semantic relatedness effect (SRE) was due to the time that context distracters were being presented. The results showed that at SOA of -250 ms there was little facilitation (+7 ms) from context word distracters while there was more facilitation (+38 ms) from context picture distracters. At 0 ms of SOA, there was interference (-19 ms) from context word distracters, while context picture distracters almost equally facilitated (+39 ms) on Stroop translation task. Last, at +150 ms of SOA, context word distracters interfered (-17 ms) bilinguals' Stroop translation task, whereas context picture distracters facilitated (+26 ms) bilinguals' Stroop translation task. Based on these results, more interference occurred at 0 ms of SOA from context word distracters, but it became less interfered when the SOA increased to +150 ms of SOA. Likewise, more semantic facilitation from context picture distracters occurred at 0 ms of SOA, but it became less facilitated when SOA increased to +150 ms of SOA. Does increasing in time for SOA could decrease semantic interference effects from context word distracters? Similarly, does increasing in time for SOA could decrease semantic facilitation effects from context picture distracters? What would be the results of SRE

when the stimulus onset asynchrony is presented at +500 ms of SOA? Will context distracters inhibition occur at this level?

To sum up, the process of bilingual language production is still controversial between various groups of linguists. Most of the studies did not separate between less-proficient and high-proficient bilinguals in their experiments. Also, there were very few studies conducted on backward language speech production tasks from L2 to L1 which is very significant and at the meantime could help linguists decide if bilinguals at what certain levels needs lexical link from L1 in order to make language productions in L2 and to what certain level that they can independently conceptualize L2 at the conceptual level. Additionally, the effect of context distracters including words and pictures on bilinguals' language speech productions has limitations of study among linguists.

Therefore, the researcher chose this area of study in order to get clearer views of how bilinguals with different language ability could be distinguished in language speech production tasks, and especially to gain clearer conclusion about semantic relatedness effect (SRE) at 0 ms of SOA and +500 ms of SOA of context distracters on bilinguals' concept selections.

Research Questions

1. How would context picture and word distracters affect bilinguals' langauge speech production at 0 ms & +500 ms of SOA?

2. How do semantically related and unrelated context picture and word distracters affect bilinguals' language speech productions? Which context leads to semantic interference and which context leads to semantic facilitation?

3. How do semantically related and unrelated context picture and word distracters affect less-proficient and high-proficient bilinguals' language speech productions?

4. What is the semantic relatedness effect (SRE) of context words and pictures on less-proficient and high-proficient bilinguals' language speech production? What is the locus of concept selection of less-proficient and high-proficient bilinguals during the language speech production?

Objectives of the Study

The purpose of this study was to find out the locus of language selection of less-proficient and high-proficient bilinguals during language speech production tasks. This study focused heavily on the experiment with context word and picture distracters with semantically related and unrelated to the stimulus which could bring different effects on bilinguals' language speech productions. Two time frames of the experiment at 0ms of SOA and +500ms of SOA with Stroop translation tasks were conducted. The main motivation of this study was to get more precise understanding of the locus of concept selections of bilinguals from various language abilities during the language speech productions. Thus, the overall objectives of this behavioral experimental research comprised four important points as below:

1. To find out the effects of context distracters on bilinguals' language speech productions at 0 ms of SOA and +500 ms of SOA.
2. To find out the effects of semantically related and unrelated context word and picture distracters on bilinguals' language speech productions.
3. To compare the effects between semantically related and unrelated context word and picture distracters on less-proficient and high-proficient bilinguals' language speech productions.
4. To compare semantic relatedness effect (SRE) of context distracters on less-proficient and high-proficient group and to draw conclusions about bilinguals' locus of concept selections during their language speech productions.

Hypotheses of the Study

This research produced the following hypotheses:

1. Bilinguals generally could produce language speech productions faster when the context words are shown while context pictures slow down language speech productions.
2. Context word distracters with semantic relatedness could interfere language speech productions while context picture distracters with semantic relatedness facilitate bilingual's language speech productions.
3. Less-proficient bilinguals are more interfered by context word distracters and less facilitated by context picture distracters during the language speech

productions. High-proficient bilinguals, in contrast, are less interfered by context word distracters and more facilitated by context picture distracters.

4. The locus of concept selection of high-proficient bilinguals occurs at the conceptual level as they use concept mediation to conceptualize the presenting stimuli. The locus of concept selection of less-proficient bilinguals, on the other hand, occurs at the lexical level as they need to rely on lexical link from L1 to conceptualize the presenting stimuli.

Conceptual Framework

This research aimed to study the locus of concept selections of less and high- proficient bilinguals in Khmer-English learning context based significantly on the Concept Selection Model of Schwieter and Sunderman (2008). Selected by Proficiency (SbP) Model was the model that intended to explain the locus of concept selections of bilinguals in backward translation tasks. In this task, the presenting stimulus was in L2 (English) while the context distracters were presented in context words (L1) and pictures with related and unrelated semantic to the stimuli. For example, if the stimulus L2 word was “house” the context word distracter with related semantic would be “window” presented in Khmer language while the unrelated semantic could be “pencil” also presented in Khmer language. Each subject in the experiment needed to give backward translation by translating the presenting stimuli from L2 (English) to L1 (Khmer) as quickly as possible by ignoring the context distracters. This model supports the ideas that less-proficient bilinguals depended on lexical link from L1 known as translation equivalent while high-proficient bilinguals could independently conceptualize words or pictures directly into their L2. Therefore, the locus of concept selection of less-proficient bilinguals according to SbP was at the lexical level where less-proficient bilinguals needed to depend on lexical link from L1 known as first language translation equivalent. The concept selections of high-proficient bilinguals, however, happen at the conceptual level where they could directly and instantly conceptualize the presenting stimuli. Additionally, context word distracters caused more semantic interference in less-proficient bilinguals whereas context picture distracters led to more semantic facilitations for high-proficient bilinguals in the language speech production task.

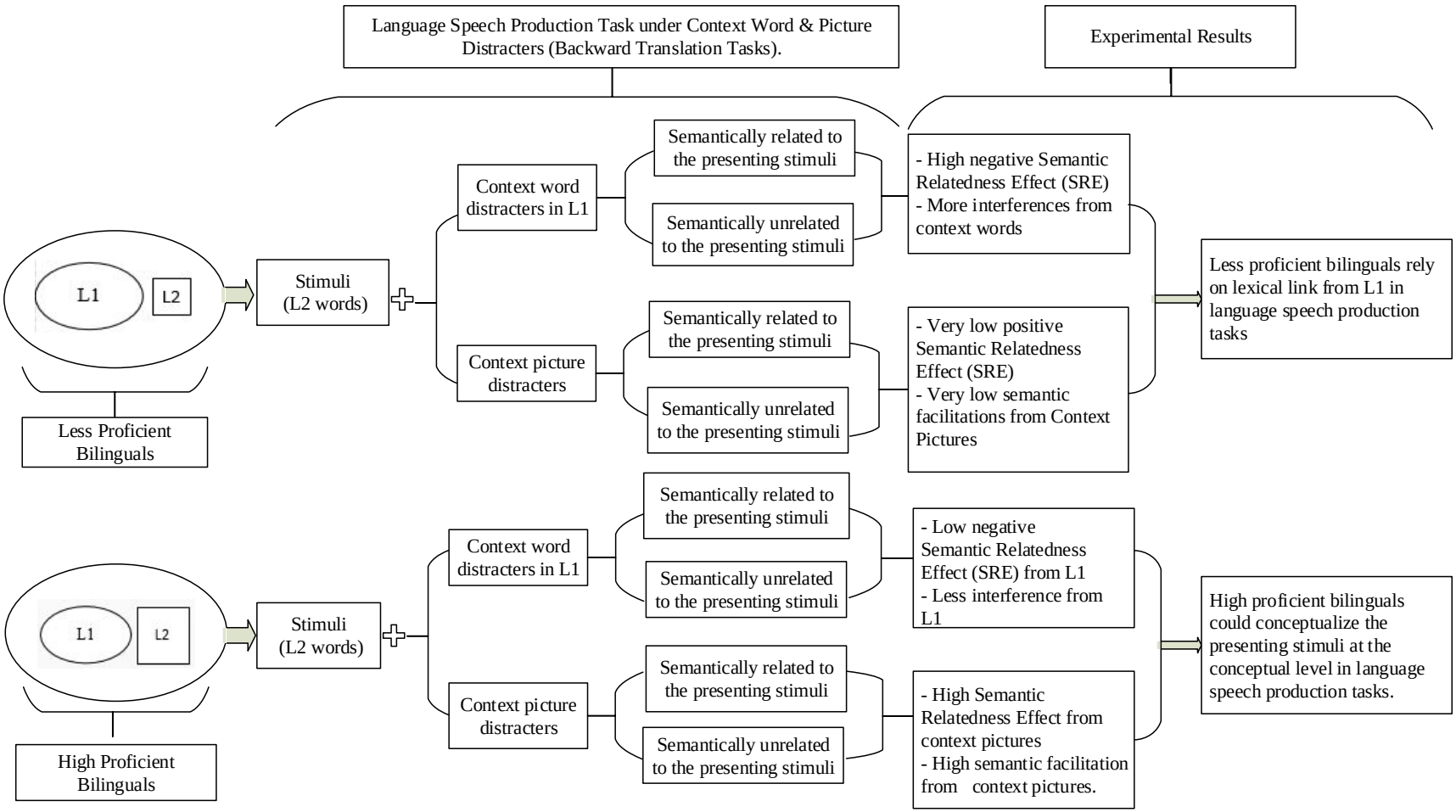


Figure 1-1 Conceptual Framework of the Effects of Language Development on Bilinguals' Concept Selections

Significances of the Research

This was an experimental research to test the model of Schwieter and Sunderman (2008) and to additionally gain more understanding of the locus of concept selection in bilinguals during language speech production tasks. Besides, the experiment on context word and picture distracters could help researcher understand how less-proficient and high-proficient bilinguals were influenced in language speech production and also how semantic relatedness effect (SRE) could be differently illustrated from context word and picture distracters. Therefore, this research would bring the following significances:

1. Getting precise understanding of how context word and picture distracters would affect Khmer-English bilinguals' language speech productions.

2. This relation between L1 and L2 in language speech production would assist language teachers to psychologically understand the language development of their students and meanwhile to gain advantages of planning their lessons and teaching techniques in order to help their students acquire English more effectively and efficiently.

3. The clear ideas of how context words and pictures affecting less and high-proficient bilinguals would surely assist language teachers and linguists to be more confident about bilinguals' language development and at the meantime to build up the most appropriate teaching materials and technique for their students so that it will enrich the teaching and learning environment.

Scope of the Study

1. Subjects were students from BELTEI International University. They were categorized into two groups of less-proficient and high-proficient bilinguals through language production test adapted from Gollan, Montoya and Werner (2002).

2. The total numbers of subjects comprised 48 people. 24 of them were categorized into less-proficient group and the other 24 were classified into high-proficient group.

Definition of Terms

Bilingual refers to a person who could use two languages comprised Khmer as their native language and English as their second foreign language.

Monolingual refers to a person who knows only his native language (Khmer).

Concept selection is an approach to study bilinguals' language speech productions in order to find out whether bilinguals' concept selection occurs at lexical level with lexical link from L1 or at conceptual level without lexical link from L1.

L1 refers to Khmer.

L2 refers to English.

Conceptual level means bilinguals could directly conceptualize the presenting picture (stimuli) into their second language (e.g. English), and they could directly produce lexical response in L2 without any lexical interference or translation equivalent from their first language (e.g. Khmer).

Lexical level means bilinguals could not directly conceptualize the presenting picture (stimuli) into their second language (e.g. English); they have to rely on their first language (Khmer) translation equivalent or conceptual link so that lexical response in L2 (English) could be produced.

Lemma level refers to the second level in language production model where target words and non-target words in both L1 (Khmer) and L2 (English) compete each other for language activation in response to the presenting picture (stimuli).

Phonological level refers to the last level in language production model where bilinguals could articulate the lexical response to the presenting picture (stimuli)

Backward translation refers to the translation from L2 (English) to L1 (Khmer).

Semantically related context word distracters refer to the presenting context word distracters that are semantically related to the stimuli (e.g. fingers-thumb, house-window, bridge-river, etc.). These semantically related context distracters consisted of coordinate (e.g. potato-pumpkin), associate (e.g. pagoda-monk) and feature (e.g. finger-glove).

Semantically related context picture distracters refer to the presenting context picture distracters that are semantically related to the stimuli (e.g. fingers-thumb, house-window, bridge-river, etc.). These semantically related context distracters consisted of coordinate (e.g. potato-pumpkin), associate (pagoda-monk) and feature (e.g. finger-glove).

Semantically unrelated context word distracters refer to the presenting context word distracters that are semantically unrelated to the stimuli (e.g. finger-book, house-pencil, bridge-whistle, etc.).

Semantically unrelated context picture distracters refer to the presenting context picture distracters that are semantically unrelated to the stimuli (e.g. finger-book, house-pencil, bridge-whistle, etc.).

Language speech production task refers to the task which subjects are instructed to translate words from L2 to L1 (known as backward translation task) as quickly as possible by ignoring four types of distractors: semantically related context words in L1 (Khmer), semantically unrelated context words in L1 (Khmer), semantically related context pictures and semantically unrelated context pictures to the presenting stimuli.

Reaction Time (RT) refers to the time counted from the time the stimulus being presented on the computer screen until the subject gives responses in language speech production task.

Semantic Relatedness Effect (SRE) could be calculated by subtracting the mean of reaction time (RT) for related context distracters from those of the unrelated context distracters.

Stimulus Onset Asynchrony (SOA) refers to the time that researchers used to present their stimuli and context distracters during the experiment.

0 ms of SOA refers to the time of presenting the stimuli and context distracters where both of them appear simultaneously on the computer screen.

+500 ms of SOA refers to the time of presenting stimuli and context distracters where the context distracters appear 500 milliseconds later than the presenting stimuli.

CHAPTER 2

LITERATURE REVIEW

The literature review is the supporting evidences to the research topic as it could provide related studies and theories which were already conducted and found by previous researchers. Literature review could provide strong guidance and relevant supporting evidences to the present research in order to make the researcher more confident about the area being studied. This chapter discussed the language development of less-proficient and high-proficient bilinguals, and how context pictures and words together with their semantic relatedness effect (SRE) could influence bilinguals' language speech productions and meanwhile variety of supporting research evidences were discussed.

1. Bilinguals and Concept Selection
   1.1 Bilingual Definition
2. Foreign Language in Cambodia
   2.1 Trend of Formal Education of Foreign Language in Cambodia
3. Introduction to BELTEI International University
4. Language Development and Concept Selection in Bilinguals
   4.1 Concept Selection Model (CSM)
      4.1.1 Summary of Concept Selection Model (CSM)
   4.2 Revised Hierarchical Model (RHM)
      4.2.1 Summary of RHM and Its Relation to CSM
   4.3 Inhibitory Control Model (ICM)
      4.3.1 Summary of Inhibitory Control Model (ICM)
   4.4 Selected by Proficiency (SbP) Model
      4.4.1 Summary of Selected by Proficiency (SbP) Model
   4.5 Conclusion of Concept Selections in Bilinguals
5. Cognitive Processing of Language
6. Theories of Language Acquisition
7. Differences between First and Second Language Acquisition

Bilinguals and Second Language Learning

1. Bilingual Definition

As the world has become more connected from one country to another, becoming bilinguals is very significant for every citizen. To ask linguists define what the term "bilingual" mean would be varied among different linguists. Some would say bilinguals are someone who could be able to speak and use more than one language since birth. Some others would say bilingual is the individual who is more fluent in their first language than second language. Anyways, the answer would not be unique and single. Therefore, below is what various linguists define "bilingual".

Gove (1961) refers bilingual to a person who has or uses two languages with the spoken fluency of the native speaker. The person has ability to control and habitually resemble the native speaker.

Butler and Hakuta (2004) defined bilinguals as someone who has ability and knowledge to use more than one language.

According to Bloomfield (1984), bilingual refers the each individual who have native-liked ability to control two different languages. Being bilingual in accordance to the term defined by Bloomfield, each person are required to have extensive range of vocabulary and also with perfect skills of reading, writing, listening, and speaking. Based on Bloomfield's definition, there would be fewer people dare to claim themselves as bilinguals.

Haugen (1953) gave the definition to bilinguals as the person who is fluent in at least one language and still have adequate ability to produce complete and meaningful utterance in another language. This terminology definition ensured more people to categorize themselves as also bilinguals even at the early stage of second language acquisitions.

Titone (1972) defined bilinguals as each individual who have ability to speak and use the second language by naturally applying and following the concepts of that language without any interference from their native language.

To classify bilingual is very complex due to the fact that there are many variables to categorize bilinguals. Some people have been counted as bilingual unconsciously since their birth while other become bilinguals later in life. Thus, age of language acquisition and exposure to two or more language are the factors to

classify bilingual. Also, there are other factors need to be considered such as frequency of language use (daily use vs. sporadic use), comprehension and production, cultural identity and so on. Baker (1996) and Goodz (1994) gave named to bilinguals who could master two languages prior to the age of three years old as “simultaneous bilingualism" which the majority happened to the family of refugees who use their heritage language (language spoken by their parents) to communicate at home and their children could use another language being spoken in their community.

Bilingual can succeed in one language better than another language in term of speaking, reading, writing, and listening; they have to practice a lot of code switches from one language to another. The better code switches they can do the more proficient of the language they could become (Dijkstra & van Heuven, 1997). Additionally, these linguists supported that bilinguals must have been flexible in mental switches when they are using one language instead of another. Also, bilinguals must be able to distinguish between input and output of their language system. For example, a person who is translating from one language (L1) to another (L2) could still be able to comprehend the input in L1. Moreover, language system must be at the different level of activation between L1 and L2 so that in order to speak one language rather than another language its level of activation must be more overwhelmed or influenced.

In conclusion, the definition of bilinguals is varied among linguists. Typically, those linguists support the fact that bilinguals are the ones who could make at least two different languages understood by other people. Bilinguals could be started since birth as the person could expose to two different languages, while others became bilinguals later in life through the effort of acquisitions with either formal or informal educations. Thus, the definitions of bilinguals are varied in accordance to different linguists.

Foreign Languages in Cambodia

In Cambodian, the official language is Khmer with 95% of the population in this country speak Khmer as their mother tongue (CIA FACTBOOK: Cambodia). Khmer was officially declared as the national language in the 1993 constitution (Clayton, 2006, p. 212). Khmer has been using as an official language for teaching

and learning at school since primary until the university level. However, at the university level for some technical precision, most of the lecturers and professor use English technical words as their preferences (Clayton, 2006, p. 213)

Chinese language has dominated in Cambodia for decades. Cambodian together with Chinese-Cambodian gained freedom to learn and use Chinese language in 1993 as this language was first ban by the Khmer Republic in 1970 and had also carried out by subsequent regimes. According to Clayton (2006), many Chinese schools have been operated throughout the country started since 1993 after it had been banned for more than 20 years. Chinese have dominated in Cambodia due to the fact that 1% of the total populations are ethnic Chinese residing in Cambodia. Additionally, owning to the influence of heavily flow of Chinese investments originally from China and Singapore coming to Cambodia from year to year has instantly encouraged the new generations learning Chinese (Clayton, 2006, p. 215).

French had very high influences in Cambodia either in school, economy and politics, especially during the French colony. Most elderly in Cambodia could speak and write French quite well. In Cambodian education system, French is one of the alternative foreign languages together with English for student to choose as their foreign language subject at school which have begun from lower secondary level to upper secondary level. Some universities in Cambodia under the sponsor from the government of France have used French as their main language for teaching and learning (Wikipedia, Cambodia). However, the number of Cambodian students learning French has decreased since 1996. Presently, fewer and fewer people use French; therefore, its popularity has been declined.

The present and most popular second language in Cambodia is English. Cambodian people view English as the world global language mainly influence in international business, education, and media (Clayton, 2007). English has started its influence in Cambodia firstly since the coming of the United Nations Transitional Authority in Cambodia (UNTAC) from 1992 to 1993 and the admission to be part of the Association of Southeast Asian Nations (ASEAN) since 1999. According to Clayton (2007) during the present of UNTAC in Cambodia, there were more than 60,000 Cambodians were employed to work with UNTAC where English proficiency was required since then more and more Cambodian people changed their concepts to

pay higher attention and interest to acquire English where they believed huge beneficiary would come later.

Besides, as Cambodia is one of the members of ASEAN, Cambodian people, especially the new generations attentively acquire English as a supplement to their skills because after the integration of ASEAN the official language of the ASEAN community is English. Therefore, in order to commute or work for other ASEAN countries, English language is very vital for them (Clayton, 2007, p. 101)

1. Trends of Formal Education of Foreign Language in Cambodia

Since gaining independent from France in 1953, foreign education existed in the school curriculum have been changed from one period to another depending on the political tendency and influence from the powerful country. According to Vira (2002), the table below provides a very clear illustration of formal foreign language Education in Cambodian society starting from the reign of the late King Sihanouk to the present time.

Table 2-1 Trends of Formal Foreign Language Education in Cambodia

#	Period	Year	Foreign Language Education
1	King Sihanouk's Government	1953-1970	French only: French was the only language officially include in school's curriculum. It was used in all sectors of Cambodia in that time.
2	Lon Nol Republic	1970-1975	French and English: because of American involvement (politics and military) in Indochina War, the study of English was also encouraged.
3	Pol Pot's Democratic Kampuchea	1976-1979	No use or study of foreign languages. No formal education was implemented. The study and use of foreign languages were severely prohibited.

Table 2-1 Trends of Formal Foreign Language Education in Cambodia (Cont.)

4	President Heng Samrin and the Age of International Politics	1979-1986	Vietnamese and Russian: Vietnamese and Russian were the official language included in the school's curriculum. The study of English and French were prohibited. If one was found to be learning either of the languages, he/she would be severely punished and even imprisoned.
		1989	English and French
5	The 1993 Elections and Afterwards	1993	English and French

French was the first foreign language being taught in Cambodia at secondary school level during the reign of King Sihanouk (1953-1970). However, in 1970 due to the influence of pro-American known as Lon Nol republic regime from 1970 to 1975, another language (English) was added to the education system of Cambodia. However, from 1976 to 1979, when a new revolution led by Pol Pot took over the country which the name of the country was changed to Democratic Kampuchea, those foreign languages including French and English were prohibited. Nobody was allowed to acquire foreign languages. Also, there was no formal education operated inside the country. The whole education system throughout the nation was shut down. If people were found learning or involving in any form of educations, they were severely punished. People were evacuated to live in the countryside to work as farmers. The whole country of Cambodia fell into darkness with a huge number of tragedies where 15 percent of the total populations died for multiple reasons under Pol Pot known as the most brutal Khmer Rouge leader (Tully, 2006).

Later after the collapse of Khmer Rouge Leaders Pol Pot in 1979, other two foreign languages were brought and influenced in Cambodian formal education system. These two languages comprised Vietnamese and Russian. French and English were still banned throughout the nation until 1980s. After the end of Cold War

between the communist country Russia and the democratic country the United States of America, English and French were normally taught at schools (Vira, 2002). According to Clayton (2006)'s observation, Cambodian people values English as their first foreign language while French was viewed as a second foreign language.

Introduction to BELTEI International University

Figure 2-1 BELTEI International University Campus Retrieved from: http://www.belteigroup.com.kh/con/

BELTEI University is a private higher educational institution in Cambodia located in Building No 21, Street 360, Sangkat Beong Keng Kong 3, Khan Chamkarmon, Phnom Penh, Cambodia. This university was transformed from BELTEI International Institute which was firstly established since January 01, 2002. After September 06, 20012, this BELTEI International Institute has been changed to BELTEI International University under strong recognition from the Ministry of Education Youth and Sport of Cambodia. To reach the demand of the local and international labor forces, BELTEI International University has focused heavily on six major faculties such as faculty of business administration, faculty of education, arts and humanities, faculty of law and economics, faculty of tourism and hospitality and faculty of information technology and science. Presently, there are 819 students studying at BELTEI International University (BELTEI International University

Report, 2015). English has been used as the main language for both learning and lecturing as students will be measured their language ability before they are allow to enroll in foundation year (year I) at the university. Besides, this university provides Bridging Courses (English Language Preparatory Courses) to make every student qualified before admitted to the university level. BELTEI International University has strong vision to build students with strong national conscience, enough ability, wisdom, and strong spirit to challenge with the labor market nationally and internationally. Additionally, students graduated from this university will be able to use English proficiently and have strong literacy in computer skills so that they could be qualified enough to challenge with the globalizations.

Language Development and Concept Selection in Bilinguals

1. Concept Selection Model (CSM)

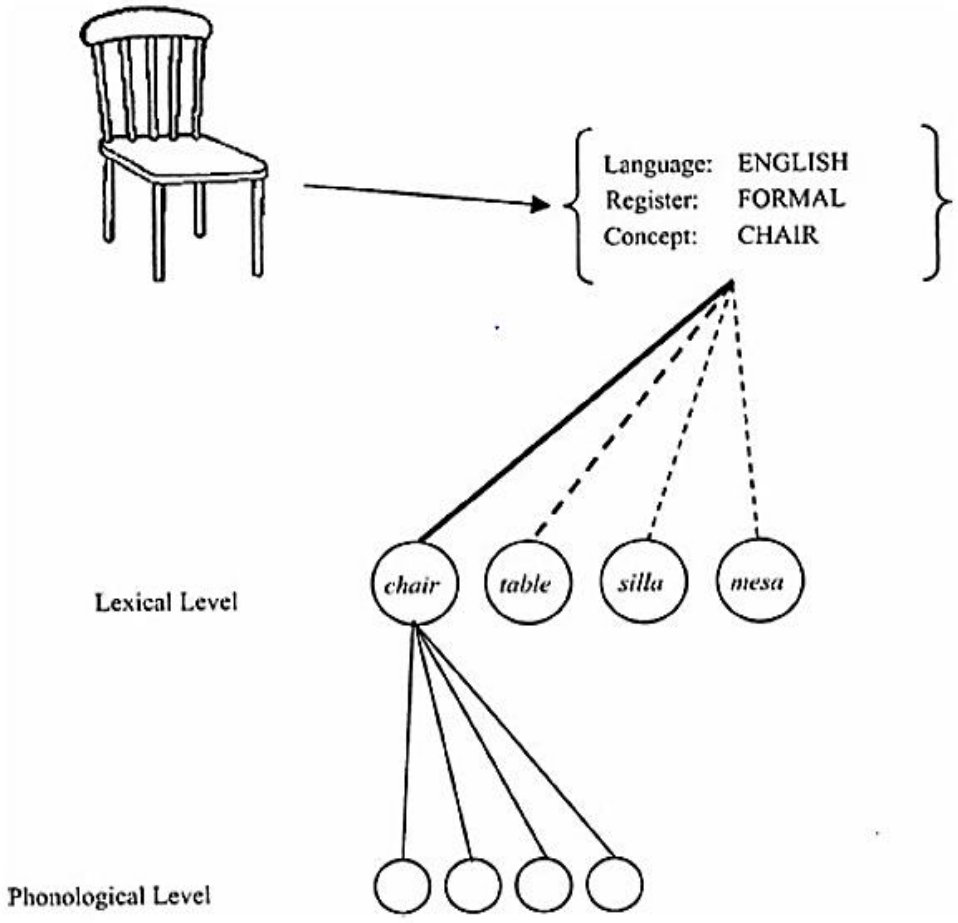


Figure 2-2 Concept Selection Model (CSM) Adapted from La Heij (2005)

Concept Selection Model was firstly introduced by La Heij (2005) as one of the solutions to the hard problem which could occur to bilinguals while producing speech in L2. The hard problem here refers how bilinguals produce language response to the stimuli whether they could independently conceptualize the stimuli or they need to rely on lexical link from L1. La Heij (2005) claimed that this hard problem could be solved at the conceptual level which bilinguals could conceptualize and decide verbal speech in L2 at conceptual level during the pre-verbalization. This pre-verbalization could assist individual bilingual to determine the target language in order to response with the right expected target language. For instance, when the bilinguals of Spanish English were asked to name the picture in English, the English word would be considered in the lexical process during the preverbal speech although some Spanish words were also activated. Enough evidences from the Stroop translation tasks supported that bilinguals' hard problem could be solved at the conceptual level (Bloem & La Heij, 2003; Blem, van den Boogaard, & La Heij, 2004). However, this Concept Selection Model evidently in favor of high-proficient bilinguals to deal with the hard problems as evidently studied and supported by Bloem and La Heij whose subjects were high-proficient bilinguals. However, the evidence to claim that this model could possibly work for the less-proficient bilinguals does not have clear with supporting evidences from linguistics.

According to the model above, when an English Spanish speaker was asked to name the picture of a chair in English, the preverbal message was responsible for specifying the concept and the target language to be responded. As a result, the target language to be responded by the subjects became more activated and selected (shown by the darker line in the model above) whereas the non-target words received less activation and attentions. To do so, the subjects would be able articulate the word "chair". Hence, the locus language speech production according to CSM occurs at the conceptual level with a special assistance from the preverbal message during the speech productions.

La Heij (2005) supported the ideas that hard problem could be solved during the preverbal message. In his explanation, he raised examples that when bilinguals intended to speak or response in one particular language for instance French, the preverbal message would activate French more strongly than the speakers' native

language. Therefore, according to La Heij (2005) the hard problem could be solved during the preverbal speech where bilingual could activate the target language to give responses. Also, at this stage, bilingual could realize who the interlocutor and what the preferred language was and so on.

La Heij et al., (1990) studied on bilinguals language productions which based significantly on Stroop task in which the researcher present the stimulus words with context word and picture as distractors. The stimulus words were presented at +140 ms and −400 ms of SOA. The subjects were asked to translate the stimulus words in second language English (L2) to their first and most dominant language (L1) Dutch. This Stroop task translation based was known as backward translation. For instance, the to-be-translated English stimulus word "spoon" was distracted by the Dutch word vork "fork" which was a semantically related context word distracter and by another semantically unrelated context word distracter. Although related distracter words caused semantic interference at SOAs of +140 ms, such interference disappeared at SOAs of −400 ms. The research explaining this outcome of the experiment that this lack of interference was modulated by a rapidly decaying semantic representation of the distracter words.

La Heij et al., (1996) conducted similar study with backward translation by using only picture distracters. Very similar to the above example, when the stimulus word "fork" was presented the distracter was presented with the picture of "spoon" as a semantically related context distracter and another word as a semantically unrelated context distracter. La Heij et al., (1996) ran their experiment twice. In accordance to the result, there was semantic facilitation occurred for first experiment (semantically related context = 817 ms and semantically unrelated context = 846 ms) and second experiment (semantically related context = 865 ms and semantically unrelated context = 910 ms).

The result of La Heij et al., (1990 & 1996) revealed their conclusions that semantic translation was impeded by the presence of semantically related context word distracter when comparing to semantically unrelated context word distracters. Additionally, bilinguals' backward translation was facilitated by the presence of related context picture distracters while unrelated context picture distracters caused interference in language speech productions.

Bloem and La Heij (2003) studied on semantic relatedness effect on bilinguals which based on the Stroop translation task where English words as stimuli were shown to highly proficient bilinguals to translate into their most dominant language L1 (Dutch). The semantic relatedness effect could be calculated by subtracting the mean of reaction time of semantically related context distracters from the mean of reaction times of semantically unrelated context distracters. (See the summary below)

Table 2-2 Mean RTs (in ms) and percentages of errors in various experimental conditions of experiment 1

	Related		**Unrelated**		**Relatedness Effect (RT unrelated – RT related)**
	RT	**%Error**	**RT**	**%Error**	
word context	793	2.0	765	1.6	-28
picture context	769	1.8	797	2.2	+28

Their results demonstrated that bilinguals' ability to translate were quicker (765 ms) for unrelated context word distracter when comparing to related context word distracters (793 ms). Context picture distracters, on the other hand, produced contradict results where semantically unrelated context picture led to slower translation (797 ms) comparing related ones (769 ms). The semantic relatedness effect from their study discovered that the reaction time (RT) of L2 to L1 translation was interfered when surrounded by semantically related context words (-28 ms) while the reaction time (RT) L2 to L1 translation was facilitated by semantically related context pictures (+28 ms). According to this result, Bloem and La Heij (2003) claimed that semantic facilitation happened at conceptual level while semantic interference occurred at lexical level.

Bloem and La Heij (2003) expanded their research study with different stimulus onset asynchrony (SOA) at three different time frames at -250 ms of SOA, 0 ms of SOA, and +150 ms of SOA on Stroop translation tasks. The intention of running the experiment at various SOAs was to find out if semantic relatedness effect (SRE) was due to the time that distracters being presented. The results showed that at

SOA of -250 ms there was little facilitation (+7 ms) from context word distracters while there was higher facilitation (+38 ms) from context picture distracters. At SOA of 0 ms, there was interference (-19 ms) from context word distracters, while context picture distracters facilitated (+39 ms) on Stroop translation task. Likewise, at SOA of +150 ms, context word distracters interfered (-17 ms) on bilinguals' Stroop translation task, whereas context picture distracters facilitated (+26 ms) on bilinguals' Stroop translation task. Based on these results, more interference occurred at 0 ms of SOA for context word distracters, but it became less interfered when the SOA increased to +150 ms. Likewise, more semantic facilitation occurred at 0 ms of SOA, but it became less facilitated when SOA increased to +150 ms.

Another experiment by Bloem and La Heij (2004) studied about backward translation with 26 highly proficient Dutch English bilinguals. The researchers focused on two different time frames of SOA: 1) context word distracters at +200 SOA and 2) context word distracters at -400 ms of SOA. The study stated the parallel results to what they had studied in 2003 where context words caused semantic interference when the context word distracters were presented in very close proximity to the target stimulus. Surprisingly, in contrast, when the distracters were presented before the target stimulus at SOA of -400 milliseconds, there were semantic facilitations. The results of the second experiment stems from the first experiment which SOA could prove changes from semantic facilitation at SOA of -400 ms to semantic interference at SOA of +200 ms.

To sum up the research finding from Bloem and La Heij, their research results showed direct impact on the ways researcher or linguists view the locus of concept selection in bilinguals' language speech production while being distracted by context word and picture distracters. These findings from Bloem and La Heij could be summarized into three major points such as 1) semantic facilitation occurred at the conceptual level 2) semantic interference was at the lexical level and 3) preverbal message assisted concept selection in language speech productions.

Schwieter and Sunderman (2008) similarly studied on concept selection and developmental effect in bilingual speech production. In their study, they adapted the research work conducted by Bloem and La Heij (2003). However, they added another group of subjects (less-proficient bilinguals) to be the main focus of their research.

Also, these groups of subjects were English-Spanish bilinguals where English was the most dominant language. There were 54 subjects divided into the group of less-proficient and high-proficient bilinguals. The research stimuli together with context distracters (semantically related and unrelated) were all adapted from Bloem and La Heij (2003). The researcher used PsyScope to present their stimuli and also to record the reaction time. The language production task was known as the backward translation task where the presented stimuli were in L2 while the context word and picture distracters were presented in L1. Subjects were asked to translate the presented stimuli as quickly as possible by ignoring the context distracters. Each stimulus was presented with context word distracter with semantic relatedness, and semantic unrelatedness, context picture distracter with semantic relatedness and semantic unrelatedness. The purposes of this study were to find out the locus of concept selection of bilinguals and to find out semantic relatedness effect of context distracters on bilinguals' language speech productions. The research results could be summary as below:

1. Language production in less-proficient bilinguals was shown faster when context word distracters were presented. However, less-proficient bilinguals spent longer time with context picture distracters.
2. Less-proficient bilingual was affected more by lexical interferences (-27 ms) from context word distracters when comparing to high-proficient bilinguals (-17 ms).
3. Less-proficient bilinguals could experience very little semantic facilitation (+1 ms) from context picture distracters while high-proficient bilinguals could experience higher facilitation (+23 ms) from context picture distracters.
4. The result from more proficient learner in overall was more consistent with the study conducted by Bloem and La Heij (2003).
5. Schwieter and Sunderman (2008) concluded their findings that concept selections for less-proficient bilinguals happened at lexical level where they needed translation equivalent from L1. Concept selection of high-proficient bilinguals happened at the conceptual level where they could directly conceptualize.

1.1. The Summary of Concept Selection Model (CSM)

To sum up, Concept Selection Model (CSM) indicated that high-proficient bilinguals could conceptualize and produce speech at conceptual level. High-proficient bilinguals' speech production could be facilitated by semantically related context picture distracters while semantically related context word distracters caused interferences in second language speech production. However, this finding and research samples from Bloem and La Heij was significantly focused on homogeneous group where high- proficient bilinguals were carefully studied. Therefore, the data and focused on less-proficient bilinguals were inadequate. More studies and supporting evidences for less-proficient bilingual needed to be studied in order to add more finding evidences to Schwieter and Sunderman (2008) especially in cross linguistic study so that a standard conclusion based on CSM could be clearly drawn. According to this CSM, the hard problem in brief was solved at the conceptual level during the preverbal speech where bilinguals could determine and activate the target language of productions.

2. Revised Hierarchical Model (RHM)

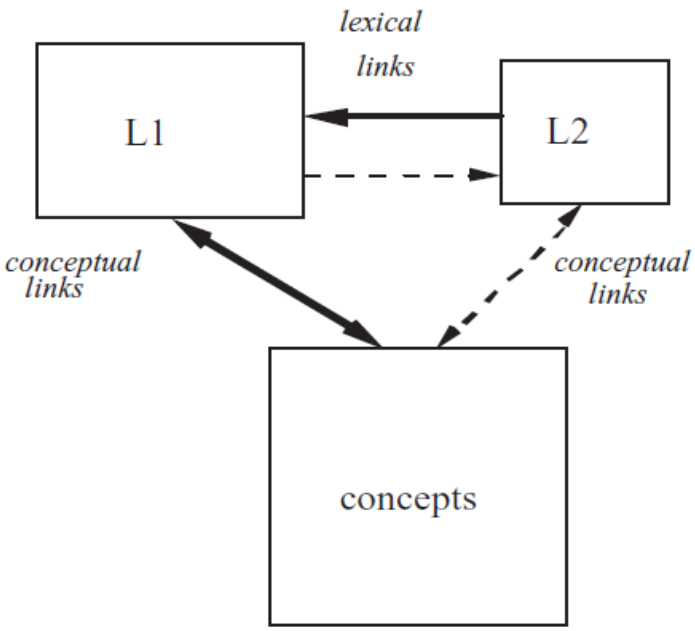


Figure 2-3 Revised Hierarchical Model Adapted from Kroll and Stewart (1994)

Revised Hierarchical Model (RHM) has been used mainly to explain pictures naming task and concept selection in bilinguals with more or less influence from L1 which heavily rely on bilinguals' language proficient level in L2. According to this model, less-proficient bilinguals were more reliant on lexical link from L1 in order to access to conceptual representation while more proficient bilinguals tend to become more independent from L1. L1 words were assumed to have direct access to their respective meanings while L2 words were hypothesized to be related with translation equivalent from L1. Hence, concept to L1 was stronger than concept to L2 for general bilinguals' concept selections process. However, when L2 language competences increased, it also increased concept to L2. This model as could be seen in the picture above illustrated that words-to-concepts develop a stronger link in L1 than L2 shown by the dark arrow above. Thus, when an English learner of Spanish see the picture of dog, they would firstly conceptualize to their L1 English first which later on they can depend on translation equivalent to produce L2 words in Spanish in order to conceptualize and to produce verbal productions in their L2 Spanish (*perro*). However, this lexical link will become less influence due to the increasing of bilinguals' language proficiency.

There were plenty of supporting evidences from linguists (De Groot, Dannenberg, & Van Hell, 1994; La Heij, Hooglander, Kerling, & Van der Velden, 1996; Zeelenberg & Pecher, 2003) who demonstrated that high-proficient bilinguals could process L2 conceptually. However, the evidence to claim about less-proficient bilinguals is still mixed and controversial among linguists. Additionally, the stage which bilinguals could conceptualize is still the matters of discussions among linguists. Several studies suggest that bilinguals had ability to conceptually mediate at quite early in learning stage (Altarriba & Mathis, 1997; De Groot & Poot, 1997; Frenck-Mestre & Prince, 1997; Potter, So, Von Eckardt, & Feldman, 1984; Schwieter, 2008). Other researchers argued that conceptual mediation in bilinguals' occurred and developed in stages (Dufour & Kroll, 1995; Schwieter & Sunderman, 2008; Talamas, Kroll, & Dufour, 1999), and it was impossible to conceptually mediate for early stage of bilingual (Kroll & Stewart, 1994; Sholl, Sankaranarayanan, & Kroll, 1995). In brief, there were linguists who debated with their supporting research evidences to claim that less-proficient bilingual could conceptualize at the early stage of second

language acquisitions while the other linguists claimed that it would need time for bilinguals to acquire L2 in order to become highly proficient first so that they could conceptually mediate later. Sunderman and Kroll (2006) did their research studies on lexical processing of second language (L2). They studied two groups of target subjects with less and more proficient bilinguals referring to Spanish (L2) while L1 was English. The language task was known as translation recognition task. Within this task, each subject was asked to give their judgment by deciding if two words were translation equivalent. In the critical conditions, the items were not translation equivalents; thus, the expected answer was "no" response. However, the forms were very similar to the translation equivalent ones. For instance, with the translation equivalent (*cara*-face) *cara* in Spanish which means face in English, the critical distracters could be (1) a form-related neighbor to the first word of the pair (e.g., *cara*-card) (2) a form-related neighbor to the second word of the pair, the translation equivalent (*cara*-fact) or (3) meaning related word (*cara*-head). This study results showed that regardless of level of language proficiency subjects with less and more proficient experienced interferences of lexical neighbor and the meaning related pairs. As a result, the study came out that both less-proficient and high-proficient bilinguals (L2) were able to draw the meaning of L2 words. This study led to one of the assumptions that learner at early stage of L2 acquisition produced the evident of L1 translation equivalent in translation recognition tasks. After learners have absorbed skills of L2, they became less sensitive and reliant on L1 translation equivalent. This study supported Revised Hierarchical Model (RHM).

Brysbaert and Duyck (2010) criticized that less-proficient learners who were able to access the semantic of some L2 words in word recognition task could not make it reliably to conceptualize lexical semantic in L2 word production from picture naming even though it was a very simple production in picture naming tasks. Revised Hierarchical Model (RHM) proposed a weaker link between concepts to words in L2 language productions; therefore, L2 could access from word to concept easier than concepts to words. However, there was a stronger link from concepts to words when bilinguals became more proficient. To conclude, less-proficient bilingual would find it more difficult to produce L2 words from concepts while they could access better from L1 word to L2 word and vice versa.

2.1 The Summary of RHM and Its Relation to CSM

It is still unclear to determine the most acceptable time and stage which bilinguals could conceptually mediate in L2, but the majority of linguists have common conclusion and agreement that in bilingual concept processing, less-proficient bilinguals are reliant on translation equivalent from L1while advanced proficient bilinguals are less reliant on L1. In other words, concept to L1 link is stronger than concept to L2 link.

Moreover, there is a logical relation between both models: Concept Selection Model (CSM) and Revised by Hierarchical Model (RHM). CSM studied and supports the fact that high-proficient bilinguals could conceptualize words in L2 without reliant on L1 lexical link and concept selection started during the preverbal speech where bilingual could determine and activate the target language to be responded. However, the theoretical explanation and supportive research evidences from CSM were mostly in favor of high-proficient bilinguals whereas less-proficient bilinguals' studied and supporting evidences were inadequate.

RHM, on the other hand, supported language translation equivalent from L1 in order to conceptualize and produce language production in L2. This lexical link also became weaker when the language proficient level of bilingual becomes more advanced. In other words, less-proficient bilinguals according to RHM depending on lexical link (translation equivalent) from L1 in order to conceptualize were significantly stronger than high-proficient bilinguals. High-proficient bilinguals, on the other hand, could independently conceptualize without reliance on L1 lexical link. Unlike CSM where the hard problem was solved at the conceptual level, the hard problem according to RHM was solved at the lexical level with lexical link from L1 basically known as translation equivalent.

3. Inhibitory Control Model (ICM)

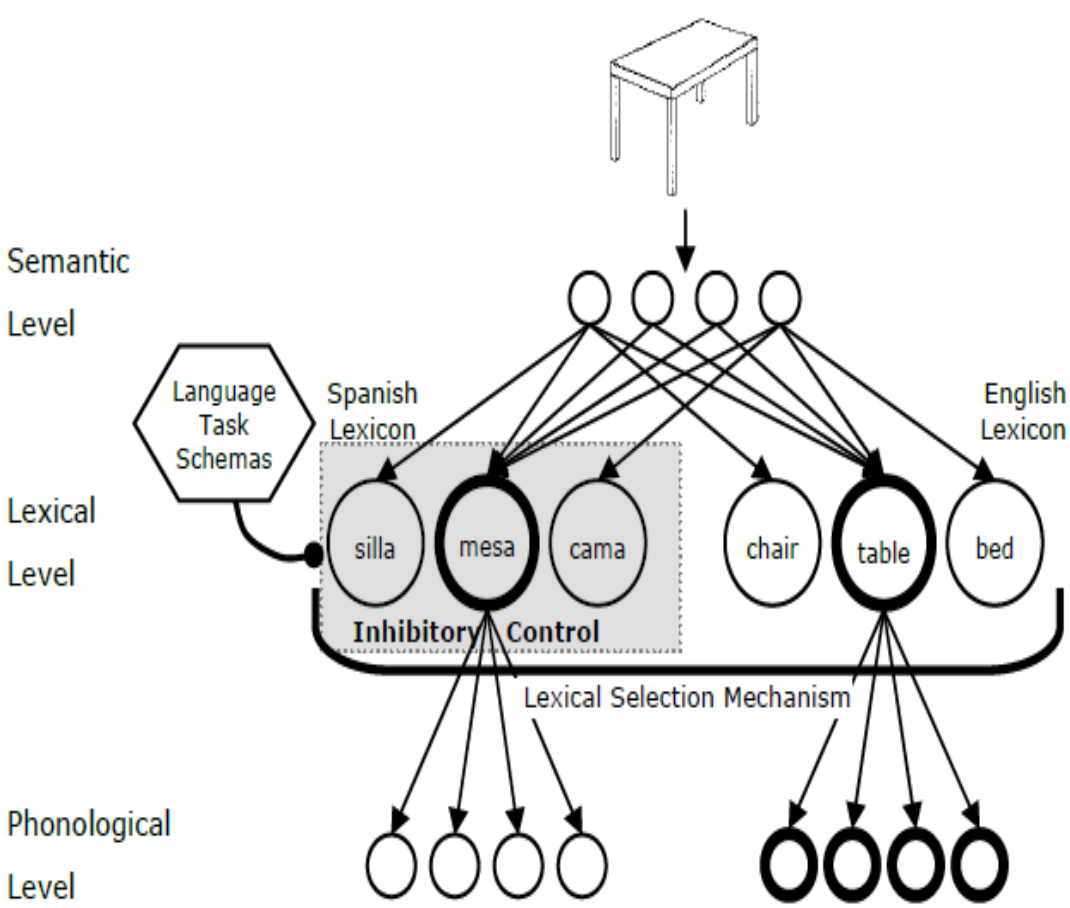


Figure 2-4 Inhibitory Control Model (ICM) Adapted from Green (1998).

Inhibitory Control Model (ICM) is the model which explains how bilinguals' speech production was lexically mediated and also how bilingual inhibit L1 or L2 while producing speech. According to ICM, more inhibition was applied to L1 when L2 was the language of production. In contrast, bilinguals will pay fewer efforts to inhibit L2 when they were producing speech in their native language (L1). This was due to the fact that the system of L1 was larger than L2 for every bilingual so more effort of inhibition was more needed for L1 as well. The locus of language selection occurs at the lexical level popularly known as lemma level and bilingual would have to invest their effort to inhibit the irrelevant active lemma together with the non-target tag which could come up during the language speech productions.

Inhibitory Control Model (ICM) was one of the alternative explanations for less-proficient bilinguals as a supplement comprehension to Concept Selection Model (CSM) and Revised Hierarchical Model (RHM). In other words, ICM empirically demonstrated that less-proficient bilingual would use high effort in L1 inhibition while they were producing speech. Additionally, more interference from L1 was stronger for less-proficient bilinguals. This model consisted of three separable aspects. First of all, one level of Inhibitory Control Model involves language task schemas that challenge to the control outputs. Such task-schemas refer to mental networks that individuals may construct in order to achieve a specific task. This task-schema can help each individual bilingual to take action in language production whether to response in L1 or L2. After realizing this task-schema, bilinguals will regulate and also activate the language representations, and after that the non-target language was inhibited. Second, the lexical selection in this model was at the lemma level. Third, the control at lemma level needed to be activated for language selection which based mainly on inhibitions. In order to ensure that the target response language would be produced, inhibitory control (IC) suppresses the non-target language so that the right target language could be spoken by bilinguals as needed. (See the figure above for more comprehension)

Based on ICM, individual bilingual would invest longer time to switch to the language that was more suppressed. Logically for unbalanced bilinguals, more inhibition was applied to their first language (L1). Thus, the backward translation from L2 to L1 was more difficult and would consume longer time. To switch from L1 to L2, in contrast, it was faster for bilingual speech production since the system of L2 is smaller to control. Various linguists also expressed their agreement toward the common assumptions of language switching among bilingual which based vitally on their research finding evidences. These linguists including Meuter (1994), Meuter and Allport (1999), Finkbeiner, Almeida, Janssen, and Caramazza (2006) proved their study by numerical naming tasks. Costa and Santesteban (2004) proved their study by picture naming task.

The lexical nodes of the non-response language had been shown to challenge for lexical selection among bilinguals (Hermans et al., 1998). The experiment was run with series of picture-word interference tasks by asking

unbalanced Dutch-English bilinguals to name pictures in their L2 (English) while ignoring auditory presented distracters in either L2 (English) or in L1 (Dutch). This study was basically known as a phono-translation task which the word distracters were phonologically related and unrelated to the stimulus words. Therefore, the stimulus and phonologically similar and non-similar word distracters were presented simultaneously. For example, if the picture of "mountain" which means "*berg*" in Dutch was presented as a stimulus, the distracter would be the Dutch's word (e.g., "*berm*" which means "verge" in English) phonologically related to the target's translation in Dutch. This research revealed that subjects took longer time to say "mountain" while the Dutch distractor's "*berm*" was being presented. However, the subjects spent less time when the phonologically unrelated distractor "*kaars*" which means "candle" in English was presented. To conclude this finding, Hermans and collaborators claimed their results that phonologically related distractor "berm" slowed down the language translation of the stimulus (mountain = *berg*). Picture semantic representation together with the distracter words (unrelated phonology) jointly enhanced the language production. Therefore, subjects could translate the stimulus words better with unrelated phonological distracter. Unrelated phonological words facilitate the language production while related phonological words distract the language translation. (See also Hermans, 2004).

Meuter and Allport (1999) did their experiment on language switching with different level of comprehension of bilinguals. The subjects were asked to name the series of Arabic digits list (from 1 to 9) which could be in L1 and L2. The response language was in accordance to the background color of the computer screen.
For example, if the background was blue, the subjects were asked to name the digit in L1 if it was red, L2 response would be needed. The results showed that the switching cost from L2-L1 was longer than L1-L2. In other words, backward translation consumed more time than forward translations.

3.1 Summary of Inhibitory Control Model (ICM)

To sum up, language speech production in ICM significantly depended on inhibition of the non-target language so that the target language had priority to be activated. Generally, both L1 and L2 had possibility to be activated. However, due to the language task schemas together with their inhibitory connection and

suppression, the non-target language could be inhibited. Then, the target language was regulated and activated so that the language to be responded was ready. However, as this language production occurred at the lemma level, ICM similarly inhibited the non-target words known as lemma in the same language. As a result, the target word could be produced correctly. (See the model above in figure 2.3)

4. Selected by Proficiency (SbP) Model

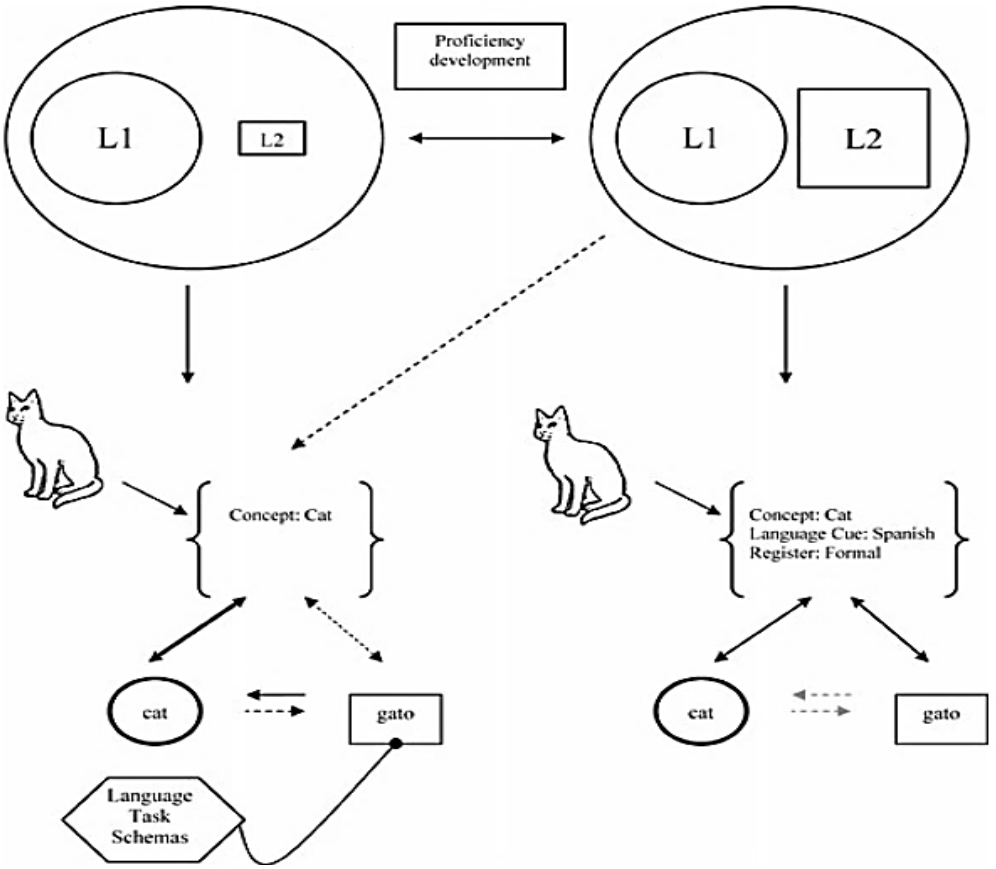


Figure 2-5 Selected by Proficiency Model Adapted from Schwieter and Sunderman (2008)

Selected by Proficiency Model was the new bilinguals' language speech production model firstly introduced by Schwieter and Sunderman in 2008. This model explained how language speech production was processed in bilingual who were less and more proficient language competent. The model above was segmented into two major parts. The left part supported less-proficient bilinguals' speech productions

while another part at the right supported the speech production of high-proficient bilinguals. The relation and link were shown by the thickness or darkness of the arrows and dashes easily seen in the model. The darker of the arrow was the stronger link whereas the dashes showed the weaker link.

According to this model (as seen in the picture above on the left-hand side), less-proficient bilingual's language speech production of English learners of Spanish occurred at lexical level rather than conceptual level and relied remarkably on inhibitory control. In other words, less-proficient bilinguals depended on lexical link from L1 (English) in order to conceptualize the picture of cat and meanwhile to give the right response in L2. The link between L2 link and their concepts were weaker. This was very similar to Revised Hierarchical Model (RHM) which less-proficient bilinguals became more dependent on lexical link rather than conceptual link when they were producing speech in L2. To conclude, when a less-proficient bilinguals in Selected by Proficiency (SbP) Model were asked to name the picture of cat in Spanish, the subjects must firstly associated the words to their L1 link (English) and at the meantime effort from inhibitory control also needed by less-proficient subjects in order to select the right language to response and inhibit the irrelevant mechanisms so that finally the word "gatto" could be responded in their L2.

Highly proficient bilinguals, on the other hand, did not rely on lexical link or association from L1 to access the concept of the picture of the cat. They were able to conceptually mediate in both languages L1 and L2. High-proficient bilinguals additionally showed strong association between concept and words in both L1 and L2. To simplify this point, more proficient bilinguals could directly conceptualize and produce L2 responses without reliance on L1 translation equivalence. However, there was a slight possibility that more proficient bilinguals could return to rely on L1 translation equivalent link in order to provide responses in L2 as obviously shown in the model above. Thus, when the high-proficient bilinguals were asked to label the picture of a cat in Spanish (L2), subject could directly conceptualize and response the word "*gatto*" in L2 instantly without influence from L1 lexical association and translation equivalence.

In brief, the picture on right-hand side of bilinguals' speech production model clearly illustrated that less-proficient bilinguals depended heavily on L1 lexical

association in language speech production. They were unable to conceptually mediate and produce speech production instantly. Additionally, lexical inhibitions also play very crucial roles for less-proficient bilinguals in order to inhibit and produce the right language productions. High-proficient bilingual, on the other hand, could rely on language cue and were instantly able to access to the conceptual link and they could response simultaneously in L2 production without relying on L1 lexical link. However, there was a very slight possibility that high-proficient bilinguals would switch back to follow less-proficient ones when in some cases they were unable to conceptually mediate in L2 (Schwieter & Sunderman, 2008).

4.1 Summary of Selected by Proficiency (SbP) Model

Selected by Proficiency (SbP) Model is the latest bilinguals' speech production model basically developed from Concept Selection Model (CSM) when less and high- proficient group of linguists were critically studied by Schwieter and Sunderman (2008) as a supplement to CSM. SbP distinguish that less-proficient bilingual rely on lexical link from L1 for translation equivalent in order to produce language speech production in L2 which also supported by RHM. SbP also demonstrated that high-proficient bilingual could conceptualize at the conceptual level without reliance on L1 translation equivalent. However, there is a possibility that high-proficient bilingual might return back to follow less-proficient bilinguals to depend on lexical translation equivalent link during the language speech production. However, in overall, it is very unlikely.

5. Conclusion of Concept Selection in Bilinguals

This section, in conclusion, has defined the term bilinguals in accordance to various linguists' perspectives which the definitions are varied. Besides, many of the concept selection and language speech productions among bilinguals have been critically discussed within this chapter. These speech production models are very inter-related from one model to another.

Concept Selection Model (CSM) firstly introduce by La Heij (1996, 2005) which focused mainly on high-proficient bilinguals whose language production could rely on conceptual link during the pre-verbal message which could bring about language speech production cues during the preverbal stage. As a result, bilinguals in

CSM could instantly conceptualize and produce language speech production without depending on L1 lexical link. The unclear evidence of this model was the fact that the study by La Heij (1996, 2005) did not include less-proficient bilinguals so additional studies are needed.

Besides, Revised Hierarchical Model (RHM) also deeply discussed in this chapter. This model was introduced by Kroll and Stewart (1994) that shared the similarity to the Concept Selection Model by supporting that high-proficient bilingual could produce language production at conceptual level without lexical link from their native language. This model took focus on less-proficient bilinguals, and in their study they demonstrated that less-proficient bilinguals could not make speech production at the conceptual level; as a result, they had to depend on lexical link from L1 to translate or produce language responses in L2. Less-proficient bilinguals in accordance to RHM relied on language translation equivalent to produce speech in L2.

Inhibitory Control Model (ICM) is the third model having been discussed in this chapter. ICM was introduced by Green (1998) which focused mainly on bilinguals' speech production inhibitions. This model gave distinguish explanations which concentrates on language inhibition between L1 and L2 during the speech production. This model indicated that in order to response with the right speech production and target language, bilinguals need to inhibit other mechanisms at the lemma level in order to phonologically produce the right target of language productions. Hence, language speech production according to ICM occurred at the lemma level simply known as lexical level.

Finally, Selected by Proficiency (SbP) Model is the latest model brought into this literature review. This model related to other models mentioned above. SbP shared common views with ICM which bilingual needs to inhibit in order to response with the right target language. Additionally, this model support CSM on high-proficient bilinguals who could give language speech productions at the conceptual level without reliance on L1 translation equivalent. In case of less-proficient bilinguals, this model shared paralleled perspectives with RHM which claimed that less-proficient bilinguals could not make language speech production at the conceptual level where they needed to rely on translation equivalent from L1.

Cognitive Processing of Language

Cognitive psychology is part of cognitive science which one of its aims focuses on the study of learning through two significant dimensions including conscious and unconscious mental activities which jointly made-up cognition. Perception, reasoning, thinking, and decisions making which occurred in every individual's experiences have been known as parts of human cognition (Galotti, 2014). According to McLeod (2007), human language has strongly influence on our cognitive development. Vygotsky had agreed with Chomsky a famous American linguist who claimed and explained that language is innate where individual person was born with this special ability to acquire the language. Chomsky additionally believed that learning would occur before development. It simply means that as we learn, our perceptions are internalized and at the meantime develop cognition (McLeod, 2007).

When human constantly develop, they involved in various experiences with variety of presenting stimuli and sound that lead to the creation of neural pathways in the brain. These pathways lead to the establishment of motivation and reaction to experiences. Based on McLeod, (2007), through the language development, whenever the sounds or phonemes are heard, our brain begins the process of relating and storing them for future uses. Additionally, when human's communication has been encouraged and developed, our cognitive processes in the brain begin to process the sounds or words and later on the brain would store them those lexicons and sounds in accordance to their similarities. In other words, similar words would be stored by the brain among other similar words and similarly for sounds (McLeod, 2007). The lexicon, like the rest of the brain, has infinite storage space, but is easier to recall information if the information is practiced often (Galotti, 2014).

Theories of Language Acquisition

Language acquisition refers to our brain ability together with its cognitive development and process to conceptualize various concepts, language structures and semantics existed in the language itself.

Linguists around the world believed that every human has innate ability to acquire a language. They claimed their supports that children are born with the

knowledge and could comprehend that language has patterns where those children are born with the ability to seek out and identify those patterns. Additionally, some theorists profoundly believed that babes are born with innate knowledge of some core characteristics which are very common in all linguistics which is simply known as linguistic universals. For example, the universal core concept of noun and verb where it shares common characteristic to all languages are innate knowledge happened among children since birth. The following discussions illustrated the language acquisition theories based significantly on Bergmann, Hall and Ross (2007) who tried to explain various theories on how learners acquire the language.

According to the imitation theory, language learner acquired their first and second language through listening to speech around them and later on they tried to produce what they have heard into language speech production. Since the connection between the way a word sounds and what it means is largely arbitrary, learners especially children could not guess the world of their target language are. Therefore, they must hear the words produced by other speakers and later on imitate them. Learning through imitations could firstly start with error in term of pronunciation as one could not instantly produce identical accent but perfection could be achieved through time, efforts and practices.

Reinforcement theory also took part to explain how people acquired languages. The main focus of this theory indicated that language learners could learn well and able to speak like adults with high confidence and accuracy resulting from the fact that they had been praised, rewarded and reinforced whenever they used the right grammatical and lexical form and were corrected when they made errors. It is very vital that language teachers together with caretakers involved in praising and correcting their children language development. Although it took time, reinforcement theory is very crucial which language teachers and especially parents need to psychologically understand and put into practices as it will enormously contribute to their children's language development. Meanwhile, positive and negative reinforcements are indispensable to assist language learners to acquire language more effectively.

Active construction of a grammar theory is one of the theories to explain how children and language learners acquired the language. Although there were

linguistic supports that children or language learners could innate ability to acquire the grammar rules, these supports were based on the speech that children hear around them and they personally developed the rules which relied significantly on what they have heard and involved. However, their self-created grammar rules are not always correct and wrong concepts could easily occur to them. For example, when children firstly acquire English grammar, they tried to create general grammar rules regarding the form of past tense which mostly occurred by adding "ed". As a result, they tended to use past forms such as eated, goed, speaked and etc. which are the common rules resulting from their self-creating grammar rules. Therefore, it is very necessary that language teachers and related groups of people contribute to shape the perfection of grammar rules among children so that those language learners could acquire the language more effectively and efficiently.

Connectionist theories tried to explain that language learners acquired the language by creating the neural connections in the brain. Children developed such connections by exposing and directly using the language. Regarding the neural connections, children learned the association between words, meanings, sound sequences, and so on. For instance, when children or language learners hear the word bottle, they would create neural connections. These neural connections could be created at various forms such as connection to the word itself, to the initial sound /b/, to the words milk, to the shape of what a bottle looks like, to the activity of drinking and so on. This theory supported that the neural connection would occur strongly with the connection link which language learners are most familiar with. For example, according to the word bottle, the neural connection could occur more significantly with milk or water. However, due to the frequency of what language learners have heard more often, that word would take stronger neural connection. As commonly known for young children, the word bottle would assume stronger neural connection with milk.

Social interaction theory explained that language learners could acquire language effectively through social interaction with other children, adults and people in their daily environment. Children need appropriate language environment to improve their social together with their linguistic communication skills; therefore, proper input from their surrounding environment is very crucial for them. Regarding

this theory, it very necessary that language educators along with relevant people to understand their role which immensely influenced children social interaction and language development.

In conclusion, many theories such as imitation, reinforcement, active construction of a grammar, connectionist, and social interaction theory were discussed and uniquely intended to explain how language learners could acquire the language effectively and efficiently. Also many learning approaches were explain to support language acquisition. It is very importance that language educators should spend time comprehending those theories and apply them into their language teaching activities in order to help learners acquire language well.

Differences between First and Second Language Acquisition

First language acquisition commonly means the acquisition of a single language since childhood happened immediately after the puberty. While first language is constantly acquired and constantly used in daily interactions, second language is learned and acquired based mainly on regular basis with infrequent interaction and dependence on inter-language translation for comprehension and mostly began later after birth. According to Cook (1969) L1 children learned the language through language exposure as they were born and grew up within that language and they acquire their first language naturally. Stephen (1988) had defined the acquisition of the first language as the natural process where students directly involved in natural communicative approaches since their puberty period while second language acquisition was a conscious one and mostly started later in life. In other words, the L1 acquisition would constantly start since the children were born and they acquire the language from various forms of input stimuli in their living environment where they are exposing in their daily life and they could naturally acquire their L1 by imitating and interacting with the people in their environment. L2 acquisition, on the other hand, is a conscious process where L2 learners tried to acquire later in life with clear objectives, motivation, efforts, and practices in order to excel in that language. It took time and tremendous efforts for L2 learners to acquire the second language. As L1 learners began since puberty, L1 learners had higher probability to acquire L1 perfection while L2 learners had problems concerning with

accents and limit lexical and grammatical systems which are very crucial for them to conquer.

Towell and Hawkins (1994, p. 14) explained that L1 acquisition is considered as complete and successful evaluating from learners' language ability in the areas of speaking, writing, reading, and listening where they could develop very strong competences in all those skills in their L1. L2 acquisition, however, is not complete acquisition due to the fact that its mastery level could not be compared to L1 acquisition and many areas of improvements such as high efforts and attentions needed to invest in order to acquire L2 to a certain level. Many areas of deficiencies in L2 skills such as speaking, reading, listening, and writing were commonly occurred among L2 learners. Schechter (1998) tried to support the evidence of L2 deficiency owning to the fact that L2 learners lack the completeness of L2 grammar, and learners could not progress beyond some particular stages.

To sum up, first language acquisition took place since puberty which simply mean after birth. Children could gain various advantages from their L1 acquisition due to the fact that they started acquiring their L1 very early since birth; as a result, they could master the perfections of their L1 in term of accent and broader range of grammatical and lexical systems in their brain. Besides, they have less anxiety, stress and difficulty to acquire their L1; therefore, they could excel their strong competences in that language. L2 acquisition, however, is quite different as learners acquire their L2 somewhere later in life. Age factor has stronger influenced on L2 acquisition and its perfection. L2 learners who began later in life need to invest a lot of efforts, preparation and practices. Besides, later L2 learners would face more challenges concerning with stress and anxiety in acquiring L2. Consequently, they have to invest higher motivation into their L2 acquisition.

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

The purpose of this chapter was to discuss general experimental approach, and research methodology. Additionally, samples, stimuli, research instruments, research procedures, data collection and data analysis were precisely presented and discussed in this chapter.

Overview of Experimental Approach

The main purpose of this study was to find out the locus of concept selections of less-proficient and high-proficient bilinguals during language speech production tasks. This study focused heavily on the experiment about language speech production tasks under semantically related and unrelated context picture and word distracters to the presenting stimulus. The experiment was conducted at two different time frames: at 0ms of SOA (stimuli and context distracters appeared simultaneously) and +500ms of SOA (context distracters appeared 500 millisecond after the stimuli) with Stroop translation known as backward translation from L2 to L1. The main motivation of this study was to get more precise understanding of how bilinguals from various language abilities would mainly rely on in their language speech productions and also to find out how semantically related and unrelated context word and picture distracters would affect bilinguals' language speech productions. Thus, the overall objectives consisted of:

1. To find out the effects of context distracters on bilinguals' language speech productions at 0 ms of SOA and +500 ms of SOA.
2. To find out the effects of semantically related and unrelated context word and picture distracters on bilinguals' language speech productions.
3. To compare the effects of semantically related and unrelated context word and picture distracters on less-proficient and high-proficient bilinguals' language speech productions.
4. To compare semantic relatedness effect (SRE) of context distracters on less-proficient and high-proficient group and to draw conclusions about bilinguals' locus of concept selections during their language speech productions.

Selected by Proficiency (SbP) Model was firstly introduced by Schwieter and Sunderman (2008). This model intended to explain how bilinguals from different language proficient backgrounds produced their speech and how they conceptualize the presenting stimuli with or without interferences from their first language (L1). This model supported the ideas that less-proficient bilinguals depended on lexical link from L1 while high-proficient bilinguals could independently conceptualize words or pictures directly into L2. However, there was a very slight lexical link between L1 and L2 among high-proficient bilinguals where they could possibly follow less-proficient bilinguals to depend on lexical link from L1 during language speech productions. It leads to the conclusion that high-proficient bilinguals could inhibit the non-target mechanisms (known as distracters) during their speech productions. This model gave clear distinguishes between less-proficient and high-proficient bilinguals in English-Spanish context. However, there was a lack of cross-linguistic study especially in Khmer-English context.

Research Design

This experimental design was based significantly on Edmonds and Kennedy 2012, p. 34).

R refers to experimental groups consisted of less-proficient and high-proficient bilinguals.

X refers to the presenting stimuli & semantically related and unrelated context distracters being presented during the experiment.

O1 and O2 refers to the measurement of effects of semantically related and unrelated context word and picture distracters on bilinguals' concept selections by measuring accuracy (O1) and reaction time (O2) during the experiment.

Table 3-1 Experimental design of Effects of Language Development on Bilinguals' Concept Selections

Experimental groups	**Presenting stimuli & Context distracters**	**Things to measure in the experiment**
R < E_1 (Less-proficient bilinguals)	X	O_1
R < E_2 (High-proficient bilinguals)		O_2

This research design was a behavioral experiment with two groups of bilinguals: less-proficient and high-proficient group. The experimental phase was run in psychological software program named DMDX version 5.1.2.1 in order to record accuracy and reaction time from each subject at two different time frames at 0 ms of SOA and +500 ms of SOA.

Pre-experiment phase: subjects were asked to practice with 10 trials for each context word and picture distracters identically at two different time frames 0ms of SOA and +500ms of SOA. This demonstration phases would help each subject to be clear about the procedures of the experiment. After the practice phase, each subject started immediately in four tests with two different time frames of SOA.

a) Test I: Language Speech Production Task with Context Word Distracters at 0 ms of SOA

b) Test II: Language Speech Production Task with Context Picture Distracters at 0 ms of SOA

c) Test III: Language Speech Production Task with Context Word Distracters at +500 ms of SOA

d) Test IV: Language Speech Production Task with Context Picture Distracters at +500 ms of SOA

There were 48 subjects who were all bilinguals splitting half into less-proficient L2 group and the other half into high-proficient L2 group. The classification of each subject were based significantly on language production test adapted from Gollan, Montoya and Werner (2002) where these selection criteria were explained precisely in the next discussion.

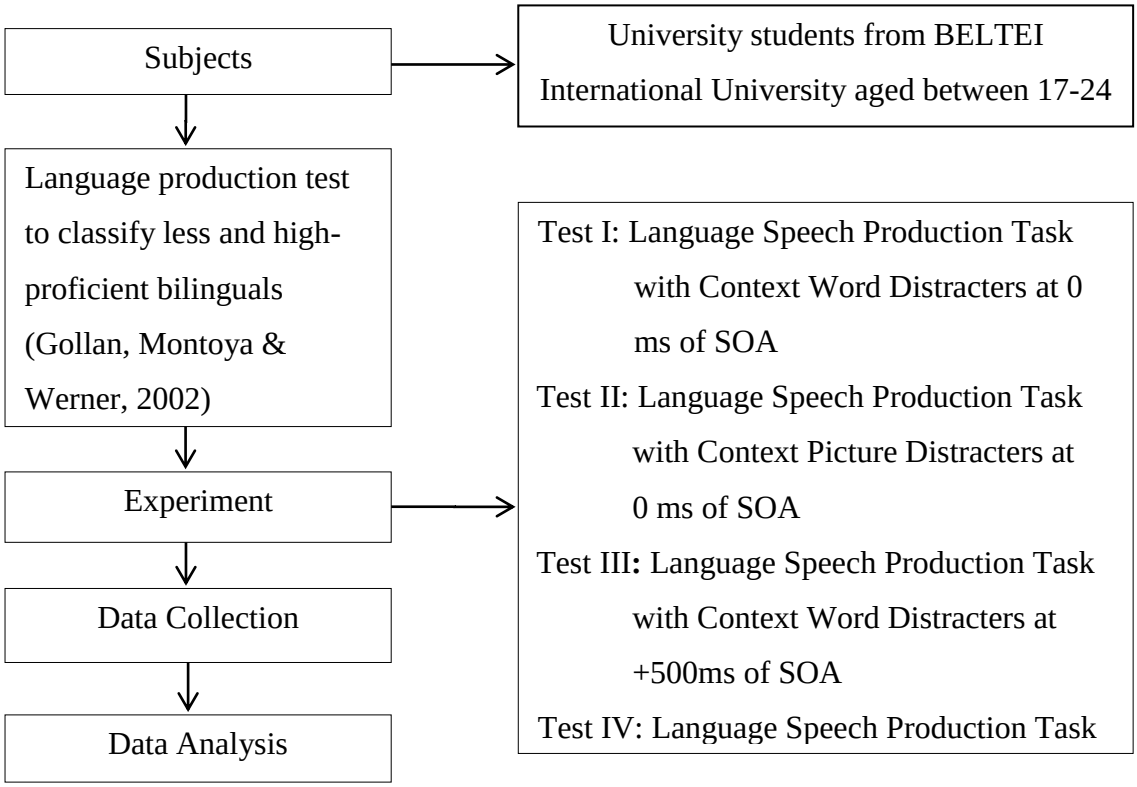


Figure 3-1 The Experimental Design and Procedures

Population and Sample

The whole number of population is 819 people who are university students at BELTEI International University, Phnom Penh, Cambodia (BELTEI International University Report, 2015). Only 48 subjects who were normally healthy without visual deficit or severe past accident affecting the brain were used as the sample for this study. The selection criteria were based significantly on purposive random sampling methods focusing on three major steps as below:

Step 1: The researcher checked the academic performance of each target subject on their English performances with direct confirmation from their lecturers.

Step 2: The language production test was given to each target subject.

Step 3: The result of the language production was checked by the researcher and the classification of less-proficient and high-proficient bilinguals were based significantly on the results from the test.

Those subjects were classified into two groups: 1) high-proficient bilinguals and 2) less-proficient bilinguals. The target less-proficient bilinguals were poor academic performance students from year 1 and bridging courses (BC) while the target high-proficient bilinguals were high-academic performance students of year three and four of English major at BELTEI International University. In the language production test, subjects were asked to generate as many words as possible as long as those words were semantically relevant to the assigned categories. This test was originally based on Gollan, Montoya and Werner (2002). There were 10 semantic categories (countries, clothing, animals, academic majors, colors, fruit, vegetable, things with wheels, musical instruments, and sports) for the whole test. Under each category, every subject was given 60 seconds (1 minute) to generate as many lexical productions as possible in second language (English). After 60 seconds, another semantic category was given, and those subjects had to continue writing spontaneously until all the categories were assigned within 10 minutes for the whole test.

The median score was 100 points to classify less-proficient and high-proficient bilinguals where this scale was based significantly on Gollan, Montoya and Werner (2002). The subjects whose score did not reach 100 were classified into less-proficient bilingual group while the subjects whose score reached 100 points were high-proficient bilingual group. Also, one correct lexical word production was accounted one point. Finally, there were 24 subjects in both less-proficient and high-proficient bilingual group.

Table 3-2 The Results of Language Production Test

	Less-proficient Bilinguals (n=24)		**High-proficient Bilinguals (n=24)**		**Mean Difference**	**t**	**p**	**d**
	Mean	**SD**	**Mean**	**SD**				
Language Production Test	79.08	6.61	108.96	4.98	-29.88	-17.68**	.00	5.11

** p<.01

According to the results from the language production test adapted from Gollan, Montoya and Werner (2002), the median score was 100 points to split less-proficient and high-proficient bilinguals. The subjects whose scores were fewer than 100 points were classified into less-proficient group while the subjects whose scores reached 100 points were categorized into high-proficient group. Later, the researcher ran the independent sample t-test in order to confirm the significant differences of mean in each group. The result showed a significant difference of mean score between less-proficient and high-proficient bilinguals at statistical level of .01. The mean score of high-proficient group (M=108.96, SD=4.98) was significantly higher than that of the less-proficient group (M=79.08, SD=6.61)

Consent Forms

Before the experiment, each subject was kindly asked to read and sign the consent form (see appendix B) in order to inform them about their roles and contribution to the research.

Research Instruments

DMDX Software Program

The researchers used DMDX software program (version 5.1.2.1 Forster & Forster, 2003) which is a free licensed psychological software program for running the experiment. This program was used to present stimuli and context distracters during the experiment. Additionally, the reaction time and accuracy which were the main study of this research were measured and recorded by this software program for later data analysis.

Stimulus/ Context Distracters

The stimuli being used in this experimental research were L2 words adapted from Bloem and La Heij (2003). The total number of stimuli consisted of 40 L2 words extracted from 9 categories such as vegetable (N=5), utensils (N=5), nature (N=4), building (N=4), vehicles (N=4), body parts (N=5), animals (N=5), furniture (N=4) and fruit (N=4). These stimuli were adapted from Schwieter and Sunderman (2008)

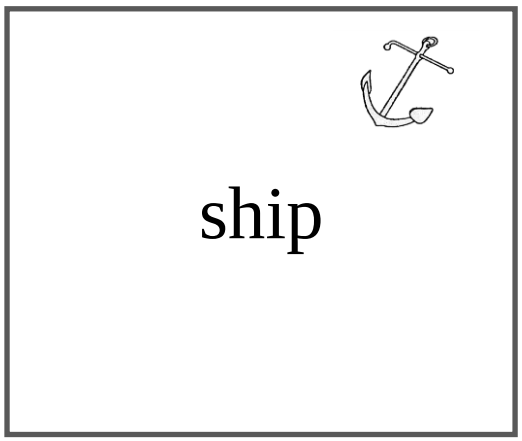
together with Bloem and La Heij (2003) and also to adjust them to rightly fit into Khmer-English bilingual context for the research study.

In addition to the stimuli, there were two types of context distracters comprising of context words and context pictures. Context word distracters were divided into two categories: 1) semantically related context word distracters with semantic relatedness to the presenting stimuli and 2) semantically unrelated context word distracters without semantic relatedness to the presenting stimuli. For context picture distracters, they were similarly classified into two groups: 1) semantically related context picture distracters and 2) semantically unrelated context picture distracters.

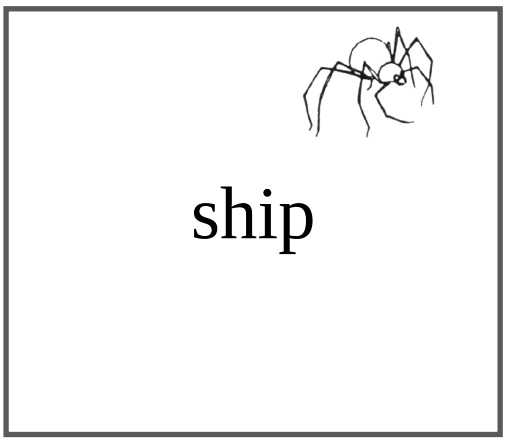
Each stimulus was used twice with semantically related and unrelated context distracters simultaneously at 0 ms of SOA and the other two tests at +500 ms of SOA. (See Appendix A: Table A-1 & Table A-2)

All the stimuli (L2 words) for the experiment were presented exactly in the middle of the computer screen in black lower-case with 52 Time New Roman font size together with a white background. The context distracters were placed directly to the right above the presenting stimuli. The position of the stimuli and the distracters were consistent with the research studied by Schwieter and Sunderman (2008). This position also was developed from the studies by Bloem and La Heij (2003) where they presented their context words and pictures exactly at the center below the stimuli which could be considered as one of the limitations of their studies because it could possibly lead to visual masking effect induced by context distracters. Thus, this new experimental display of both stimuli and distracters were designed to avoid that problem of inconsistency. The figures below were the best illustration of the position of the stimuli together with the context distracters for this experimental study.

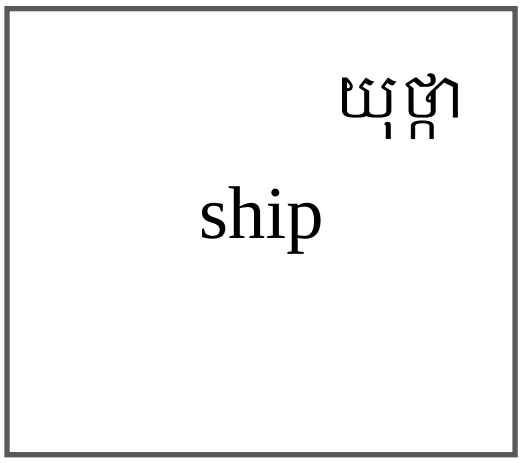
According to Schwieter and Sunderman (2008), this experimental design especially the position of the presenting stimuli and context distracters could avoid the problem of visual effects which could easily occur if the context distracters were presented directly above or below the presenting stimuli.



Semantically related context picture distracter



Semantically unrelated context picture distracter



Semantically related context word distracter

Semantically unrelated context word distracter

Figure 3-2 the Position of Presenting Stimuli and Context Distracters

The context pictures being used in this experiment were line drawing from Snodgrass and Vanderwart (1980). All the context picture distracters were all identically-matched in size of line drawing (128 x 197 cm). 80 line drawing pictures were extracted from Snodgrass and Vanderwart (1980) to be used in this experiment with 40 semantically related pictures and 40 semantically unrelated pictures to the stimuli. Each picture from Snodgrass and Vanderwart (1980) were used once only for each subject during the experiment. See the examples below:

umbrella

tomato

tree

Trumpet

Figure 3-3 Samples of Line Drawing Context Picture Distracters

Once all the stimuli together with the context word and picture distracters were designed, they were all coded into DMDX software (version 5.1.2.1 Forster & Forster, 2003) in order to run the experiment. (See appendix A, table A-5)

All the 40 target stimuli with 4 groups of distracters such as semantically related context word distracters, semantically unrelated context word distracters, semantically related context picture distracters, and semantically unrelated context picture distracters were all classified into two blocks for each test. Two tests with 2 blocks each were run at 0 ms of SOA and the other two tests with two blocks each were run at +500 ms of SOA. (See appendix A, table A-4)

The first two tests were about context word and picture distracters in bilinguals' language speech production task running at 0 ms of SOA. There were two blocks designed for each test. Block #1 consisted of 40 stimuli with 20 semantically related context distracters, and 20 semantically unrelated context distracters. Block #2

similarly comprised 40 stimuli with 20 semantically related context distracters, and 20 semantically unrelated context distracters. As there were 40 stimuli, each stimulus was used twice with semantically related and unrelated context picture distracters and the other two times with semantically related and unrelated context word distracters. In overall, each stimulus was presented four times during the language speech productions at 0 ms of SOA. (See appendix A, table A-4)

The last two tests were about context word and picture distracters in bilinguals' language speech production task running at +500 ms of SOA. Likewise, each test comprised two blocks. Identically, Block #1 consisted of 40 stimuli with 20 semantically related context distracters and 20 semantically unrelated context distracters. Block #2 similarly comprised the other 40 stimuli with 20 semantically related context distracters and 20 semantically unrelated context distracters. However, each test was operated at +500 ms of SOA where the stimulus appeared 500 milliseconds before the context distracters.

In summary, there were two blocks for each test and there were four tests for the whole experiment for each subject: Test I: Language Speech Production Task with Context Word Distracters at 0 ms of SOA, Test II: Language Speech Production Task with Context Picture Distracters at 0 ms of SOA, Test III: Language Speech Production Task with Context Word Distracters at +500 ms of SOA and Test IV: Language Speech Production Task with Context Picture Distracters at +500 ms of SOA. The start of each test was rotated between context word and picture distracters together with the stimulus onset asynchrony (SOA). For instance, when the first subject started with context word distracter, the second subject would automatically start with context picture distracters and vice versa. Additionally, if the first subject started with 0 ms of SOA, the second subject would begin with +500 ms of SOA and vice versa. This rotation strategy continued to all the subjects until the whole experiment was completed. Among the four tests, two tests were run simultaneously at 0 ms of SOA while the other two tests were operated at +500 ms of SOA with 500 milliseconds of delay time for both context word and picture distracters.

Validity of the Presenting Stimuli and Context Distracters

Step one: stimuli and context distracters were developed by adapting from Schwieter and Sunderman (2008) to adjust them to fit into Khmer-English context.

Step two: stimuli and context distracters were corrected and adjusted in accordance with the comments and recommendations made by advisory committee.

Step three: stimuli and context distracters were checked by three independent experts specialized in linguistic to evaluate their suitability.

Step four: stimuli and context distracters were finalized after getting feedback from experts. Then, the Item-Objective Congruence (IOC) was used to evaluate each item in the questionnaire and the relation between stimuli and context distracters based on the score ranged from -1 to +1.

Agree = +1

Not sure = 0

Disagree = -1

The item with score lower than 0.5 was revised. The item with score higher than 0.5 was reserved for the experiment (See appendix C, table C-1 & Table C-2).

Reliability of DMDX Software Program for Data Collection

The reliability of the research instrument was checked in order to ensure that the responses collected through this program were reliable and consistent. Regarding the DMDX software program for running the experiment, the researcher firstly coded the approved presenting stimuli and context distracters from three independent experts. Later, the researcher brought the software with already written syntax of representing stimuli together with context picture and word distracters to discuss with thesis advisor for constructive feedback. Next, the researcher brought the software program to consult with the expert to discuss about the appropriateness of the presenting stimuli and context distracters and also to be certain about the fluency and consistency of each trial for the experiment. After receiving feedbacks from the expert, the researcher made final updated to the presenting stimuli and context distracters in accordance to the expert's comments, especially to edit the consistency of font size of the presenting stimuli, context distracters. (See appendix B, table B-1). Prior to the real data collection, the researcher conducted the pilot study with 5 Cambodian students from BELTEI International University. After that, the researcher discussed the results with the advisor for approval before real data collections.

Procedures

1. Language History Questionnaire

All the subjects were asked to complete the survey in order to find out their language history, education, and language experiences. This survey was very significant for the researcher to later analyze and conclude this study result relevant to less and high- proficient bilinguals' language proficiency. This survey was adapted from Schwieter and Sunderman (2008). (See Appendix B: Language History Questionnaires)

2. Familiarization

Before running the experiment, the familiarization test was conducted with each subject. In this familiarization, all the subjects were asked to translate each stimulus into their L1 as many stimuli as possible, and meanwhile they had to ignore words that they were uncertain. (See Appendix B: Familiarization Task)

3. Practice Phase

Prior to running the experiment, each subject was asked to start with 4 practice tests comprising of 10 trials each. These tests represented the real tests consisting of Test I: Language Speech Production Task with Context Word Distracters at 0 ms of SOA, Test II: Language Speech Production Task with Context Picture Distracters at 0 ms of SOA, Test III: Language Speech Production Task with Context Word Distracters at +500 ms of SOA and Test IV: Language Speech Production Task with Context Picture Distracters at +500 ms of SOA. Each practice test would take at least 1.5 minutes where every individual subject received verbal instruction and explanation from the researcher. This objective was to ensure that all the subjects understood the procedures and goals of the experiment.

4. Test Phase

Each subject firstly involved with 0 ms of SOA test where both stimulus and distracter appeared simultaneously. Individual subject was asked to produce response in L1 by translating the presenting stimuli from English (L2) into Khmer (L1) while at the meantime they were being distracted by context word distracters in L1 (Khmer) and context picture distracters. For test I, the distracters were context words in L1 (Khmer) with semantic relatedness and unrelatedness to the presenting stimuli. Thus, the same stimulus was used twice in test I. For test II, the distracters

were semantically related and unrelated context picture distracters. Likewise, each stimulus was used twice for test II. The stimuli and context distracters for test I and II were simultaneously run at 0 ms of SOA and each trial was randomized during the experiment. The software program DMDX firstly started with a fixation point known as a plus sign (+) in the middle of the computer screen against the white background. The fixation point, stimuli and context word distracters were all designed in black color and were typed in small cases. Similarly, context picture distracters were black and white line drawings adapted from Snodgrass and Vanderwart (1980).

The fixation point (+) remained for 500 milliseconds in the middle of the screen before it disappeared and then the stimuli and context distracters instantly followed simultaneously. The context distracters appeared to the right above the stimuli developed from Schwieter and Sunderman (2008). After the stimulus and context distracter were shown on the screen simultaneously, each subject had to translate each stimulus into their L1 as quickly as possible by ignoring the context distracters. The subjects were expected to response within the time limit of 3000 millisecond, and then the stimulus and context distracter disappear with blank computer screen lasted for 5001 millisecond. Later, the new fixation point (+) in the next trial came for 500 milliseconds and then was replaced by both stimulus and context distracter simultaneously and each subject needed to response as quickly as possible within 3000 milliseconds, and then the stimulus and context distracter disappeared with blank screen remained for 5001 milliseconds. This running of DMDX continued until all the trials (N=80) for both blocks in each test were successfully completed. For test II, the process was the same, but the context word distracters were replaced by context picture distracters. Each test I and II took at least 10 minutes equally from each subject during the experiment.

Likewise for test III & IV, the presenting stimuli and context distracters were the same to test I & II. However, in test III & IV the stimulus onset asynchrony (SOA) was operated at +500 ms which the delayed time for the context distracters appeared 500 milliseconds later than the presenting stimuli. In other words, the presenting stimuli appeared first and context distracters followed after 500 ms. Like test I & II, the reaction time and accuracy from each subject in test III & IV were recorded. Additionally, the time for test III and IV similarly took at least 10 minutes.

The procedures of this experiment created more variance and randomization for every subject as the tests and trials were all randomized. The starting for each subject was also different. For example, when the first subject started with context word distracters, the second person automatically began with context picture distracters and vice versa. This kind of running continued until all the subjects completed the experiment. This experimental procedure was adapted from Schwieter and Sunderman (2008) together with Bloem and La Heij (2003) who repeatedly used context distracters during the experiment. However, this new study used context distracters only once for each test. Additionally, the SOA also operated randomly from one subject to another. For instance, if the first subject started with 0 ms of SOA, the second person definitely started with +500 ms of SOA.

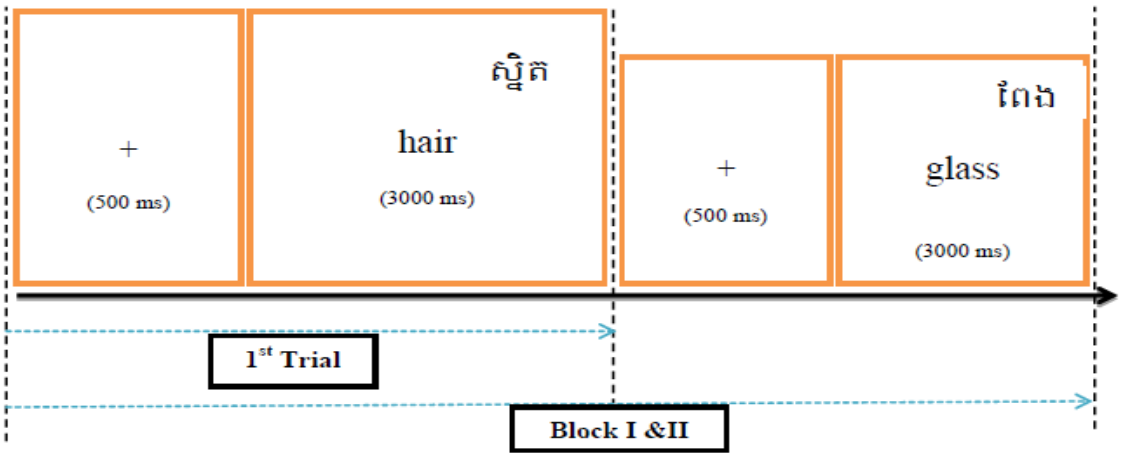


Figure 3-4 Examples of Language Speech Production Task with Context Word Distracters at 0 ms of SOA

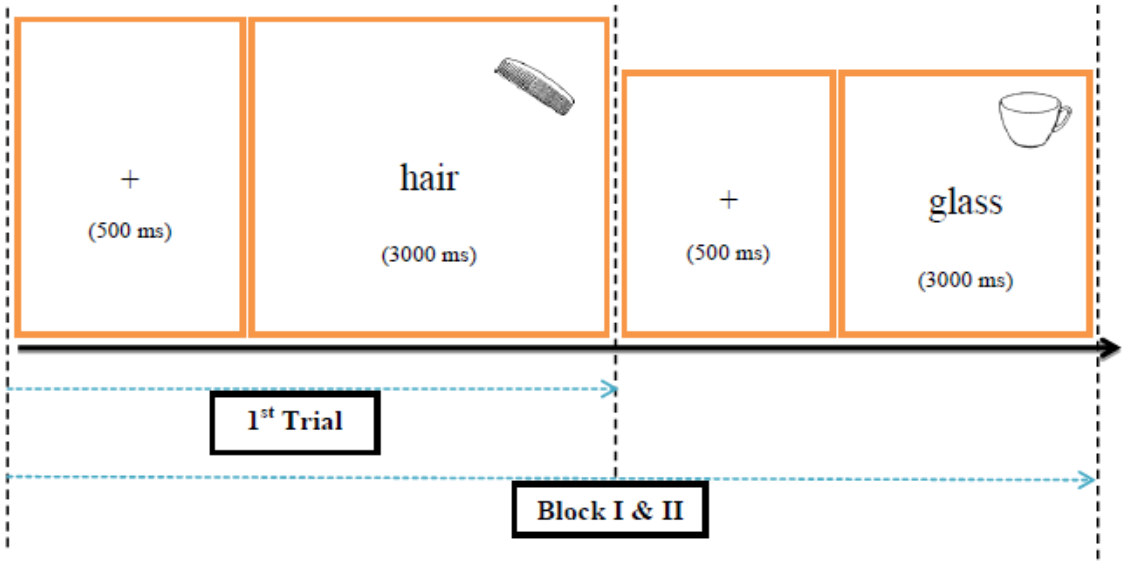


Figure 3-5 Examples of Language Speech Production Task with Context Picture Distracters at 0 ms of SOA

The other two tests were identical in term of the number of stimuli and context distracters Also, the trials were run randomly. However, the stimulus onset asynchrony between the stimuli and context distracters were different. The last two tests were operated at +500 ms of SOA where the context word and picture distracters appeared 500 milliseconds after the stimuli. This experiment firstly began with the fixation point (+) lasted for 500 milliseconds in the middle of the computer screen. After that, the stimuli firstly appeared for 500 ms in L2 (English) and immediately after 500 millisecond, they were followed by the random context distracters. Each subject had to produce response by translating each stimulus into their L1 as quickly as possible by ignoring any form of context distracters. (See the figure 3.6 & 3.7)

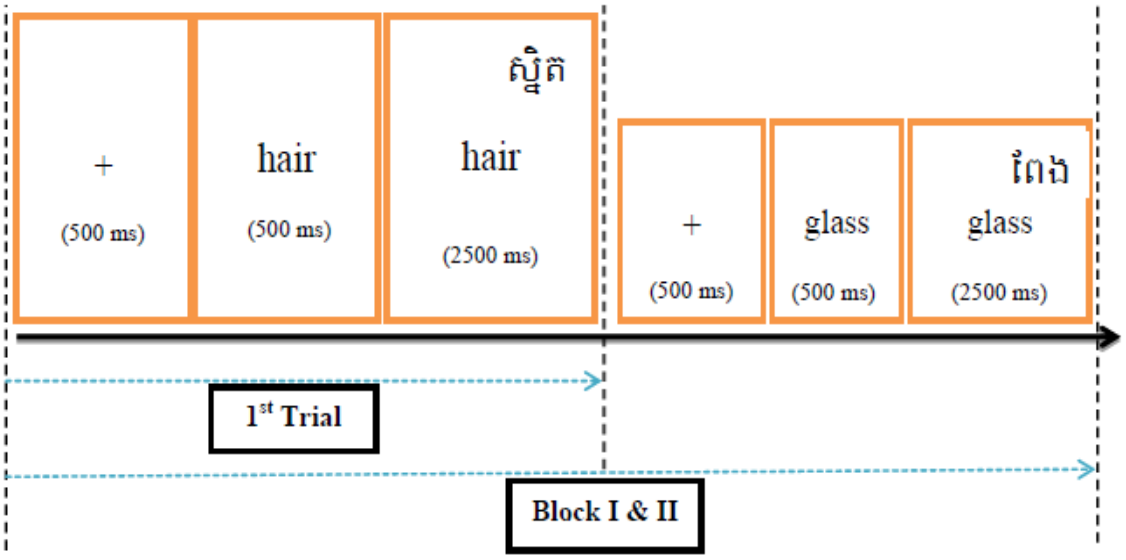


Figure 3-6 Examples of Language Speech Production Task with Context Word Distracters at +500 ms of SOA

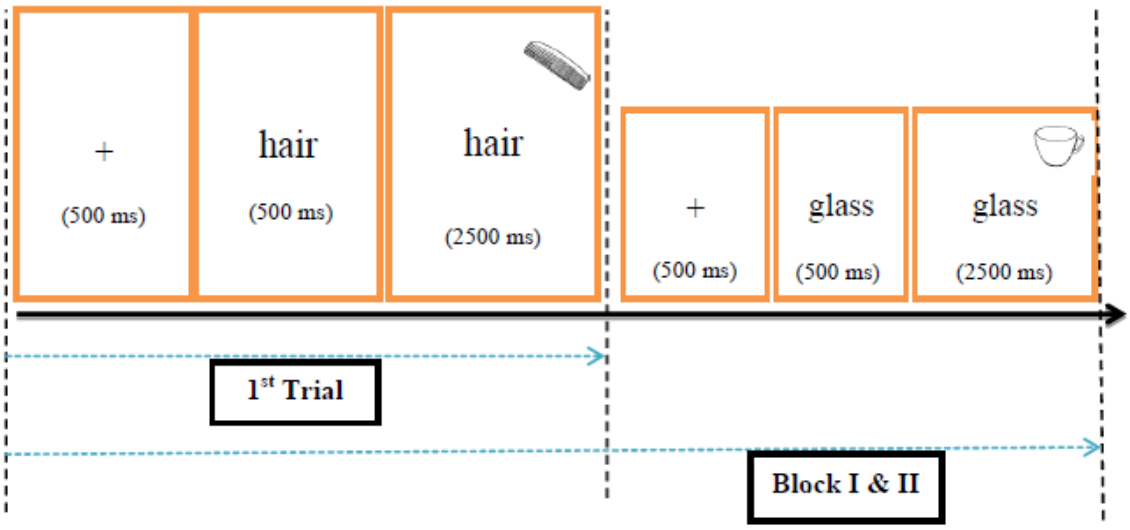


Figure 3-7 Examples of Language Speech Production Task with Context Picture Distracters at +500 ms of SOA

Data Collection

The dependent variables to be studied in this behavioral experiment consisted of accuracy and the reaction times (RTs). The reaction times and response accuracy from each subject were recorded into the software program called DMDX

version 5.1.2.1. The recorded audio files from each subject were carefully checked to verify its accuracy. Only the reaction times (RTs) from accurate responses were included into the analysis. The reaction times (RTs) from incorrect responses were treated as errors and were excluded from the analyses.

Data Analysis

The results obtained from the software program DMDX were compared and analyzed by the means of statistical tools.

1. The mean of reaction times and standard deviation (SD) were calculated.
2. Independent t-test was used to compare the results of language proficient background in L1 and L2 of less-proficient and high-proficient subjects.
3. Three way (2x2x2) of repeated measurement ANOVA was used to analyze the effects of context (word & picture) relatedness (related & unrelated) and proficiency level (less & high) on bilinguals' language speech productions.
4. The semantic relatedness effect of both groups of less-proficient and high-proficient bilinguals were calculated by subtracting the mean of reaction times for the semantically related context distracters from semantically unrelated context distracters (RTs of unrelated contexts – RTs of related contexts) for both context words and picture distracters. The positive results showed that there were semantic facilitations from the context distracters. However, the negative results illustrated that there were semantic interferences from the context distracters.

CHAPTER 4
RESULTS

The results obtained from this study were presented in this chapter. Prior to data analysis, it would be great to briefly revise all the four research objectives of this study as followings: 1) to find out the effects of context distracters on bilinguals' language speech productions at 0 ms of SOA and +500 ms of SOA, 2) to find out the effects of semantically related and unrelated context word and picture distracters on bilinguals' language speech productions, 3) to compare the effects of semantically related and unrelated context word and picture distracters on less-proficient and high-proficient bilinguals' language speech productions and 4) to compare semantic relatedness effect (SRE) of context distracters on less-proficient and high-proficient group and to draw conclusions about bilinguals' locus of concept selections during their language speech productions.

The data analyses and results were divided into 9 main points as below:

1. The general data of less-proficient group of bilinguals
2. The general data of high-proficient group of bilinguals
3. Comparison of language proficiency level between less-proficient and high-proficient bilinguals in their L1 (Khmer) and L2 (English)
4. Mean of reaction times (milliseconds) from the effects of context, relatedness and proficiency on bilinguals' language speech production at 0 ms of SOA
5. The effects of context, relatedness and proficiency on bilinguals' language speech production at 0 ms of SOA
6. Semantic relatedness effect (SRE) on bilinguals' concept selections at 0 ms of SOA
7. Mean of reaction times (milliseconds) from the effects of context, relatedness and proficiency on bilinguals' language speech production at +500 ms of SOA
8. The effects of context, relatedness and proficiency on bilinguals' language speech production at +500 ms of SOA
9. Semantic relatedness effect (SRE) on bilinguals' concept selections at +500 ms of SOA.

The data to be interpreted in this chapter were all the correct responses from each subject. The incorrect responses which were basically caused by wrong translation and exceeding the time limit were excluded from the analyses. The results were separately analyzed into two different experimental phases:

Experiment 1: effects of context distracters on bilinguals' language speech production and concept selection at 0 ms of SOA

Experiment 2: effects of context distracters on bilinguals' language speech production and concept selection at +500 ms of SOA

The symbols to be used in this chapter:

n	=	number of subjects
M	=	mean
SD	=	standard deviation
MS	=	mean of squares
SS	=	sum of squares
F	=	the value of the F-statistic
df	=	degree of freedom
t	=	the values of the t-statistic
p	=	p - value
η^2	=	effect size (Wilks' Lambda)
d	=	effect size (Cohen's d)

General Data of Less-proficient Group of Bilinguals

There were 24 subjects in less-proficient group of bilinguals from BELTEI International University. There were 14 (58.30%) females and 10 (41.70%) males. There were 23 (95.80%) subjects aged between 18-20 years old and only 1 (4.20%) subject aged between 21-23 years old. All the 24 (100%) subjects did not have visual problem. Identically, all the 24 (100%) subjects had no past history accident severely affecting their brain. All the 24 (100%) subjects used Khmer as their first language and also home spoken language. There was 1 (4.17%) subject stated that they rarely used English at school, 4 (16.66%) subjects stated that they sometimes used English at school, 18 (75.00%) subjects stated that they used English very often at school and only 1 (4.17%) subject stated that they always used English at school. Additionally, among the 24 subjects of less-proficient bilinguals, 2 (8.33%) subjects claimed that they rarely used English with their friends, 14 (58.34%) subjects claimed that they sometimes used English with their friends and, 8 (33.33%) subjects claimed that they used English with their friends very often. Moreover, regarding the duration of learning English of less-proficient bilinguals, 1 (4.20%) subject has spent less than 2 years acquiring English, 3 (12.50%) subjects have spent from 2-3 years acquiring English, 12 (50.00%) subjects have spent from 4-5 years acquiring English and 8 (33.30%) subjects have spent from 6-7 years acquiring English. (See table 4.1)

Table 4-1 General data of less-proficient group (n=24)

General Data	Number	Percentage
Gender		
Female	14	58.30
Male	10	41.70
Age		
18-20 years old	23	95.80
21-23 years old	1	4.20
V**isual problem**		
Yes	0	0.00
No	24	100.00
Past history accident severely affecting the brain		
Yes	0	0.00
No	24	100.00
First language		
Khmer	24	100.00
Other	0	0.00
Home spoken language		
Khmer	24	100.00
Other	0	0.00
English use at school		
Rarely	1	4.17
Sometimes	4	16.66
Very often	18	75.00
Always	1	4.17
English use with friends		
Rarely	2	8.33
Sometimes	14	58.34
Very often	8	33.33
Duration of learning English		
Less than 2 years	1	4.20
2-3 years	3	12.50
4-5 years	12	50.00
6-7 years	8	33.30

General Data of High-proficient Group of Bilinguals

There were 24 subjects in high-proficient group of bilinguals from BELTEI International University. There were 10 (41.70%) females and 14 (58.30%) males. There was 1(4.20%) subject aged less than 18 years old, 2 (8.30%) subjects aged between 18-20 years old, 16 (66.70%) subjects aged between 21-23 years old and 5 (20.80%) subjects aged more than 23 years old. All the 24 (100%) subjects did not have visual problem. Identically all the 24 (100%) subjects had no past history accident severely affecting their brain. All the 24 (100%) subjects used Khmer as their first language and also home spoken language. There were 4 (16.70%) subjects stated that they sometimes used English at school and 20 (83.30%) subjects stated that they used English very often at school. Additionally, among the 24 subjects of high-proficient bilinguals, 10 (41.70%) subjects claimed that they sometimes used English with their friends and 14 (58.30%) subjects claimed that they used English very often with their friends. Moreover, regarding the duration of learning English of high-proficient bilinguals, 2 (8.33%) subjects have spent from 2-3 years acquiring English, 3 (12.50%) subjects have spent from 4-5 years acquiring English, 17 (70.84%) subjects have spent from 6-7 years acquiring English and 2 (8.33%) subjects have spent from 8-9 years acquiring English. (See table 4.2)

Table 4-2 General data of high-proficient group (n=24)

General Data	Number	Percentage
Gender		
Female	10	41.70
Male	14	58.30
Age		
Less than 18 years old	1	4.20
18-20 years old	2	8.30
21-23 years old	16	66.70
More than 23 years old	5	20.80
Visual problem		
Yes	0	0.00
No	24	100.00
Past history accident severely affecting the brain		
Yes	0	0.00
No	24	100.00
First language		
Khmer	24	100.00
Other	0	0.00
Home spoken language		
Khmer	24	100.00
Other	0	0.00
English use at school		
Sometimes	4	16.70
Very often	20	83.30
English use with friends		
Sometimes	10	41.70
Very often	14	58.30
Duration of learning English		
2-3 years	2	8.33
4-5 years	3	12.50
6-7 years	17	70.84
8-9 years	2	8.33

Comparison of language proficiency level between less-proficient and high-proficient bilinguals in their L1 (Khmer) and L2 (English)

The data from the language history questionnaire was analyzed by using independent sample t-test in order to compare the language proficient level in L1 (Khmer) and L2 (English) of less-proficient and high-proficient subjects. The results showed that there was no statistical significant difference in Khmer language proficiency between less-proficient and high-proficient group of bilinguals ($p>.05$). This meant that regardless of English language both less-proficient and high-proficient bilinguals have similar level of Khmer language proficiency in all the four aspects: reading, writing, speaking and listening. However, the English language proficiency level of less-proficient and high-proficient subjects was shown significantly different at statistical level of .01. High-proficient bilinguals had better English language proficiency than less-proficient bilinguals in all the four aspects: reading, writing, speaking and listening. (See table 4.3)

Table 4-3 Comparison of language proficiency level between less-proficient and high-proficient bilinguals in their L1 (Khmer) and L2 (English)

	Less-proficient Bilinguals (n=24)		**High-proficient Bilinguals (n=24)**		**t**	**p**
	M	**SD**	**M**	**SD**		
Khmer Reading Proficiency	3.96	.69	4.21	.41	1.52	.14
Khmer Writing Proficiency	3.96	.75	4.08	.65	.62	.54
Khmer Speaking Proficiency	4.13	.74	4.25	.61	.64	.53
Khmer Listening Proficiency	4.17	.92	4.21	.59	.19	.85
English Reading Proficiency	2.63	.49	3.87	.34	10.23**	.00
English Writing Proficiency	2.58	.65	3.70	.69	5.80**	.00
English Speaking Proficiency	3.00	.42	3.63	.49	4.73**	.00
English Listening Proficiency	2.92	.41	3.70	.46	6.27**	.00

** $p < .01$

Mean of reaction time (milliseconds) from the effects of context (word & picture), relatedness (semantically related & unrelated) and proficiency (less & high) on bilinguals' language speech production at 0 ms of SOA

According to the results of mean from various types of context distracters above, the reaction time of bilinguals were faster with context word distracters (M = 1029.40, SD = 118.64) than context picture distracters (M = 1091.47, SD = 142.68). Regarding type of context distracters, less-proficient group spent longer reaction times than high-proficient group in both context pictures and words during their language speech productions. Regarding relatedness, less-proficient group of bilinguals similarly spent longer reaction times than high-proficient bilinguals in both semantically related and unrelated context distracters. Regarding semantic relatedness, semantically related context picture distracters (M = 1068.45, SD = 144.38) led to faster reaction time than semantically unrelated context picture distracters (M = 1114.49, SD = 138.64). However, semantically related context word distracters (M = 1051.49, SD = 138.64) caused slower reaction time than semantically unrelated context word distracters (M = 1007.31, SD = 111.87). Last, high-proficient group of bilingual could perform faster in both semantically related and unrelated context picture and word distracters when comparing to less-proficient group of bilinguals. (See table 4.4)

Table 4-4 The mean of reaction times (milliseconds) from the effects of context, relatedness and proficiency on bilinguals' language speech production at 0 ms of SOA

	M	SD
1. Less-proficient group	1090.02	125.53
2. High-proficient group	1030.83	127.48
3. Context picture distracters	1091.47	142.68
4. Context word distracters	1029.40	118.64
5. Semantically related	1059.97	122.42
6. Semantically unrelated	1060.90	111.83
7. Context picture distracters from less-proficient group	1126.93	135.26
8. Context picture distracters from high-proficient group	1056.00	132.52
9. Context word distracters from less-proficient group	1053.19	105.23
10. Context word distracters from high-proficient group	1005.68	119.51
11. Semantically related context distracters from less-proficient group	1101.16	123.08
12. Semantically related context distracter from high-proficient group	1018.78	109.26
13. Semantically unrelated context distracters from less-proficient group	1078.89	112.20
14. Semantically unrelated context distracters from high-proficient group	1042.90	110.87
15. Semantically related context picture distracters	1068.45	144.38
16. Semantically unrelated context picture distracters	1114.49	138.64
17. Semantically related context word distracters	1051.49	122.22
18. Semantically unrelated context word distracters	1007.31	111.87
19. Semantically related context picture distracters from less-proficient group	1122.74	135.91

Table 4-4 The mean of reaction times (milliseconds) from the effects of context, relatedness and proficiency on bilinguals' language speech production at 0 ms of SOA (Cont.)

	M	SD
20. Semantically related context picture distracters from high-proficient group	1014.16	134.07
21. Semantically unrelated context picture distracters from less-proficient group	1131.13	139.24
22. Semantically unrelated context picture distracters from high-proficient group	1097.84	138.97
23. Semantically related context word distracters from less-proficient group	1079.58	117.91
24. Semantically related context word distracters from high-proficient group	1023.39	122.38
25. Semantically unrelated context word distracters from less-proficient group	1026.66	96.86
26. Semantically unrelated context word distracters from high-proficient group	987.96	124.14

The effects of context, relatedness and proficiency on bilinguals' language speech production at 0 ms of SOA

A three way ($2\times2\times2$) repeated measurement ANOVA was performed on the mean of reaction times (RTs) with context (word & picture) and relatedness (related & unrelated) as within-subject factor and group (less & high proficiency) as between-subject factor.

The main results of $2\times2\times2$ repeated measurement ANOVA were reported in Table 4-5. The main findings were the following:

There was no significant different effect of proficiency on reaction times (RTs) between less-proficient and high-proficient subjects during the language speech production test $F(1, 46) = 3.35$, $p = .07$. The main effect of context (word & picture) on language speech production was significantly different. The mean of reaction times

under context word distracters (M = 1029.40, SD = 118.64) was faster than context picture distracters (M = 1091.47, SD = 142.68), F (1, 46) = 16.78, p< .01, η^2= .26. Relatedness (semantically related & unrelated context distracters) did not have significant effect on bilinguals' language speech production F (1, 46) = .02, p = .88, η^2= .001.

Regarding interaction effect, there was no statistical significant interaction effect between context and proficiency F (1, 46) = .60, p< .44, η^2= .01. However, there was statistical significant interaction effects between relatedness and proficiency level F (1, 46) = 14.80, p< .01, η^2= .24. There was also statistical significant interaction effects between context and relatedness F (1, 46) = 68.87, p< .01, η^2= .60. Additionally, there was statistical significant interaction between context, relatedness and proficiency level F (1, 46) = 7.06, p< .01, η^2=.13.

This interaction effects showed that semantically related and unrelated context picture and word distracters could have different effects on the reaction times of less-proficient and high-proficient bilinguals during their language speech production. In other words, less-proficient and high-proficient bilinguals would produce different reaction times (RTs) when they were translating the same presenting stimuli from L2 (English) to L1 (Khmer) while they were simultaneously being distracted by semantically related and unrelated context picture and word distracters.

Table 4-5 Result of $2 \times 2 \times 2$ repeated measurement ANOVA about the effects of context, relatedness and proficiency on reaction times (RTs) of bilinguals' language speech production at 0 ms of SOA (n = 48)

	SS	**df**	**MS**	**F**	**p**	η^2
Between Subjects						
Proficiency	168149.74	1	168149.74	3.35	.07	.07
Error	2310207.04	46	50221.89			
Within-subject						
Context	184921.08	1	184921.08	16.78**	.00	.26
Relatedness	41.56	1	41.56	.02	.88	.001
Context × proficiency	6622.58	1	6622.58	.60	.44	.01
Relatedness × proficiency	25824.50	1	25824.50	14.80**	.00	.24
Context × relatedness	97662.85	1	97662.85	68.87**	.00	.60
Context × relatedness × proficiency	10017.94	1	10017.94	7.06*	.01	.13
Error	65234.88	46	1418.15			

* $p < .05$, ** $p < .01$

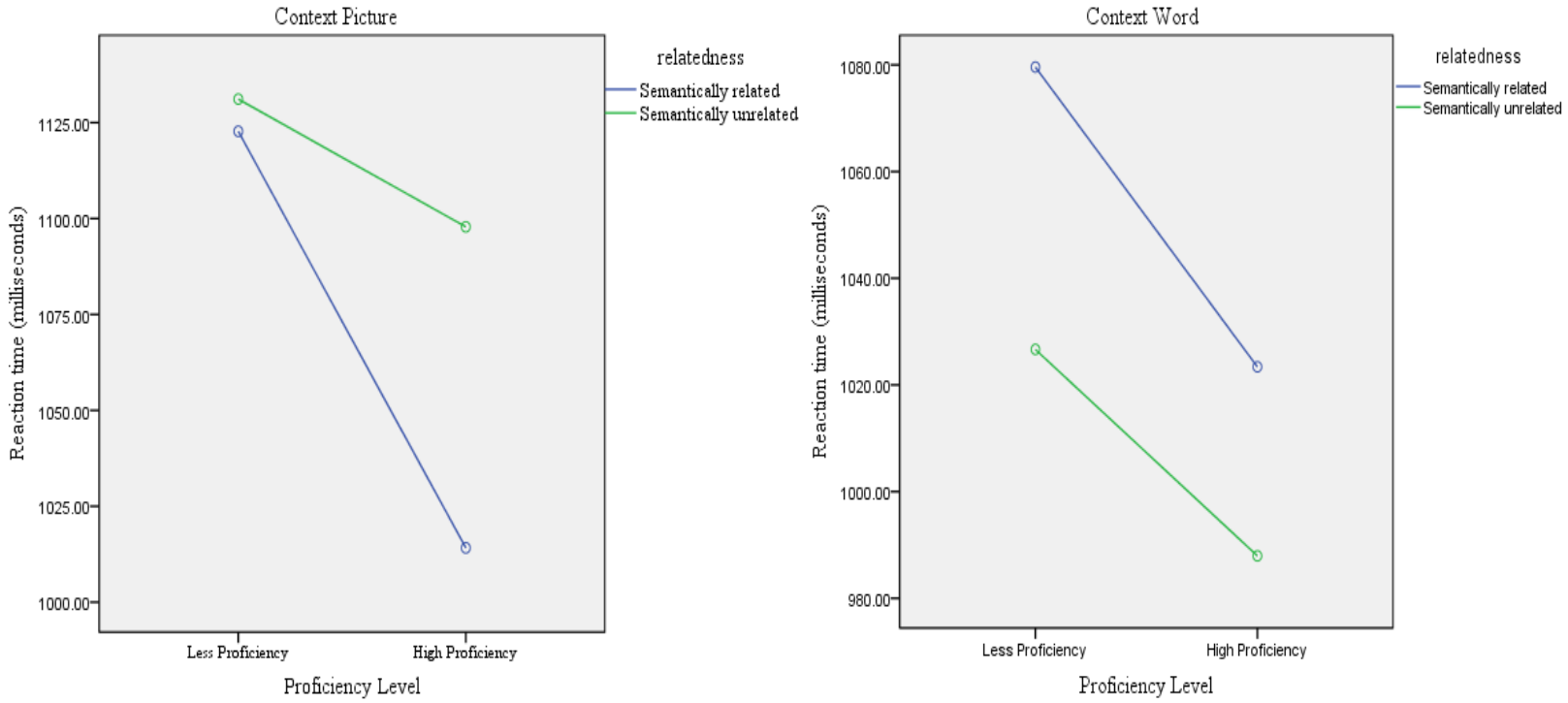


Figure 4-1 The interaction effect among context, relatedness and proficiency on bilinguals' language speech production at 0 ms of SOA

There was the significant interaction effect among context, relatedness and proficiency. The mean of reaction times under semantically related context picture distracters of high-proficient bilinguals (M= 1014.16, SD= 134.07) was faster than that of less-proficient bilinguals (M=1122.74, SD= 135.91). This meant that semantically related context pictures facilitated language speech production and concept selections to high-proficient bilinguals more than less-proficient bilinguals. This result supported Selected by Proficiency (SbP) Model of Schwieter and Sunderman (2008) together with Concept Selection Model (CSM) of Bloem and La Heij (2003) who claimed that semantically related context picture distracters increased semantic facilitation to high-proficient learners. In other words, high-proficient bilinguals could conceptualize the semantic representations from the semantically related context pictures.

However, the reaction time under semantically related context word distracters from less-proficient bilingual (M = 1079.58, SD = 117.91) was slower than that of high-proficient bilinguals (M = 1023.39, SD = 122.38). In other words, semantically related context word distracters caused more semantic interference among less-proficient bilinguals. Regarding semantically unrelated context word and picture distracters, less-proficient bilinguals in overall spent longer reaction time than high-proficient bilinguals.

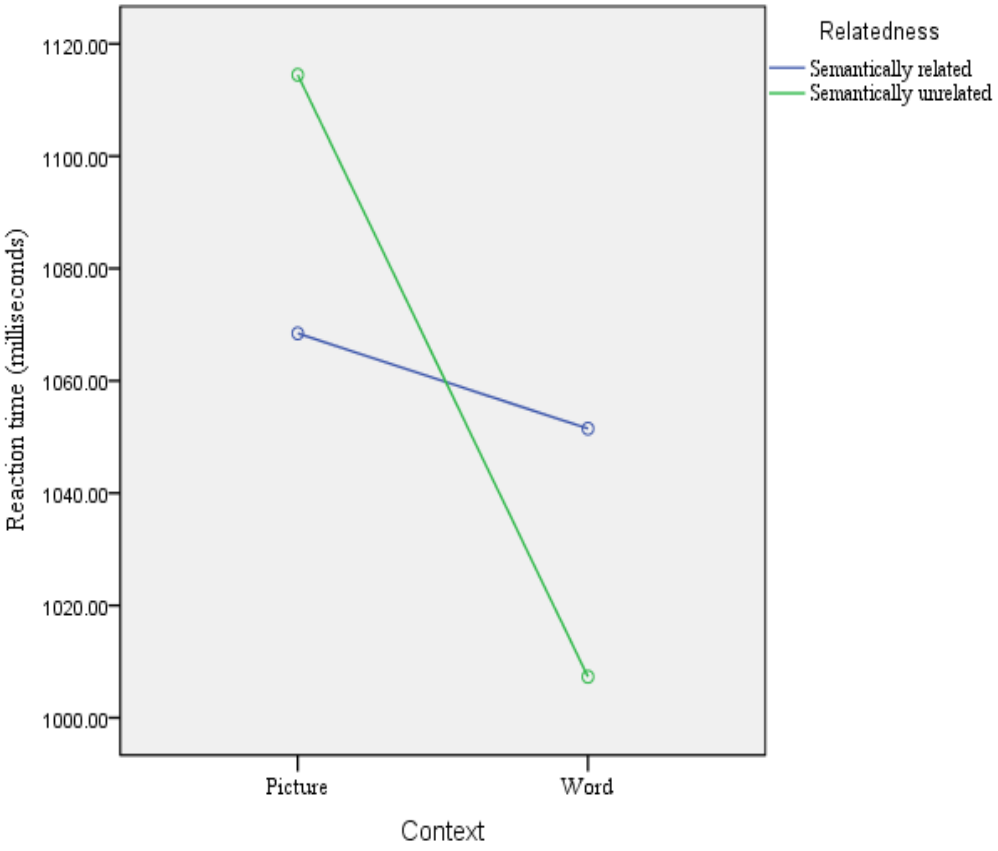


Figure 4-2 The interaction effect between context and relatedness on bilinguals' language speech production at 0 ms of SOA

There were the interaction effects between context and relatedness. The mean of reaction time under semantically related context picture distracters (M = 1068.45, SD = 144.38) was faster than the mean of reaction time under semantically unrelated context picture distracters (M= 1114.49, SD = 138.64). In contrast, the mean of reaction time under semantically related context word distracters (M = 1051.49, SD= 122.22) caused slower reaction time than the mean of reaction time under semantically unrelated context word distracters (M = 1007.31, SD = 111.87). This meant that context pictures with semantic relatedness led to semantic facilitation which assisted bilinguals' language speech production while context words with semantic relatedness caused semantic interference which slowed down bilinguals' language speech production.

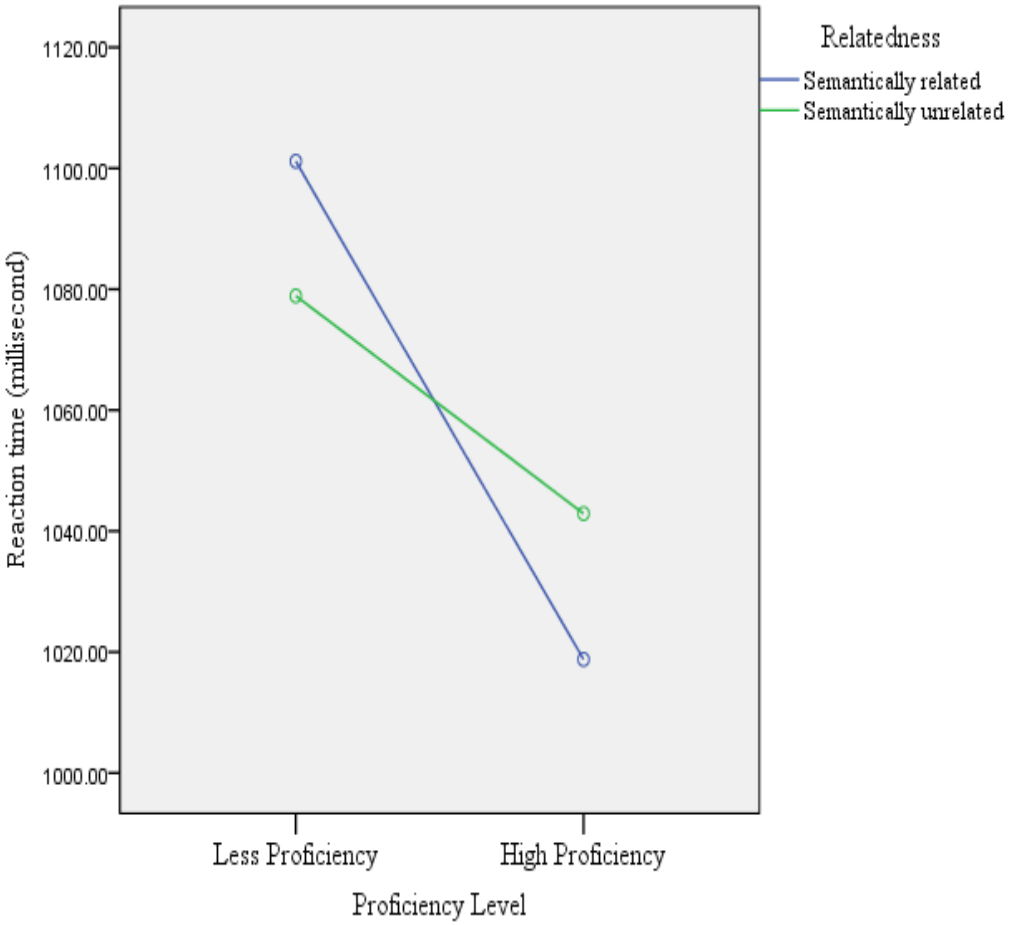


Figure 4-3 The interaction effect between relatedness and proficiency on bilinguals' language speech production at 0 ms of SOA

There was the interaction effect between relatedness and proficiency level. Less-proficient bilinguals (M= 1101.16, SD = 123.08) spent longer reaction time than high-proficient bilinguals (M=1018.78, SD= 109.26) when semantically related context distracters were being presented. Similarly, less-proficient bilinguals (M = 1078.89, SD = 112.20) spent longer reaction time than high-proficient bilinguals (M = 1042.90, SD = 110.87) when semantically unrelated context distracters were presented. To conclude, more semantic interference which caused slower reaction time occurred to less-proficient bilinguals, especially when semantically related context distracters were being shown.

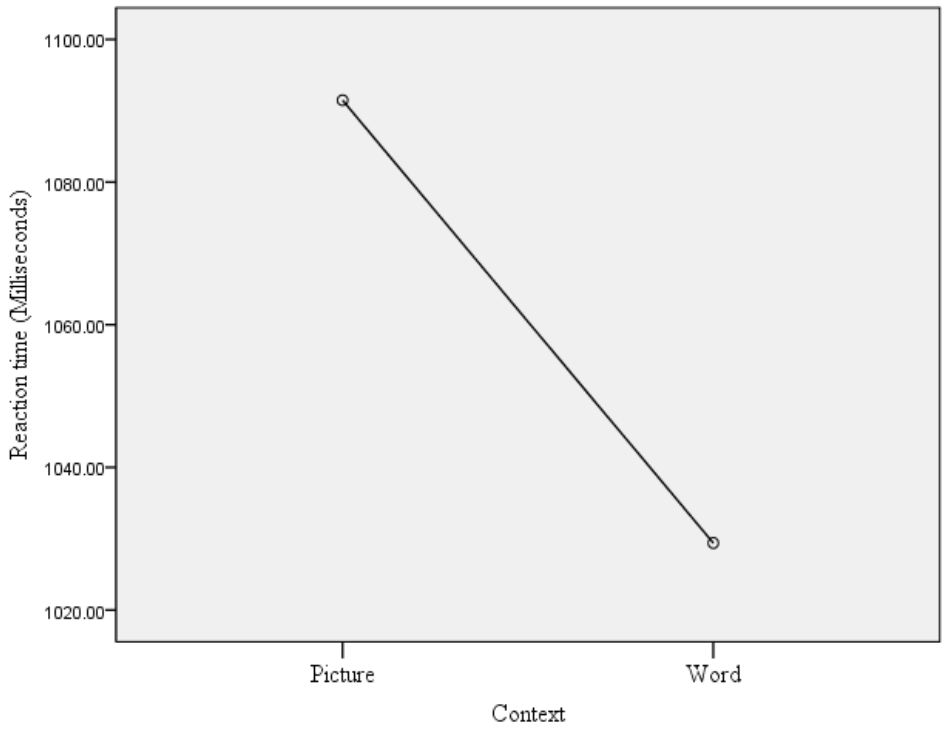


Figure 4-4 The Effect of Context Distracters on Bilinguals' Language Speech Production at 0 ms of SOA

There was a significant effect of context on bilinguals' language speech production. The mean of reaction time of bilinguals' language speech production under context word distracters (M = 1029.40, SD = 118.64) was faster than the mean of reaction time under context picture distracters (M = 1091.47, SD = 142.68). This meant that bilinguals could produce faster reaction time with context word distracters than context picture distracters.

Semantic relatedness effects (SRE) on bilinguals' concept selections at 0 ms of SOA

Table 4-6 Mean of reaction time (RTs), percentage of accuracy (%Acc), and semantic relatedness effects (SRE) at 0 ms of SOA

	Less-proficient group (n=24)				**High-proficient group (n=24)**			
	word		**picture**		**word**		**picture**	
	RT	**%Acc**	**RT**	**%Acc**	**RT**	**%Acc**	**RT**	**%Acc**
Unrelated	1026.66	87.08	1131.13	91.80	987.96	94.69	1097.84	96.77
Related	1079.58	88.23	1122.74	93.02	1023.39	95.00	1014.16	94.17
SRE[1]	-52.92		+8.39		-35.43		+83.68	

Table 4-7 Mean of reaction time (RTs), accuracy (Acc), and semantic relatedness effects (SRE) from Schwieter and Sunderman (2008) and Bloem and La Heij (2003) at 0 ms of SOA

	Schwieter and Sunderman (2008)								**Bloem and La Heij (2003)**			
	Less-proficient group (n = 29)				**High-proficient group (n =25)**				**High-proficient group (n=26)**			
	word		**picture**		**word**		**picture**		**word**		**picture**	
	RT	**%Acc**	**RT**	**%Acc**	**RT**	**%Acc**	**RT**	**%Acc**	**RT**	**%Acc**	**RT**	**%Acc**
Unrelated	1063	96.30	1140	96.00	889	97.90	928	96.60	765	98.40	797	97.80
Related	1090	97.30	1139	96.20	906	97.30	905	97.30	793	98.00	769	98.20
SRE[1]	-27		+1		-17		+23		-28		+28	

[1] The semantic relatedness effect is calculated as the difference between unrelated and related conditions. Positive values refer to facilitation while negative values refer to interference.

Regarding semantic interference, the less-proficient learners suffered more lexical interference (-52.92 ms) comparing to high-proficient learners (-35.43 ms) when context word distracters were being presented during the experiment. This meant that less-proficient bilinguals needed to rely more on lexical link from L1 in language speech production while high-proficient bilinguals relied less on L1 link.

Regarding semantic facilitation, the less-proficient learners experienced less semantic facilitation from context picture distracters (+8.39 ms) than more proficient learners (+83.68 ms). This finding in Khmer-English bilingual context supported Selected by Proficiency (SbP) Model of Schwieter and Sunderman (2008) who explained their experimental results that semantically related context words distracters caused semantic interference resulting in slower responses in bilinguals' language speech production. Semantically related context pictures, in contrast, led to semantic facilitation resulting in faster responses in bilinguals' language speech productions.

In summary of SbP, they claimed their findings that high-proficient bilinguals increasingly used concept mediation at the conceptual level but not yet exclusively as they still relied on word association (i.e. the SRE of -17 ms for more proficient learners suggests that they still relied on word association despite their high-proficient language ability) while concept selections of less-proficient bilinguals relied on lexical mediation as they needed to depend more on lexical link from L1 in their language speech production.

Regarding high-proficient bilinguals, the results also paralleled with Concept Selection Model (CSM) of Bloem and La Heij (2003) who only studied with high-proficient bilinguals. They interpreted their findings that semantically related context pictures activated their conceptual representations but do not activate their name. Also, concept selections of high-proficient bilinguals occurred at the conceptual level. To conclude, the concept selections of less-proficient learners in Khmer-English context occurred at the lexical level. High-proficient bilinguals' concept selections in Khmer-English context occurred at the conceptual level but not yet exclusively as they still somehow relied on lexical link from L1.

Mean of reaction time (milliseconds) from the effects of context (word & picture), relatedness (semantically related & unrelated) and proficiency (less & high) on bilinguals' language speech production at +500 ms of SOA

The results of mean from each type of context distracter below were not so much different even though they were separately compared in term of context, relatedness and proficiency. This could lead to the conclusion that at +500 ms of SOA where context distracters appeared 500 milliseconds after the presenting stimuli shared similar reaction times during bilinguals' language speech productions. In other words, at +500 ms of SOA, less-proficient and high-proficient group produced similar reaction time in their language speech production with all types of context distracters such as: semantically related context picture distracters, semantically unrelated context picture distracters, semantically related context word distracters and semantically unrelated context word distracters. (See table 4.8)

Table 4-8 The mean of reaction times (milliseconds) from the effects of context, relatedness and proficiency on bilinguals' language speech production at +500 ms of SOA

	M	**SD**
1. Less-proficient group	1072.49	120.97
2. High-proficient group	1021.09	114.11
3. Context picture distracters	1057.93	133.21
4. Context word distracters	1036.01	131.48
5. Semantically related	1050.74	122.86
6. Semantically unrelated	1042.83	118.89
7. Context picture distracters from less-proficient group	1081.18	138.07
8. Context picture distracters from high-proficient group	1034.66	126.81
9. Context word distracters from less-proficient group	1063.78	117.51
10. Context word distracters from high-proficient group	1007.51	140.87

Table 4-8 The mean of reaction times (milliseconds) from the effects of context, relatedness and proficiency on bilinguals' language speech production at +500 ms of SOA (Cont.)

	M	**SD**
11. Semantically related context distracters from less-proficient group	1077.57	134.08
12. Semantically related context distracter from high-proficient group	1023.92	135.43
13. Semantically unrelated context distracters from less-proficient group	1067.40	126.32
14. Semantically unrelated context distracters from high-proficient group	1018.25	137.27
15. Semantically related context picture distracters	1056.76	138.31
16. Semantically unrelated context picture distracters	1059.08	132.82
17. Semantically related context word distracters	1044.72	135.32
18. Semantically unrelated context word distracters	1026.58	133.62
19. Semantically related context picture distracters from less-proficient group	1080.62	147.38
20. Semantically related context picture distracters from high-proficient group	1032.90	127.20
21. Semantically unrelated context picture distracters from less-proficient group	1081.75	133.79
22. Semantically unrelated context picture distracters from high-proficient group	1036.41	130.68
23. Semantically related context word distracters from less-proficient group	1074.50	122.46
24. Semantically related context word distracters from high-proficient group	1014.94	143.45

Table 4-8 The mean of reaction times (milliseconds) from the effects of context, relatedness and proficiency on bilinguals' language speech production at +500 ms of SOA (Cont.)

	M	SD
25. Semantically unrelated context word distracters from less-proficient group	1053.06	119.50
26. Semantically unrelated context word distracters from high-proficient group	1000.09	144.01

The effects of context, relatedness and proficiency on bilinguals' language speech production at +500 ms of SOA

A three way ($2 \times 2 \times 2$) repeated measurement ANOVA was performed on the mean of reaction times (RTs) with context (word & picture) and relatedness (related & unrelated) as within-subject factor and group (less & high proficiency) as between-subject factor.

The main results of $2 \times 2 \times 2$ repeated measurement ANOVA were reported in Table 4-9. There was no statistical significant effect between less-proficient and high-proficient group of bilinguals $F(1, 46) = 2.29$, $p = .14$, $\eta^2 = .05$. There was no statistical significant effect of context on bilinguals' language speech production $F(1, 46) = 1.77$, $p = .19$, $\eta^2 = .04$. Relatedness did not have statistical significant effect on bilinguals' language speech production $F(1, 46) = 1.82$, $p = .18$, $\eta^2 = .04$. Interaction effect did not occur between context and proficiency $F(1, 46) = .08$, $p = .77$, $\eta^2 = .002$. Additionally, there was no interaction effect between relatedness and proficiency $F(1, 46) = .15$, $p = .70$, $\eta^2 = .003$. Similarly, context and relatedness did not show interaction effect on bilinguals' language speech production $F(1, 46) = 3.89$, $p = .06$, $\eta^2 = .08$. Finally, there was no interaction effect between context, relatedness and proficiency on bilinguals' language speech production $F(1, 46) = .04$, $p = .84$, $\eta^2 = .001$.

To sum up, the second experiment operating at +500 ms of SOA did not show the significant effects of context, relatedness and proficiency on bilinguals' language

speech productions. This could occur due to the fact that semantic representation of context distracters showing 500 milliseconds after the presenting stimuli became semantically decayed; consequently, it did not produce statistical significant effects on bilinguals' language speech production (La Heij et al., 1996). Additionally, according to the Inhibitory Control Model (ICM) of Green (1998), this experimental result without the effect of context distracters at +500 ms of SOA supported ICM theory that bilingual could inhibit the context distracters presenting after 500 ms of SOA.

.

Table 4-9 Results of $2 \times 2 \times 2$ repeated measurement ANOVA about the effects of context distracters, relatedness and proficiency on Reaction Times (RTs) of bilinguals' language speech production at +500 ms of SOA (n = 48)

	SS	**df**	**MS**	**F**	**p**	η^2
Between Subjects						
Proficiency	126806.29	1	126806.29	2.29	.14	.05
Error	2544236.39	46	55309.49			
Within-subject						
Context	23810.70	1	23810.70	1.77	.19	.04
Relatedness	3007.05	1	3007.05	1.82	.18	.04
Context × proficiency	1137.17	1	1137.17	.08	.77	.002
Relatedness × proficiency	241.75	1	241.75	.15	.70	.003
Context × relatedness	5026.48	1	5026.48	3.89	.06	.08
Context × relatedness × proficiency	52.89	1	52.89	.04	.84	.001
Error	59404.97	46	1291.41			

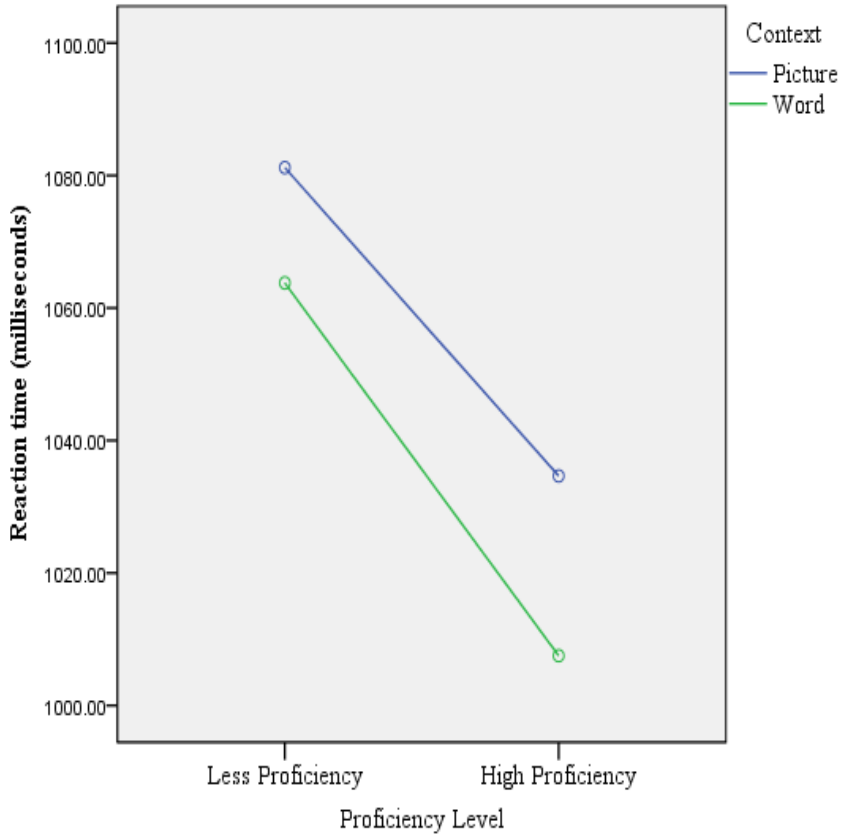


Figure 4-5 No interaction effect between context and proficiency on bilinguals' language speech production at +500 ms of SOA

There was no interaction effect between context and proficiency on bilinguals' language speech productions when context distracters were being presented at +500 ms of SOA. The reaction time of language speech productions under context picture distracters from less-proficient bilinguals (M = 1081.18, SD = 138.07) and context picture distracters from high-proficient bilinguals (M = 1034.66, SD = 126.81) were not significantly different. Similarly, the reaction time of language speech productions under context word distracters from less-proficient group (M = 1063.78, SD = 117.51) and under context word distracters from high-proficient group (M = 1007.51, SD = 140.87) were not significantly different.

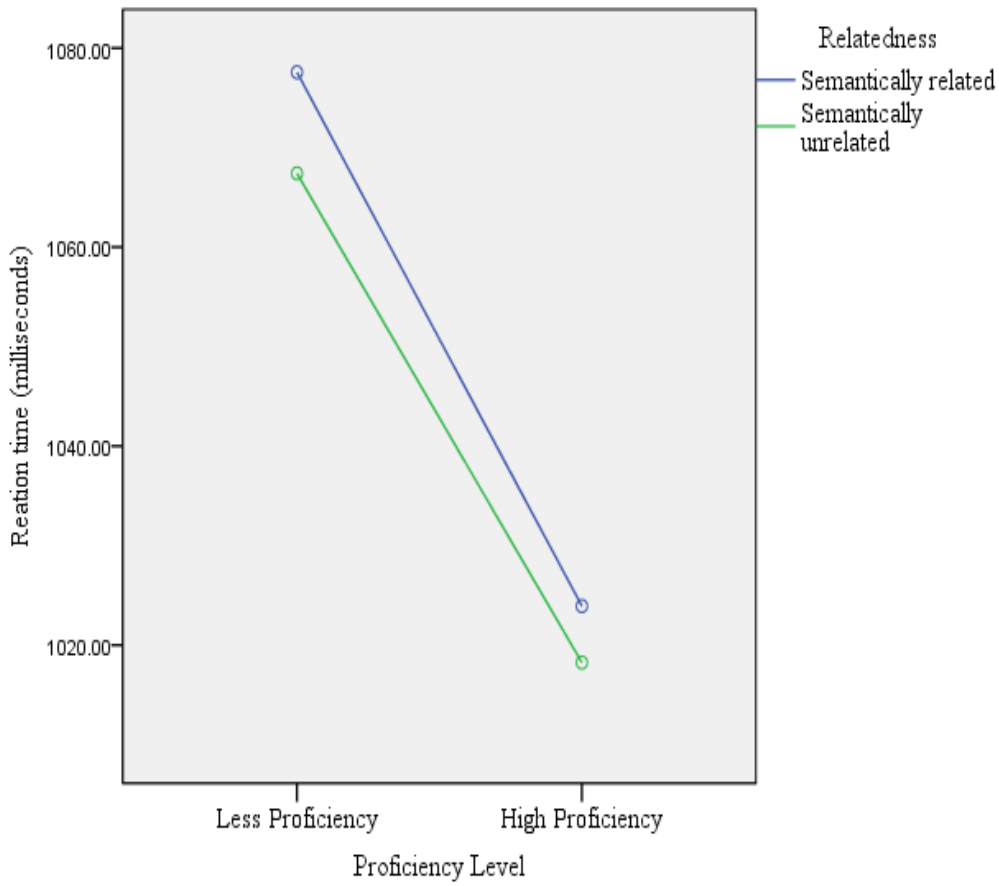


Figure 4-6 No interaction effect between relatedness and proficiency on bilinguals' language speech production at +500 ms of SOA

There was no interaction effect between proficiency and relatedness. Less-proficient and high-proficient bilinguals spent similar reaction times in their language speech productions when semantically related or unrelated context distracters were shown at +500 ms of SOA. In other words, the mean of reaction under semantically related context distracters from less-proficient group (M = 1077.57, SD = 134.08) and high-proficient group (M = 1023.92, SD = 135.43) were not significantly different. Likewise, the mean of reaction time under semantically unrelated context distracters from less-proficient group (M = 1067.40, SD = 126.32) and from high-proficient group (M = 1018.25, SD = 137.27) were not significantly different.

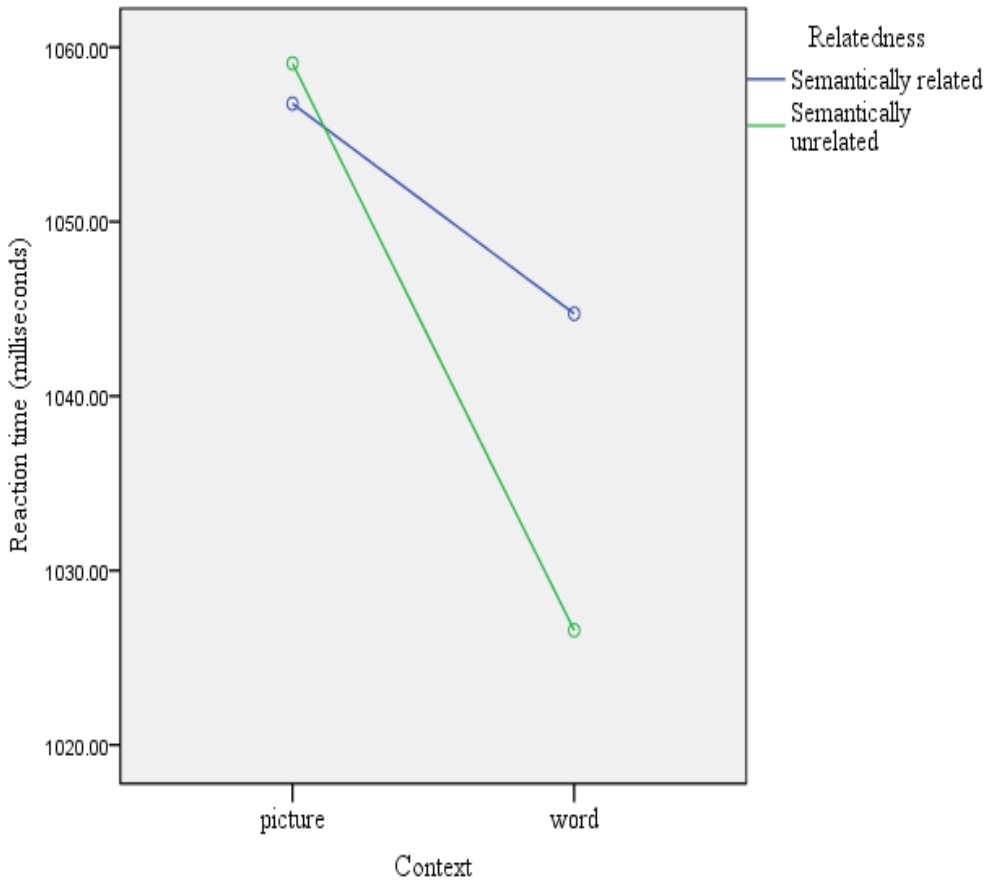


Figure 4-7 No interaction effect between context and relatedness on bilinguals' language speech production at +500 ms of SOA

Additionally, there was no interaction effect between context and relatedness. Bilinguals spent similar reaction times in their language speech productions when semantically related and unrelated context picture and word distracters were shown at +500 ms of SOA. In other words, the reactions under semantically related context picture distracters (M = 1056.76, SD = 138.31) and semantically unrelated context picture distracters (M = 1059.08, SD = 132.82) were not significantly different. Similarly, the reaction times under semantically related context word distracters (M = 1044.72, SD = 135.32) and semantically unrelated context word distracters (M = 1026.58, SD = 133.62) were not significantly different.

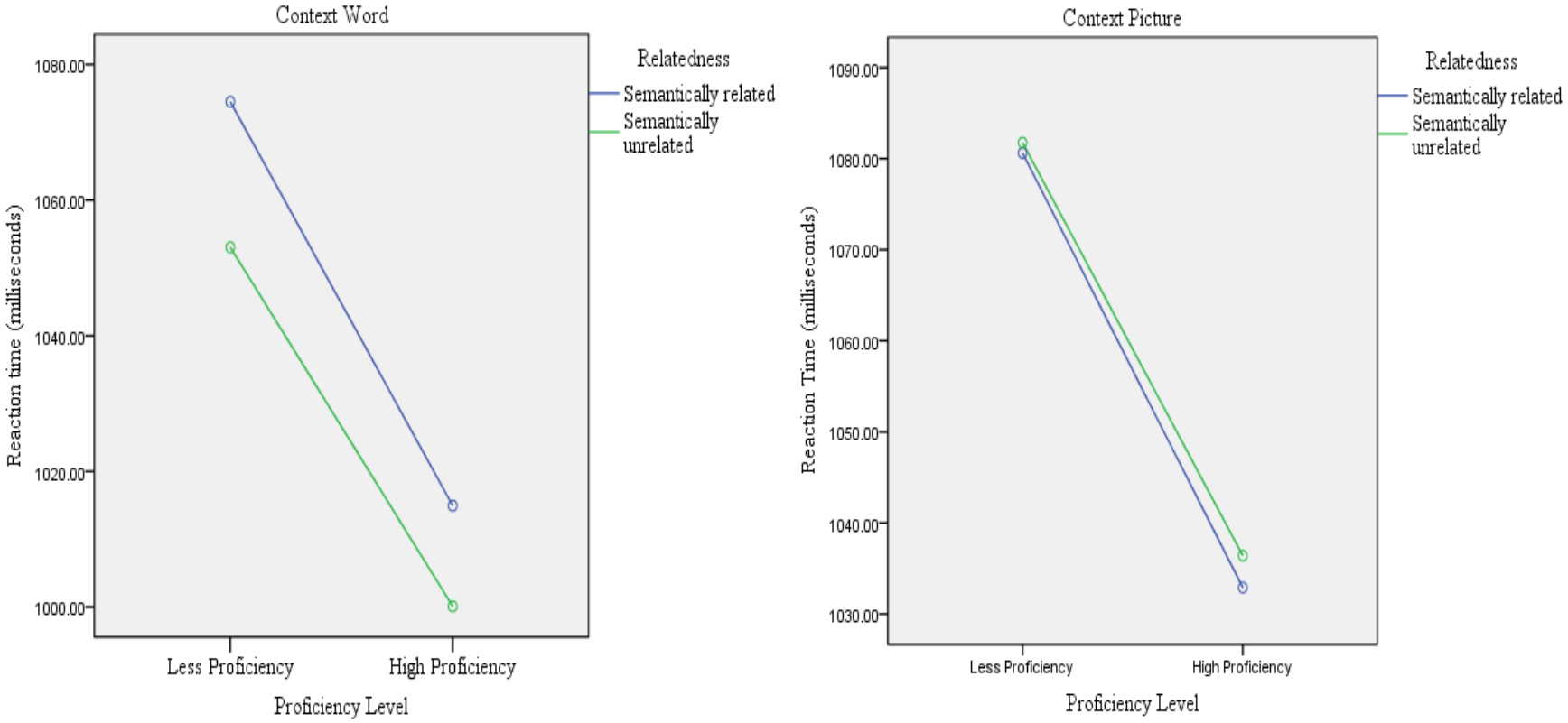


Figure 4-8 No interaction effect among context, relatedness and proficiency on bilinguals' language speech production at +500 ms of SOA

There was no interaction effect among context, relatedness and proficiency. The mean of reaction time under semantically related context picture distracters from less-proficient group (M = 1080.62, SD = 147.38) and high-proficient group (M = 1032.90, SD = 127.20) were not significantly different. The mean of reaction time under semantically unrelated context picture distracters from less-proficient group (M = 1081.75, SD = 133.79) and high-proficient group (M = 1036.41, SD = 130.68) were not significantly different. Additionally, the mean of reaction times under semantically related context word distracters from less-proficient group (M = 1074.50, SD = 122.46) and high-proficient group (M = 1014.94, SD = 143.45) were not significantly different. Also, the mean of reaction time under semantically unrelated context word distracters from less-proficient group (M = 1053.06, SD = 119.50) and high-proficient group (1000.09, SD = 144.01) were not significantly different. To sum up, at +500 ms of SOA, the reaction time during the language speech production of less-proficient group and high-proficient group under semantically related and unrelated context picture and word distracters was not significantly different.

Semantic relatedness effects (SRE) on bilinguals' concept selections at +500 ms of SOA

Table 4-10 Mean of reaction time (milliseconds), percentage of accuracy (%Acc), and semantic relatedness effects (SRE) at +500 ms of SOA

	Less-proficient group (n=24)				**High-proficient group (n=24)**			
	word		**picture**		**word**		**picture**	
	RT	**%Acc**	**RT**	**%Acc**	**RT**	**%Acc**	**RT**	**%Acc**
Unrelated	1053.06	89.17	1081.75	91.67	1000.09	93.85	1036.41	93.85
Related	1074.50	90.10	1080.62	93.02	1014.94	94.69	1032.90	93.85
SRE[1]	-21.44		+1.13		-14.85		+3.51	

Regarding semantic relatedness effect (SRE), there was very little impact from context distracters. Obviously, context word distracters still caused more semantic interferences to less-proficient group than high-proficient group. Context picture distracters still led to semantic facilitation.

[1] The semantic relatedness effect is calculated as the difference between unrelated and related conditions. Positive values refer to facilitation while negative values refer to interference.

CHAPTER 5
CONCLUSION

This chapter focuses mainly on the summary, discussion, and interpretation of the results from the study in the previous chapter. The summary of the findings and discussion of the theoretical and practical implications of the results is included in this chapter. Additionally, recommendations for the next study are listed at the end of this chapter.

Summary of the Study

The aim of this study was mainly to find out the effects of semantically related and unrelated context words and pictures on bilinguals' language speech productions. Additionally, semantic relatedness effects were critically studied in this research. Last, the locus of concept selections of less-proficient and high-proficient bilinguals were carefully studied among Khmer-English bilinguals. The experiment of language speech productions were conducted with BELTEI International University students. The data collection lasted for three weeks.

The participants of this study comprised 48 Khmer-English bilinguals who were bachelor's degree students from BELTEI International University, Phnom Penh, Cambodia. These participants were divided into two major groups of less-proficient and high-proficient bilinguals in accordance to the results from the language production test adapted from Gollan, Montoya and Werner (2002). Consequently, both less-proficient and high-proficient group of bilinguals comprised equal number of subjects (n=24).

Prior to the experiment, the language history questionnaire were administered to find out participants' language learning history and their proficiency level in both English and Khmer. This questionnaire took around 5 minutes from every subject. After that, each subject was asked to do the familiarization task which a list of presenting stimuli was all printed in a piece of paper. Each subject was asked to translate each stimulus into their L1 (Khmer) as quickly as possible by ignoring the unknown ones. The purpose of this familiarization task was to make sure that those presenting stimuli were known by each participant so that everyone could response

correctly during the experiment. Later on, the researcher checked the participant's translation and at the meantime the researcher gave the verbal answers to the unknown stimuli.

The experiment started with a single participant at a time. Each subject spent around 40 minutes for the language speech production test. During the experiment, there were 40 stimuli which were all written in L2 (English) words. Each stimulus was used four times: two times with context picture distracters and the other two times with context word distracters. Each context word and picture distracters comprised semantic relatedness and unrelatedness to the presenting stimuli. Each context word and picture was divided into two block designs. Each block consisted of 40 trials (20 semantically related context distracters and 20 semantically unrelated context distracters) (see appendix A, table A-4). Each trial was run randomly during the experiment. Additionally, this experiment about the effect of context distracters on bilinguals' language speech production was conducted at two time frames at 0 ms of SOA where both stimuli and context distracters appeared simultaneously and +500 ms of SOA where context distracters appeared 500 milliseconds after the stimuli.

The dependent variables collected from this study comprised reaction times (RTs) and accuracy rates, which were all recorded in the psychological software program called DMDX (version 5.1.2.1 Forster & Forster, 2003). Only the data from correct responses were included into the analyses. The data of incorrect responses were treated as error. A three-ways ($2 \times 2 \times 2$) repeated measurement ANOVA was performed to find out the effects of context distracters (pictures & words), relatedness (semantically related and unrelated) and proficiency (less & high) on bilinguals' language speech productions. Participants' proficiency level (less and high) was used as between-subject group. Context (word & picture) and relatedness (seamantically related & unrelated) were used as within-subject group. Also, the semantic relatedness effect (SRE) was calculated to analyse the semantic relatedness effects and the locus of bilinguals' concept selections.

The main results of the study were briefly presented with references to the four research questions (RQs) which this study aimed to address. The answers to the research question (RQ) were divided into two time frames during the experiment: 0 ms of SOA and +500 ms of SOA.

Experiment 1: Effects of context distracters on bilinguals' language speech production and concept selection at 0 ms of SOA.

RQ1: How would context picture and word distracters affect bilinguals' langauge speech production at 0 ms of SOA?

The main findings of the experiment showed that the main effects of context (word & picture) was significant due to the faster reaction times occurring to the context word distracters (M = 1029.40, SD =118.64) than context picture distracters (M = 1091.47, SD = 142.68).

RQ2: How do semantically related and unrelated context picture and word distracters affect bilinguals' language speech productions at 0 ms of SOA? Which context leads to semantic interference and which context leads to semantic facilitation?

The experimental results revealed that semantically related context pictures (M = 1068.45, SD = 144.38) significantly increased faster reaction times (RTs) than semantically unrelated context pictures (M= 1114.49, SD = 138.64). In contrast, semantically related context words (M = 1051.49, SD = 122.22 significantly caused slower reaction time than semantically unrelated context words (M = 1007.31, SD = 111.87). This meant that context pictures with semantic relatedness led to semantic facilitation which contributed to assist bilinguals' language speech production while context words with semantic relatedness caused semantic interference which slowed down bilinguals' language speech production.

RQ3: How do semantically related and unrelated context picture and word distracters affect less-proficient and high-proficient bilinguals' language speech productions?

Semantically related context picture for high-proficient bilinguals (M= 1014.16, SD= 134.07) increased faster reaction time than that of less-proficient bilinguals (M=1122.74, SD= 135.91). This meant that context pictures with sematic relatedness facilitated language speech production. This result supported Selected by Proficiency (SbP) Model of Schwieter and Sunderman (2008) together with Concept Selection Model (CSM) of Bloem and La Heij (2003) who claimed semantically related context picture distracters increased semantic facilitation to high-proficient

learners. It literally meant that high-proficient bilinguals could conceptualize the semantic representations from the semantically related context picture (but not its name). However, semantically related context word distracters for less-proficient bilinguals (M = 1079.58, SD = 117.91) caused slower reaction times than that of high-proficient bilinguals (M = 1023.39, SD = 122.38) during the language speech productions. Noticeably, semantically related context word distracters caused more semantic interferences among less-proficient bilinguals. Regarding semantic unrelatedness, less-proficient bilinguals spent longer reaction times in both unrelated context picture and word distracters.

RQ4: What is the semantic relatedness effect (SRE) of context words and pictures on less-proficient and high-proficient bilinguals' language speech productions? What is the locus of concept selections of less-proficient and high-proficient bilinguals during the language speech productions?

Regarding semantic interference, the less-proficient learners suffered more lexical interference (-52.92 ms) in comparison to high-proficient learners (-35.43 ms) when context word distracters were being presented during the experiment. This meant that less-proficient bilinguals needed to rely more on lexical link from L1 in language speech production while high-proficient bilinguals relied less on lexical link from L1. Regarding semantic facilitation, less-proficient learners experienced very little semantic facilitation from context picture distracters (+8.39 ms) when comparing to high-proficient learners (+83.68 ms). To conclude, high-proficient bilinguals' concept selections in Khmer-English context occurred at the conceptual level but not yet exclusively as they still somehow relied on lexical link from L1. The locus of concept selections of less-proficient learners in Khmer-English bilingual context occurred at the lexical level as they needed to depend more on lexical link from L1 in their language speech productions.

Experiment 2: Effects of context distracters on bilinguals' language speech production and concept selections at +500 ms of SOA.

RQ: Is there the effects of context, relatedness and proficiency on bilinguals' language speech productions at +500 ms of SOA? Could bilinguals in Khmer-English context inhibit the context distracters at +500 ms of SOA?

The finding showed that there was no statistical significant effect of context on bilinguals' language speech production $F (1, 46) = 1.77$, $p = .19$, $\eta^2 = .04$. Semantic relatedness did not have statistical significant effect on bilinguals' language speech production $F (1, 46) = 1.82$, $p = .18$, $\eta^2 = .04$. Interaction effect did not occur between context and proficiency $F (1, 46) = .08$, $p = .77$, $\eta^2 = .002$. Additionally, there was no interaction effect between relatedness and proficiency $F (1, 46) = .15$, $p = .70$, $\eta^2 = .003$. Similarly, context and relatedness did not show interaction effect on bilinguals' language speech production $F (1, 46) = 3.89$, $p = .06$, $\eta^2 = .08$. Finally, there was no interaction effect between context, relatedness and proficiency on bilinguals' language speech production $F (1, 46) = .04$, $p = .84$, $\eta^2 = .001$.

To sum up, the second experiment operating at +500 ms of SOA where context distracters appeared 500 ms after the presenting stimuli did not show the significant effects of context, relatedness and proficiency on bilinguals' language speech productions. This could occur due to the fact that semantic representations of context distracters showing 500 milliseconds after the presenting stimuli was already decayed; consequently, it did not show the different effects on bilinguals' language speech production (La Heij et al., 1996). Additionally, according to the Inhibitory Control Model (ICM) of Green (1998), this experimental result without the effect of context distracters at +500 ms of SOA supported ICM theory that bilingual could inhibit the context distracters presenting at +500 ms of SOA.

Discussion

Experiment 1: Effects of context distracters on bilinguals' language speech production and concept selections at 0 ms of SOA.

Could context (picture & word) differently affect bilinguals' language speech production? The answer is definitely "yes". The reaction times (RTs) of language speech production with context word distracters were faster than context picture distracters. This meant that while context picture was being presented, the majority of Khmer-English bilinguals spent longer time to translate the presenting stimuli. These context picture distracters took more participants' attentions and time when comparing to context word distracters. This finding supported the experiment conducted by Schwieter and Sunderman (2008) who studied in English-Spanish bilingual context and Bloem and La Heij (2003) who studied in Dutch-English bilingual context. Their results similarly supported that context word distracters would less interfere than context picture distracters.

When relatedness combined with proficiency level of less-proficient and high-proficient group of bilinguals, significant interaction effects occurred to the reaction time of bilinguals' language speech production. High-proficient bilinguals spent less time in language speech production when semantically related picture was being presented. According to the Concept Selection Model (CSM) of Bloem and La Heij (2003) and Selected by Proficiency Model of Schwieter and Sunderman (2008), semantically related pictures activated their conceptual representations but not their names and high-proficient bilinguals could conceptually mediate the semantically related context picture distracter but not its name. In other words, high-proficient learners relied on concept mediations from semantically related context picture distracters. This concept mediation could occur at the conceptual level.

There was a significant interaction effect between context and relatedness on bilinguals' language speech production. Semantically related context word distracters significantly caused slower reaction time than semantically unrelated context word distracters. To put this result into critical analysis, semantically related context word distracters caused semantic interferences which distracted and slowed down bilinguals' language speech productions. However, semantically related context picture distracters led to faster reaction times than semantically unrelated ones. It

meant that semantically related context picture distracters facilitated bilinguals' language speech productions which made the reaction time faster. The results from Selected by Proficiency (SbP) Model of Schwieter and Sunderman (2008) together with Bloem and La Heij (2003) also claimed parallel explanations that semantic interferences were caused by semantically related context word distracters while semantically related context picture distracters led to semantic facilitations during bilinguals' language speech productions.

Regarding semantic relatedness effect (SRE), it revealed that less-proficient Khmer-English bilinguals relied more on lexical link from L1 in their language speech productions. It meant that less-proficient bilinguals needed to think and relate the presenting stimuli into their L1 first when they were asked to translate the presenting stimuli from L2 (English) into L1 (Khmer). That was the reasons that more sematic interferences occurred to less-proficient bilinguals (-52.92 ms). To conclude, the locus of concept selections of less-proficient bilinguals' occurred at the lexical level as they required lexical link from L1 to response in their language speech productions. In other words, less-proficient learners used lexical mediations to produce language translation from L2 (English) to L1 (Khmer). It is logical that less-proficient bilinguals get more influence and interference from their L1. That is why when less-proficient bilinguals speak or write in L2, they show more tendencies to their L1, especially in term of grammatical structures, concepts and styles. This tendency and influence from L1 would be decreased respectively when they become more proficient. According to the Revised Hierarchical Model (RHM) of Kroll and Stewart (1994), lexical link from L1 is very strong for less-proficient bilinguals. For example, if less-proficient bilinguals see the picture, first of all they will translate it into their L1 first and then they rely on translation equivalent from L1 to L2 so that L2 word could be responded to the picture correctly.

High-proficient bilinguals, on the other hand, relied less on lexical link from L1 as there were less semantic relatedness effect from context word distracters (-35.43 ms). Additionally, more semantic facilitation occurred to high-proficient bilinguals (+83.68 ms) than less-proficient bilinguals (+8.39 ms) when context picture distracter were being presented during the experiment. This meant that high-proficient bilinguals used concept mediations from context picture distracters to response to the

presenting stimuli. To sum up, the locus of concept selections of high-proficient bilinguals occurred at the conceptual level as high-proficient bilinguals could conceptualized the semantically related context picture distracters but not their names. However, the ability to conceptualize from semantically related context picture distracters was not exclusively as they still somehow rely on lexical link from L1. The results of the locus of concept selection of Khmer-English bilinguals were paralleled with Concept Selection Model of Bloem and La Heij (2003) together with Selected by Proficiency (SbP) Model of Schwieter and Sunderman (2008).

To sum up regarding the "hard problem" being discussed in the introduction of chapter 1, less-proficient bilinguals solved the hard problem by relying on strong lexical link from L1 known as translation equivalent. Therefore, when less-proficient bilinguals speak or response in L2, firstly they have to rely on their L1 translation equivalent so that the target L2 word could be spoken out or responded. High-proficient bilinguals, on the other hand, relied less on lexical link or translation equivalent from L1 as they could conceptualize the word directly into their L2. As a result, they could speak out or response in L2 word directly with less interference from L1.

Experiment 2: Effects of context distracters on bilinguals' language speech production and concept selection at +500 ms of SOA.

The main results from $2 \times 2 \times 2$ repeated measurement ANOVA showed that there was no statistical significant effect of context (picture & word), relatedness (semantically related & unrelated) and proficiency (less & high) on bilinguals' language speech production. This meant that there was no influence from context and semantic relatedness on less-proficient and high-proficient bilinguals' language speech productions when those context distracter with and without semantic relatedness were being presented at 500 ms after the presenting stimuli. Semantic interference did not occur at this level was based significantly on two theoretical explanations.

First of all, according to the Inhibitory Control Model (ICM) of Green (1998), the presenting of context distracters at +500 ms of SOA did not cause semantic interference due to the fact that less-proficient and high-proficient bilinguals could inhibit those context distracters. In other words, language inhibition occurred to

less-proficient and high-proficient bilinguals when those context distracters were presented 500 ms after the stimuli. It meant that both less-proficient and high-proficient bilinguals could inhibit the irrelevant context distracters at +500 ms of SOA.

Second, according to La Heij et al., (1996), the semantic representations of context distracters which were being presented at 500 ms after the stimuli became already decayed. This did not cause any influences or effects on bilinguals' language speech productions. In short, the semantic representations at +500 ms of SOA of context distracters were decayed and language inhibition occurred at this level; as a result, no semantic interferences would occur at this level.

Recommendations

The benefits of the current study

1. As semantically related context pictures assist English language acquisition, the learning material designs should have as many related context pictures as possible, so that Khmer-English learners could highly benefit from them.

2. Semantically related context pictures could be presented to Khmer-English learners as a technique to present new vocabulary, so that they could improve learners' context comprehension and vocabulary development.

3. As semantically related context words cause semantic interferences, and high-proficient learners rely less on lexical link from Khmer (L1), it is recommended that word translations from Khmer is not effective while direct translations or explanations in English (L2) are more crucial in enhancing English language acquisition among Khmer-English learners.

Recommendation for further studies

The following recommendations are recommended for further studies:

1. The effects of context, relatedness, and proficiency level on the locus of bilinguals' concept selections should be studied in other bilingual contexts besides Khmer-English, so that a comparison of sematic relatedness effects and locus of concept selections of bilinguals could be drawn out for example in Thai-English bilingual or Vietnamese-English bilingual.

2. As this present study focused on the black and white context picture distracters, the next study should be conducted on the comparison between colored and non-colored context picture distracters in order to find out if colors could bring significantly different results in bilinguals' language speech production. Therefore, this new experimental result could guide language instructors to decide whether to use color or non-color pictures in their language teaching.

3. The next study should be conducted with only one stimulus onset asynchrony (SOA) to avoid too many repetitions of the presenting stimuli during the experiment.

REFERENCES

Altarriba, J., & Mathis, K. M. (1997). Conceptual and lexical development in second language acquisition. *Journal of Memory and Language, 36*, 550-568.

ASEAN. (2008). *The ASEAN Charter*. Jakarta: Association of Southeast Asian Nations.

Baker, C. (1996). *Foundations of Bilingual Education and Bilingualism* (2nd ed.). Clevedon: Multilingual Matters.

Bergmann, A., Hall, K., & Ross, S. (2007*). Language files: Materials for an introduction to language and linguistics*. Columbus, OH: The Ohio State University Press.

Bloem, I., & La Heij, W. (2003). Semantic facilitation and semantic interference in word translation: Implications for models of lexical access in language production. *Journal of Memory and Language, 48*, 468-488.

Bloem, I., Van Den Boogaard, S., & La Heij, W. (2004). Semantic facilitation and semantic interference in language production: Further evidence for the conceptual selection model of lexical access. *Journal of Memory and Language, 51*, 307-323.

Bloomfield, L. (1984). *Language*. Chicago: University of Chicago Press.

Brysbaert, M., Duyck, W. (2010). Is it time to leave behind the Revised Hierarchical Model of bilingual language processing after 15 years of service? *Bilingualism: Language and Cognition*. In press.

Butler, Y. G., & Hakuta, K. (2004). Bilingualism and Second Language Acquisitions. In T. K. Bhatia & W. C. Ritchie (Eds.) *The Handbook of Bilingualism: Malden*, MA: Blackwell, (pp. 114-144). Clevedon: Multilingual Matters.

Clayton, T. (2006). *Language choice in a nation under transition: English language spread in Cambodia*. New York: Springer Science + Business Media.

Clayton, T. (2007). Transition, culture, and language in Cambodia. In A. B. M. Tsui, & J. W. Tollefson (Eds.), *Language policy, culture, and identity in Asian contexts* (pp. 95-120). Mahwah, NJ: Lawrence Erlbaum Associates.

Cook, V. J. (1969). The analogy between first and second language learning. *IRAL V11/3*, 207-216.

Costa, A., & Santesteban, M. (2004). Lexical access in bilingual speech production: Evidence from language switching in highly proficient bilinguals and L2 learners. *Journal of Memory and Language, 50,* 491-511.

Costa, A., Miozzo, M., & Caramazza, A. (1999). Lexical selection in bilinguals: Do words in bilingual's lexicon compete for selection? *Journal of Memory and Language, 41,* 365-397.

De Groot, A. M. B., & Poot, R. (1997).Word translation at three levels of proficiency in a second language: The ubiquitous involvement of conceptual memory. *Language Learning, 47,* 215-264.

Dijkstra T., Van Heuven, W. J. B. (1998). The BIA model and bilingual word recognition. In J. Grainger & J. Jacobs (Eds), *Localist Connectionist Approaches to Human Cognition* (pp. 189-225). NJ: Lawrence Erlbaum Associates.

Dufour, R., & Kroll, J. F. (1995). Matching words to concepts in two languages: A test of the concept mediation model of bilingual representation. *Memory and Cognition, 23*, 166-180.

Edmonds, W. A., & Kennedy, T. D. (2012). *An Applied Reference Guide to Research Designs: Quantitative, Qualitative, and Mixed Methods*. Thousand Oaks: SAGE Publications, Inc.

Finkbeiner, M., Gollán, T., and Caramazza, A. (2006). Lexical access in bilingual speakers: What's the (hard) problem? *Bilingualism: Language and Cognition, 9*(2), 153-166.

Forster, K. I., & Forster, J. C. (2003). DMDX: A windows display program with millisecond accuracy. *Behavior Research Methods, Instruments, & Computers, 35,* 116-124.

Frenck-Mestre, C., & Prince, P. (1997). Second language autonomy. *Journal of Memory and Language, 37*, 481-501.

Galotti, K. M. (2014). *Cognitive Psychology: In and Out of the Laboratory,* (5th ed.). Retrieved from The University of Phoenix eBook Collection database.

Gollán, T. H., & Kroll, J. F. (2001). Bilingual lexical access. In B. Rapp (Ed.), *The Handbook of cognitive neuropsychology: What deficits reveal about the human mind* (pp. 321-345). Philadelphia, PA: Psychology Press.

Gollan, T. H., Montoya, R. I., & Werner, G. A. (2002). Semantic and letter fluency in Spanish-English bilinguals. *Neuropsychology, 16(4),* 562-576.

Goodz, N. (1994). Interaction between parents and children in bilingual families. In F. Genesee (Ed.) *Educating Second Language Children: The Whole Child, the Whole Curriculum, the Whole Community* (pp. 61-82) Cambridge: Cambridge University Press.

Gove, P. B. (1961). *Webster's third new international dictionary of the English language. Unabridged*. G. & C. Merriam.

Grainger, J. & Jacobs, A. (1998). *Localist connectionist approaches to human cognition*. Mahwah, NJ: Lawrence Erlbaum Associates.

Green, D. W. (1998). Mental control of the bilingual lexico-semantic system. *Bilingualism: Language and Cognition, 1*, 67-81.

Haugen, E. (1953). *The Norwegian Language in America*. Philadelphia: University of Pennsylvania Press.

Hermans, D. (2000). *Word production in a foreign language.* Unpublished master's thesis, University of Nijmegen, Nijmegen.

Hermans, D. (2004). Between-language identity effects in picture-word interference tasks: A challenge for language-nonspecific or language specific models of lexical access? *International Journal of Bilingualism, 8(2),* 115-125.

Hermans, D., Bongaerts, T., De Bot, K., & Schreuder, R. (1998). Producing words in a foreign language: can speakers prevent interference from their first language? *Bilingualism: Language and Cognition, 1*, 213-230.

Jescheniak, J. D., & Schriefers, K. I. (1998). Discrete serial versus cascading processing in lexical access in speech production: Further evidence from the coactivation of near-synonyms. *Journal of Experimental Psychology: Learning, Memory and Cognition, 24,* 1256-1274.

Kroll, J., & De Groot, A. M. B. (Eds.), *Handbook of bilingualism: Psycholinguistic approaches* (pp. 289–307). New York: Oxford University Press.

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

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

La Heij, W. (2005). Selection processes in monolingual and bilingual lexical access. In J. F. Kroll & A. M. B. de Groot (Eds.), *Handbook of bilingualism: Psycholinguistic approaches*. Oxford: Oxford University Press.

La Heij, W., et al. (1990). Orthographic facilitation and categorical interference in a word-translation variant of the Stroop task. *Canadian Journal of Psychology, 44*(1), 76-83.

La Heij, W., et al. (1996). Nonverbal context effects in forward and backward translation: Evidence for concept mediation. *Journal of Memory and Language, 35*, 648-665.

McLeod, S. A. (2007). Lev Vygotsky. Retrieved from http://www.simplypsychology. org/vygotsky. html

Meuter, R. F. I. (1994). *Language switching in naming tasks.* Unpublished doctoral dissertation, Oxford University.

Meuter, R. F. I., & Allport, A. (1999). Bilingual language switching in naming: Asymmetrical costs of language selection. *Journal of Memory and Language, 40*, 25-40. Pennsylvania Press.

Peterson, R. R., & Savoy, P. (1998). Lexical selection and phonological encoding during language production: Evidence for cascaded processing. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 24*, 539-557.

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

Poulisse, N., & Bongaerts, T. (1994). First language use in second language production. *Applied Linguistics, 15*, 36-57.

Schechter, J. (1988). Second language acquisition and its relationship to universal grammar. *Applied Linguistics, 9(3),* 219-235.

Schwieter, J. (2007). A psycholinguistic investigation of language selectivity in bilingual speech production. *Dissertation Abstracts International, 68*(9), 100-115

Schwieter, J. W., & Sunderman, G. (2008). Language switching in bilingual speech production: In search of the language-specific selection mechanism. *The Mental Lexicon, 3*(2), 214-238.

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

Snodgrass, J. G., & Vanderwart, M. (1980). A standardized set of 260 pictures: Norms for name agreement, image agreement, familiarity, and visual complexity. *Journal of Experimental Psychology: Human Learning and Memory, 6*, 174-215.

Stephen, D. (1988). *Second Language Acquisition and Second Language Learning*. Prentice-Hall International.

Sunderman, G., Kroll, J. F. (2006). First language activation during second language lexical processing: An investigation of lexical form, meaning, and grammatical class. *Studies in Second Language Acquisition, 28*, 387-422.

Talamas, A., Kroll, J., & Dufour, R. (1999). Form related errors in second language learning: A preliminary stage in the acquisition of L2 vocabulary. *Bilingualism: Language and Cognition, 2*, 45-58.

Titone, R. (1972). *Le Bilingualisme Precoce*. Brussels: Dessart.

Towell, R., & Hawkins, R. (1994). *Approaches to second language acquisition*. Clevedon, UK: Multilingual Matters.

Tully, J. (2006). *A short history of Cambodia*. Chiang Mai, Thailand: Silkworm.

Vira, N. (2002). Teaching English in Cambodian secondary schools: With a special focus on teachers' preferences towards the improvement of their professional careers in language teaching. *Bulletin, Graduate School of Education, Hiroshima University Part II, 51*, 197-206

Wikipedia (2008, March 13). *Cambodia*. Retrieved March 15, 2008 from http://en.wikipedia.org/wiki/Cambodia

Zeelenberg, R., & Pecher, D. (2003). Evidence for long-term language repetition priming in conceptual implicit memory tasks. *Journal of Memory and Language, 49*, 80-94.

APPENDICES

APPENDIX A

Table A-1 List of Stimuli, Context Distracters and Frequency Level

No.	Stimuli	Semantic category	Translation in Khmer	Related Context Distracters	Unrelated Context Distracters	Frequency of Stimuli
1	garlic	vegetable	ខ្ទឹមស	onion	ant	784
2	bean	vegetable	សណ្តែក	corn	horse	526
3	eggplant	vegetable	ត្រប់	tomato	ruler	3
4	potato	vegetable	ដំឡូង	pumpkin	motorbike	851
5	cabbage	vegetable	ស្ពៃក្តោប	cucumber	glove	350
6	fork	utensils	សម	spoon	vase	825
7	knife	utensils	កាំបិត	stake	lemon	2563
8	glass	utensils	កែវ	cup	key	9303
9	pot	utensils	ឆ្នាំង	soup	moon	1991
10	kettle	utensils	កំសៀវ	bowl	sun	841
11	tree	natures	ដើមឈើ	leaf	balloon	5982
12	rain	natures	ភ្លៀង	umbrella	mouse	6214
13	hill	natures	ដីទួល	mountain	swan	6822
14	flower	natures	ផ្កា	bee	hammer	2276
15	bridge	buildings	ស្ពាន	river	whistle	6292
16	house	buildings	ផ្ទះ	window	pencil	48666
17	pagoda	buildings	វត្ត	monk	pen	55
18	temple	buildings	ប្រាសាទ	castle	tie	2024
19	airplane	vehicles	យន្តហោះ	lorry	hand	77
20	car	vehicles	ឡាន	train	tiger	26343
21	cart	vehicles	រទេះ	wheel	violin	910
22	ship	vehicles	កប៉ាល់	anchor	spider	4558
23	hair	body parts	សក់	comb	telephone	13455
24	waist	body parts	ចង្កេះ	belt	deer	1320
25	leg	body parts	ជើង	trousers	trumpet	5042
26	ear	body parts	ត្រចៀក	nose	star	2742
27	finger	body parts	ម្រាមដៃ	thumb	book	3013
28	camel	animals	អូដ្ឋ	desert	piano	358

Table A-1 List of Stimuli, Context Distracters and Frequency Level (Cont.)

No.	Stimuli	Semantic category	Translation in Khmer	Related Context Distracters	Unrelated Context Distracters	Frequency of Stimuli
29	rabbit	animals	ទន្សាយ	carrot	watch	1254
30	dog	animals	ឆ្កែ	leash	axe	7780
31	cow	animals	គោ	zebra	shaw	1334
32	cat	animals	ឆ្មា	lion	gun	3788
33	bed	furniture	គ្រែ	pillow	fish	14607
34	wardrobe	furniture	ទូសម្លៀកបំពាក់	hanger	frog	895
35	table	furniture	តុ	chair	giraffe	19128
36	couch	furniture	សាឡុង	television	glasses	488
37	pomegranate	fruit	ផ្លែទទឹម	durian	Eye	29
38	apple	fruit	ផ្លែប៉ោម	mango	hat	2570
39	orange	fruit	ផ្លែក្រូច	watermelon	letter	2582
40	grape	fruit	ទំពាំងបាយជូ	tin	fly	280

All the frequency of each stimulus in this research study was cited from the British National Corpus with 100 million words existed. (Retrieved from: http://corpus.byu.edu/bnc/, December 25, 2014)

Table A-2 Stimuli, Context Distracters and L1 (Khmer) Translation Equivalent

No.	Stimuli	Translation in Khmer	Related Context Distracters	Translation in Khmer	Unrelated Context Distracters	Translation in Khmer
1	garlic	ខ្ទឹមស	onion	ខ្ទឹមបារាំង	ant	ស្រមោច
2	bean	ផ្សឺត	corn	ពោត	horse	សេះ
3	eggplant	ត្រប់	tomato	ប៉េងប៉ោះ	ruler	បន្ទាត់
4	potato	ដំឡូង	pumpkin	ល្ពៅ	motorbike	ម៉ូតូ
5	cabbage	ស្ពៃក្តោប	cucumber	ត្រសក់	glove	ស្រោមដៃ
6	fork	សម	spoon	ស្លាបព្រា	vase	ថូផ្កា
7	knife	កាំបិត	stake	សាច់បន្ទះ	lemon	ក្រូចឆ្មា
8	glass	កែវ	cup	ពែង	key	កូនសោ
9	pot	ឆ្នាំង	soup	សម្ល	moon	ព្រះច័ន្ទ
10	kettle	កំសៀវ	bowl	ចានក្រឡុង	sun	ព្រះអាទិត្យ
11	tree	ដើមឈើ	leaf	ស្លឹកឈើ	balloon	ប៉េងប៉ោង
12	rain	ភ្លៀង	umbrella	ឆ័ត្រ	mouse	កណ្តុរ
13	hill	ដីទួល	mountain	ភ្នំ	swan	ក្ងាន
14	flower	ផ្កា	bee	ឃ្មុំ	hammer	ញញួរ
15	bridge	ស្ពាន	river	ស្ទឹង	whistle	កញ្ជ្រៃ
16	house	ផ្ទះ	window	បង្អួច	pencil	ខ្មៅដៃ
17	pagoda	វត្ត	monk	ព្រះសង្ឃ	pen	ប៊ិច
18	temple	ប្រាសាទ	castle	វិមាន	tie	ក្រវ៉ាត់ក
19	airplane	យន្តហោះ	lorry	ឡានដឹកទំនិញ	hand	ប្រអប់ដៃ
20	car	ឡាន	train	រថភ្លើង	tiger	ខ្លា
21	cart	រទេះ	wheel	កង់	violin	វិយ៉ូឡុង
22	ship	កប៉ាល់	anchor	យុថ្កា	spider	ពីងពាង
23	hair	សក់	comb	ក្រាស	telephone	ទូរស័ព្ទ
24	waist	ចង្កេះ	belt	ខ្សែក្រវ៉ាត់	deer	ក្តាន់
25	leg	ជើង	trousers	ខោជើងវែង	trumpet	ត្រែ
26	ear	ត្រចៀក	nose	ច្រមុះ	star	ផ្កាយ
27	finger	ម្រាមដៃ	thumb	មេដៃ	book	សៀវភៅ
28	camel	សត្វអូដ្ឋ	desert	វាលខ្សាច់	piano	ព្យាណូ

Table A-2 Stimuli, Context Distracters and L1 (Khmer) Translation Equivalent

No	Stimuli	Translation in Khmer	Related Context Distracters	Translation in Khmer	Unrelated Context Distracters	Translation in Khmer
29	rabbit	ទន្សាយ	carrot	ការ៉ុត	watch	នាឡិកាដៃ
30	dog	ឆ្កែ	leash	ខ្សែប្រឡោកឆ្កែ	axe	ពូថៅ
31	cow	គោ	zebra	សេះបង្គង	shaw	រណា
32	cat	ឆ្មា	lion	តោ	gun	កាំភ្លើង
33	bed	គ្រែ	pillow	ខ្នើយ	fish	ត្រី
34	wardrobe	ទូរសម្លៀកបំពាក់	hanger	ស្មាព្យួរសំលៀកបំពាក់	frog	កង្កែប
35	table	តុ	chair	កៅអី	giraffe	សត្វកវែង
36	couch	សាឡុង	television	ទូរទស្សន៍	glasses	វ៉ែនតា
37	pomegranate	ផ្លែទទឹម	durian	ធុរេន	eye	ភ្នែក
38	apple	ផ្លែប៉ោម	mango	ស្វាយ	hat	មួក
39	orange	ផ្លែក្រូច	watermelon	ឪឡឹក	letter	សំបុត្រ
40	grape	ផ្លែទំពាំងបាយជូ	tin	កំប៉ុង	fly	រុយ

Table A-3 Semantically Related Line Drawing Context Picture Distracters

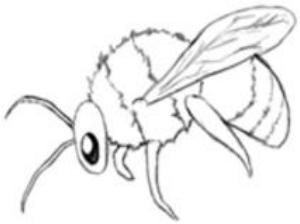
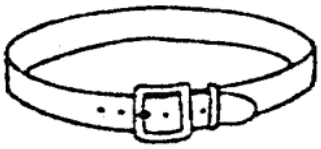
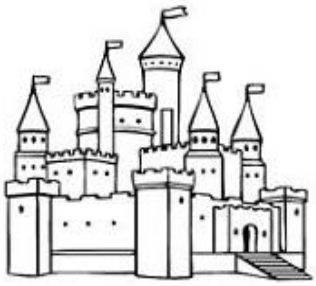
	anchor		mango
	bee		belt
	carrot		bowl
	castle		chair
	comb		cup

Table A-3 Semantically Related Line Drawing Context Picture Distracters (Cont.)

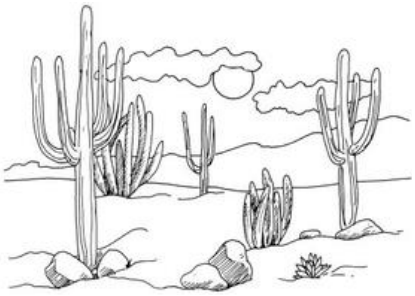
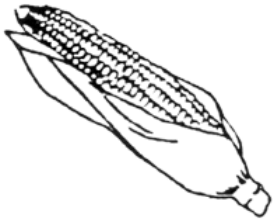
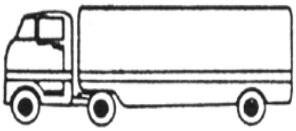
	desert		hanger
	cucumber		corn
	leaf		leash
	lion		lorry
	monk		mountain

Table A-3 Semantically Related Line Drawing Context Picture Distracters (Cont.)

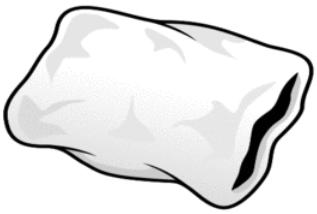
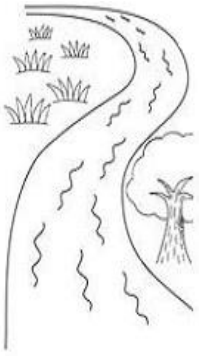
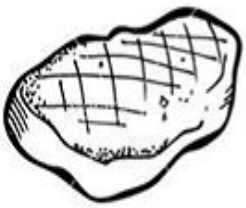
	nose		onion
	pillow		pumpkin
	monkey		river
	soup		spoon
	steak		strawberry

Table A-3 Semantically Related Line Drawing Context Picture Distracters (Cont.)

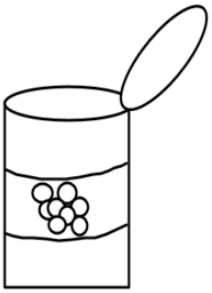
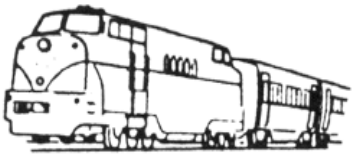
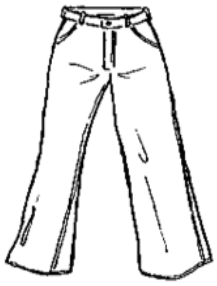
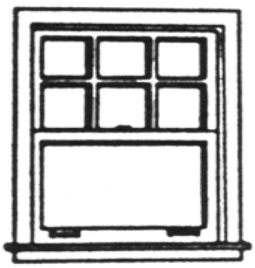
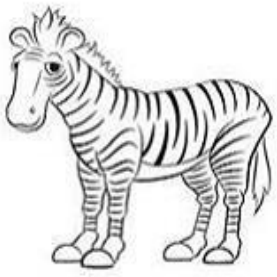
	thumb		tin
	tomato		train
	trousers		umbrella
	watermelon		wheel
	window		zebra

Table A-4 Semantically Unrelated Line Drawing Context Picture Distracters

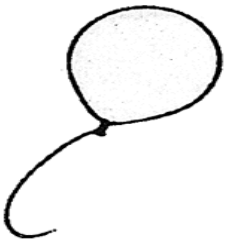
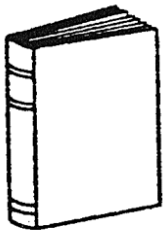
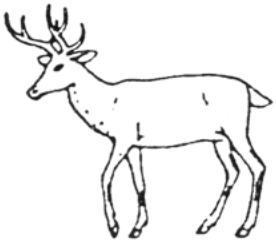
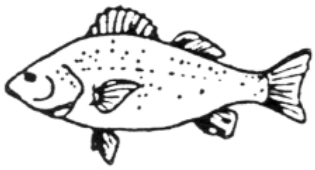
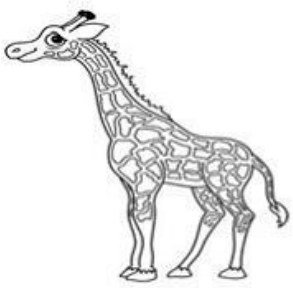
	axe		balloon
	ant		book
	deer		eye
	fish		fly
	frog		giraffe

Table A-4 Semantically Unrelated Line Drawing Context Picture Distracters (Cont.)

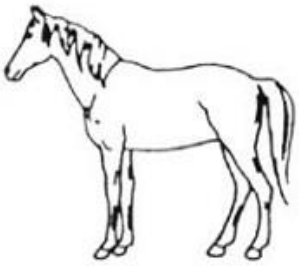
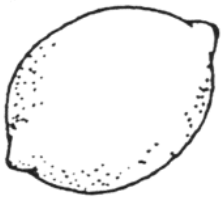
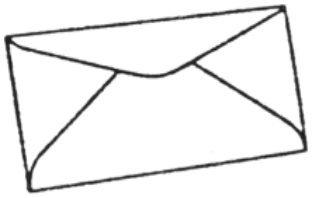
	glasses		glove
	hammer		hand
	hat		key
	horse		Lemon
	letter		moon

Table A-4 Semantically Unrelated Line Drawing Context Picture Distracters (Cont.)

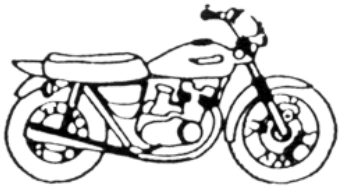
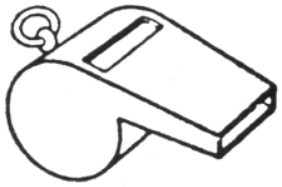
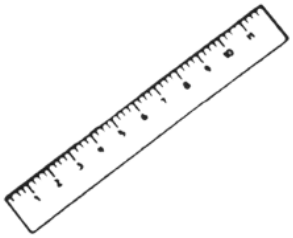
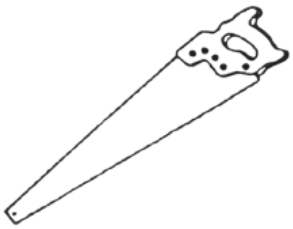
	motorbike		mouse
	whistle		pen
	pencil		piano
	ruler		shaw
	spider		star

Table A-4 Semantically Unrelated Line Drawing Context Picture Distracters (Cont.)

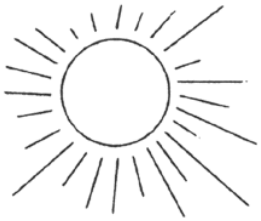
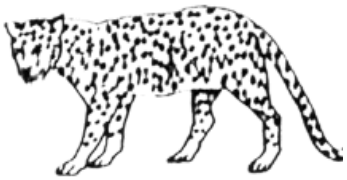
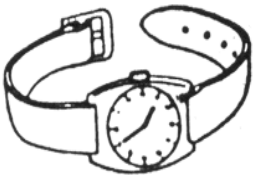
	sun		swan
	telephone		gun
	tie		tiger
	trumpet		vase
	violin		watch

Table A-5 Blocks Design for the Language Speech Productions (Block I)

No.	Code for DMDX	Stimuli	Context Word Distracters	Kind of Context Distracters
1	14191	garlic	onion	semantically related
2	10721	knife	steak	semantically related
3	11131	tree	leaf	semantically related
4	11641	house	window	semantically related
5	12361	hair	comb	semantically related
6	12871	camel	desert	semantically related
7	11131	dog	leash	semantically related
8	13171	cow	zebra	semantically related
9	13381	bed	pillow	semantically related
10	10921	pot	soup	semantically related
11	10311	eggplant	tomato	semantically related
12	10821	glass	cup	semantically related
13	11231	rain	umbrella	semantically related
14	11951	airplane	lorry	semantically related
15	12661	ear	nose	semantically related
16	13481	wardrobe	hanger	semantically related
17	13581	table	chair	semantically related
18	13791	pomegranate	durian	semantically related
19	13891	apple	mango	semantically related
20	10411	potato	pumpkin	semantically related
21	10512	cabbage	glove	semantically unrelated
22	11022	kettle	sun	semantically unrelated
23	11332	hill	swan	semantically unrelated
24	10312	bridge	whistle	semantically unrelated
25	12052	car	tiger	semantically unrelated
26	12462	waist	deer	semantically unrelated
27	12972	rabbit	watch	semantically unrelated
28	13992	orange	letter	semantically unrelated
29	11842	temple	tie	semantically unrelated
30	12762	finger	book	semantically unrelated
31	10212	bean	horse	semantically unrelated
32	10622	fork	vase	semantically unrelated
33	11432	flower	hammer	semantically unrelated
34	11742	pagoda	pen	semantically unrelated
35	12152	cart	violin	semantically unrelated
36	12252	ship	spider	semantically unrelated
37	12562	leg	trumpet	semantically unrelated
38	13272	cat	gun	semantically unrelated
39	13682	couch	glass	semantically unrelated
40	14092	grape	fly	semantically unrelated

Table A-6 Blocks Design for the Language Speech Productions (Block II)

No.	Code	Stimuli	Context Word Distracters	Kind of Context Distracters
1	10211	bean	corn	semantically related
2	11431	flower	bee	semantically related
3	11541	bridge	river	semantically related
4	11741	pagoda	monk	semantically related
5	12151	cart	wheel	semantically related
6	12251	ship	anchor	semantically related
7	12461	waist	belt	semantically related
8	12561	leg	trousers	semantically related
9	12971	rabbit	carrot	semantically related
10	14091	grape	tin	semantically related
11	10511	cabbage	cucumber	semantically related
12	10621	fork	spoon	semantically related
13	11021	kettle	bowl	semantically related
14	11331	hill	mountain	semantically related
15	11841	temple	castle	semantically related
16	12051	car	train	semantically related
17	12761	finger	thumb	semantically related
18	13271	cat	lion	semantically related
19	13681	couch	television	semantically related
20	13991	orange	watermelon	semantically related
21	14192	garlic	ant	semantically unrelated
22	10312	eggplant	ruler	semantically unrelated
23	10412	potato	motorbike	semantically unrelated
24	10722	knife	lemon	semantically unrelated
25	10822	glass	key	semantically unrelated
26	10922	pot	moon	semantically unrelated
27	11132	tree	balloon	semantically unrelated
28	11232	rain	mouse	semantically unrelated
29	11642	house	pencil	semantically unrelated
30	11952	airplane	hand	semantically unrelated
31	12362	hair	telephone	semantically unrelated
32	12662	ear	star	semantically unrelated
33	12872	camel	piano	semantically unrelated
34	13072	dog	axe	semantically unrelated
35	11641	cow	window	semantically unrelated
36	13382	bed	fish	semantically unrelated
37	13482	wardrobe	frog	semantically unrelated
38	13582	table	giraffe	semantically unrelated
39	13792	pomegranate	eye	semantically unrelated
40	13892	apple	hat	semantically unrelated

Table A-7 DMDX Code for language speech production at 0 ms of SOA

DMDX Syntax for Context Word and Picture Distracters at 0 ms of SOA
<ep><azk><fd 500><d 300><t 3000><s 40><id digitalVOX><id RecordVocal 3000><id Keyboard><MapRequest +space><dbc 255255255><vm 1366,768,768,32,60><dfs 52><cr><clfb><rcot><eop> $ 0 <ln -3> “Language Speech Production Test”, <ln -1> "Translate the following words into Khmer.", <ln 2>“Press SPACE to start.”; $ =10111 "+"<fd 30> / * "garlic",<XY 0.6, 0.1><bmp>"onion"; =10721 "+"<fd 30> / * "knife",<XY 0.6, 0.1><bmp>"steak"; =11131 "+"<fd 30> / * "tree",<XY 0.6, 0.1><bmp>"leaf"; =11641 "+"<fd 30> / * "house",<XY 0.6, 0.1><bmp>"window"; =12361 "+"<fd 30> / * "hair",<XY 0.6, 0.1><bmp>"comb"; =12871 "+"<fd 30> / * "camel",<XY 0.6, 0.1><bmp>"desert"; =13071 "+"<fd 30> / * "dog",<XY 0.6, 0.1><bmp>"leash"; =13171 "+"<fd 30> / * "cow",<XY 0.6, 0.1><bmp>"zebra"; =13381 "+"<fd 30> / * "bed",<XY 0.6, 0.1><bmp>"pillow"; =10921 "+"<fd 30> / * "pot",<XY 0.6, 0.1><bmp>"soup"; =10311 "+"<fd 30> / * "eggplant",<XY 0.6, 0.1><bmp>"tomato"; =10821 "+"<fd 30> / * "glass",<XY 0.6, 0.1><bmp>"cup"; =11231 "+"<fd 30> / * "rain",<XY 0.6, 0.1><bmp>"umbrella"; =11951 "+"<fd 30> / * "airplane",<XY 0.6, 0.1><bmp>"lorry"; =12661 "+"<fd 30> / * "ear",<XY 0.6, 0.1><bmp>"nose"; =13481 "+"<fd 30> / * "wardrobe",<XY 0.6, 0.1><bmp>"hanger"; =13581 "+"<fd 30> / * "table",<XY 0.6, 0.1><bmp>"chair"; =13791 "+"<fd 30> / * "pomegranate",<XY 0.6, 0.1><bmp>"durian"; =13891 "+"<fd 30> / * "apple",<XY 0.6, 0.1><bmp>"mango"; =10411 "+"<fd 30> / * "potato",<XY 0.6, 0.1><bmp>"pumpkin"; =10512 "+"<fd 30> / * "cabbage",<XY 0.6, 0.1><bmp>"glove"; =11022 "+"<fd 30> / * "kettle",<XY 0.6, 0.1><bmp>"sun"; =11332 "+"<fd 30> / * "hill",<XY 0.6, 0.1><bmp>"swan"; =11542 "+"<fd 30> / * "bridge",<XY 0.6, 0.1><bmp>"whistle"; =12052 "+"<fd 30> / * "car",<XY 0.6, 0.1><bmp>"tiger"; =12462 "+"<fd 30> / * "waist",<XY 0.6, 0.1><bmp>"deer"; =12972 "+"<fd 30> / * "rabbit",<XY 0.6, 0.1><bmp>"watch"; =13992 "+"<fd 30> / * "orange",<XY 0.6, 0.1><bmp>"letter"; =11842 "+"<fd 30> / * "temple",<XY 0.6, 0.1><bmp>"tie"; =12762 "+"<fd 30> / * "finger",<XY 0.6, 0.1><bmp>"book"; =10212 "+"<fd 30> / * "bean",<XY 0.6, 0.1><bmp>"horse"; =10622 "+"<fd 30> / * "fork",<XY 0.6, 0.1><bmp>"vase"; =11432 "+"<fd 30> / * "flower",<XY 0.6, 0.1><bmp>"hammer"; =11742 "+"<fd 30> / * "pagoda",<XY 0.6, 0.1><bmp>"pen"; =12152 "+"<fd 30> / * "cart",<XY 0.6, 0.1><bmp>"violin"; =12252 "+"<fd 30> / * "ship",<XY 0.6, 0.1><bmp>"spider"; =12562 "+"<fd 30> / * "leg",<XY 0.6, 0.1><bmp>"trumpet";

Table A-7 DMDX Code for language speech production at 0 ms of SOA (Cont.)

DMDX Syntax for Context Word and Picture Distracters at 0 ms of SOA
=13272 "+"<fd 30> / * "cat",<XY 0.6, 0.1><bmp>"gun"; =13682 "+"<fd 30> / * "couch",<XY 0.6, 0.1><bmp>"glasses"; =14092 "+"<fd 30> / * "grape",<XY 0.6, 0.1><bmp>"fly"; $ 0 <ln 0> "Press SPACE to Continue to Block II"; $ =10211 "+"<fd 30> / * "bean",<XY 0.6, 0.1><bmp>"corn"; =11431 "+"<fd 30> / * "flower",<XY 0.6, 0.1><bmp>"bee"; =11541 "+"<fd 30> / * "bridge",<XY 0.6, 0.1><bmp>"river"; =11741 "+"<fd 30> / * "pagoda",<XY 0.6, 0.1><bmp>"monk"; =12151 "+"<fd 30> / * "cart",<XY 0.6, 0.1><bmp>"wheel"; =12251 "+"<fd 30> / * "ship",<XY 0.6, 0.1><bmp>"anchor"; =12461 "+"<fd 30> / * "waist",<XY 0.6, 0.1><bmp>"belt"; =12561 "+"<fd 30> / * "leg",<XY 0.6, 0.1><bmp>"trousers"; =12971 "+"<fd 30> / * "rabbit",<XY 0.6, 0.1><bmp>"carrot"; =14091 "+"<fd 30> / * "grape",<XY 0.6, 0.1><bmp>"tin"; =10511 "+"<fd 30> / * "cabbage",<XY 0.6, 0.1><bmp>"cucumber"; =10621 "+"<fd 30> / * "fork",<XY 0.6, 0.1><bmp>"spoon"; =11021 "+"<fd 30> / * "kettle",<XY 0.6, 0.1><bmp>"bowl"; =11331 "+"<fd 30> / * "hill",<XY 0.6, 0.1><bmp>"mountain"; =11841 "+"<fd 30> / * "temple",<XY 0.6, 0.1><bmp>"castle"; =12051 "+"<fd 30> / * "car",<XY 0.6, 0.1><bmp>"train"; =12761 "+"<fd 30> / * "finger",<XY 0.6, 0.1><bmp>"thumb"; =13271 "+"<fd 30> / * "cat",<XY 0.6, 0.1><bmp>"lion"; =13681 "+"<fd 30> / * "couch",<XY 0.6, 0.1><bmp>"television"; =13991 "+"<fd 30> / * "orange",<XY 0.6, 0.1><bmp>"watermelon"; =10112 "+"<fd 30> / * "garlic",<XY 0.6, 0.1><bmp>"ant"; =10312 "+"<fd 30> / * "eggplant",<XY 0.6, 0.1><bmp>"ruler"; =10412 "+"<fd 30> / * "potato",<XY 0.6, 0.1><bmp>"motorbike"; =10722 "+"<fd 30> / * "knife",<XY 0.6, 0.1><bmp>"lemon"; =10822 "+"<fd 30> / * "glass",<XY 0.6, 0.1><bmp>"key"; =10922 "+"<fd 30> / * "pot",<XY 0.6, 0.1><bmp>"moon"; =11132 "+"<fd 30> / * "tree",<XY 0.6, 0.1><bmp>"balloon"; =11232 "+"<fd 30> / * "rain",<XY 0.6, 0.1><bmp>"mouse"; =11642 "+"<fd 30> / * "house",<XY 0.6, 0.1><bmp>"pencil"; =11952 "+"<fd 30> / * "airplane",<XY 0.6, 0.1><bmp>"hand"; =12362 "+"<fd 30> / * "hair",<XY 0.6, 0.1><bmp>"telephone"; =12662 "+"<fd 30> / * "ear",<XY 0.6, 0.1><bmp>"star"; =12872 "+"<fd 30> / * "camel",<XY 0.6, 0.1><bmp>"piano"; =13072 "+"<fd 30> / * "dog",<XY 0.6, 0.1><bmp>"axe"; =13172 "+"<fd 30> / * "cow",<XY 0.6, 0.1><bmp>"shaw"; =13382 "+"<fd 30> / * "bed",<XY 0.6, 0.1><bmp>"fish"; =13482 "+"<fd 30> / * "wardrobe",<XY 0.6, 0.1><bmp>"frog"; =13582 "+"<fd 30> / * "table",<XY 0.6, 0.1><bmp>"giraffe";

Table A-7 DMDX Code for language speech production at 0 ms of SOA (Cont.)

```
=13792 "+"<fd 30> / * "pomegranate",<XY 0.6, 0.1><bmp>"eye";
=13892 "+"<fd 30> / * "apple",<XY 0.6, 0.1><bmp>"hat";
$
0          <ln 0>“End of the Experiment.”;
$
```

Table A-8 DMDX Code for language speech production at +500 ms of SOA

DMDX Syntax for Context Word and Picture Distracters at +500 ms of SOA

```
<ep><azk><fd 500><d 300><t 3000><s 40><id digitalVOX><id RecordVocal
3000><id Keyboard><MapRequest +space><dbc 255255255><dfs 52><vm
1366,768,768,32,60> <cr> <clfb> <rcot> <eop>
$
0 <ln -3> “Language Speech Production Test”, <ln -1> "Translate the following
words into Khmer.", <ln 2>“Press SPACE to start.”;
$
=10111 "+"<fd 30> / * "garlic"<fd 30> / "garlic",<XY 0.6, 0.2><bmp>"onion";
=10721 "+"<fd 30> / * "knife"<fd 30> / "knife",<XY 0.6, 0.2><bmp>"steak";
=11131 "+"<fd 30> / * "tree"<fd 30> / "tree",<XY 0.6, 0.2><bmp>"leaf";
=11641 "+"<fd 30> / * "house"<fd 30> / "house",<XY 0.6, 0.2><bmp>"window";
=12361 "+"<fd 30> / * "hair"<fd 30> / "hair",<XY 0.6, 0.2><bmp>"comb";
=12871 "+"<fd 30> / * "camel"<fd 30> / "camel",<XY 0.6, 0.2><bmp>"desert";
=13071 "+"<fd 30> / * "dog"<fd 30> / "dog",<XY 0.6, 0.2><bmp>"leash";
=13171 "+"<fd 30> / * "cow"<fd 30> / "cow",<XY 0.6, 0.2><bmp>"zebra";
=13381 "+"<fd 30> / * "bed"<fd 30> / "bed",<XY 0.6, 0.2><bmp>"pillow";
=10921 "+"<fd 30> / * "pot"<fd 30> / "pot",<XY 0.6, 0.2><bmp>"soup";
=10311 "+"<fd 30> / * "eggplant"<fd 30> / "eggplant",<XY 0.6,
0.2><bmp>"tomato";
=10821 "+"<fd 30> / * "glass"<fd 30> / "glass",<XY 0.6, 0.2><bmp>"cup";
=11231 "+"<fd 30> / * "rain"<fd 30> / "rain",<XY 0.6, 0.2><bmp>"umbrella";
=11951 "+"<fd 30> / * "airplane"<fd 30> / "airplane",<XY 0.6, 0.2><bmp>"lorry";
=12661 "+"<fd 30> / * "ear"<fd 30> / "ear",<XY 0.6, 0.2><bmp>"nose";
=13481 "+"<fd 30> / * "wardrobe"<fd 30> / "wardrobe",<XY 0.6,
0.2><bmp>"hanger";
=13581 "+"<fd 30> / * "table"<fd 30> / "table",<XY 0.6, 0.2><bmp>"chair";
=13791 "+"<fd 30> / * "pomegranate"<fd 30> / "pomegranate",<XY 0.6,
0.2><bmp>"durian";
=13891 "+"<fd 30> / * "apple"<fd 30> / "apple",<XY 0.6, 0.2><bmp>"mango";
=10411 "+"<fd 30> / * "potato"<fd 30> / "potato",<XY 0.6, 0.2><bmp>"pumpkin";
=10512 "+"<fd 30> / * "cabbage"<fd 30> / "cabbage",<XY 0.6, 0.2><bmp>"glove";
=11022 "+"<fd 30> / * "kettle"<fd 30> / "kettle",<XY 0.6, 0.2><bmp>"sun";
=11332 "+"<fd 30> / * "hill"<fd 30> / "hill",<XY 0.6, 0.2><bmp>"swan";
=11542 "+"<fd 30> / * "bridge"<fd 30> / "bridge",<XY 0.6, 0.2><bmp>"whistle";
=12052 "+"<fd 30> / * "car"<fd 30> / "car",<XY 0.6, 0.2><bmp>"tiger";
```

Table A-8 DMDX Code for language speech production at +500 ms of SOA (Cont.)

DMDX Syntax for Context Word and Picture Distracters at +500 ms of SOA

```
=12462 "+"<fd 30> / * "waist"<fd 30> / "waist",<XY 0.6, 0.2><bmp>"deer";
=12972 "+"<fd 30> / * "rabbit"<fd 30> / "rabbit",<XY 0.6, 0.2><bmp>"watch";
=13992 "+"<fd 30> / * "orange"<fd 30> / "orange",<XY 0.6, 0.2><bmp>"letter";
=11842 "+"<fd 30> / * "temple"<fd 30> / "temple",<XY 0.6, 0.2><bmp>"tie";
=12762 "+"<fd 30> / * "finger"<fd 30> / "finger",<XY 0.6, 0.2><bmp>"book";
=10212 "+"<fd 30> / * "bean"<fd 30> / "bean",<XY 0.6, 0.2><bmp>"horse";
=10622 "+"<fd 30> / * "fork"<fd 30> / "fork",<XY 0.6, 0.2><bmp>"vase";
=11432 "+"<fd 30> / * "flower"<fd 30> / "flower",<XY 0.6, 0.2><bmp>"hammer";
=11742 "+"<fd 30> / * "pagoda"<fd 30> / "pagoda",<XY 0.6, 0.2><bmp>"pen";
=12152 "+"<fd 30> / * "cart"<fd 30> / "cart",<XY 0.6, 0.2><bmp>"violin";
=12252 "+"<fd 30> / * "ship"<fd 30> / "ship",<XY 0.6, 0.2><bmp>"spider";
=12562 "+"<fd 30> / * "leg"<fd 30> / "leg",<XY 0.6, 0.2><bmp>"trumpet";
=13272 "+"<fd 30> / * "cat"<fd 30> / "cat",<XY 0.6, 0.2><bmp>"gun";
=13682 "+"<fd 30> / * "couch"<fd 30> / "couch",<XY 0.6, 0.2><bmp>"glasses";
=14092 "+"<fd 30> / * "grape"<fd 30> / "grape",<XY 0.6, 0.2><bmp>"fly";
$
 0 <ln 0> "Press SPACE to Continue to Block II";
$
=10211 "+"<fd 30> / * "bean"<fd 30> / "bean",<XY 0.6, 0.2><bmp>"corn";
=11431 "+"<fd 30> / * "flower"<fd 30> / "flower",<XY 0.6, 0.2><bmp>"bee";
=11541 "+"<fd 30> / * "bridge"<fd 30> / "bridge",<XY 0.6, 0.2><bmp>"river";
=11741 "+"<fd 30> / * "pagoda"<fd 30> / "pagoda",<XY 0.6, 0.2><bmp>"monk";
=12151 "+"<fd 30> / * "cart"<fd 30> / "cart",<XY 0.6, 0.2><bmp>"wheel";
=12251 "+"<fd 30> / * "ship"<fd 30> / "ship",<XY 0.6, 0.2><bmp>"anchor";
=12461 "+"<fd 30> / * "waist"<fd 30> / "waist",<XY 0.6, 0.2><bmp>"belt";
=12561 "+"<fd 30> / * "leg"<fd 30> / "leg",<XY 0.6, 0.2><bmp>"trousers";
=12971 "+"<fd 30> / * "rabbit"<fd 30> / "rabbit",<XY 0.6, 0.2><bmp>"carrot";
=14091 "+"<fd 30> / * "grape"<fd 30> / "grape",<XY 0.6, 0.2><bmp>"tin";
=10511 "+"<fd 30> / * "cabbage"<fd 30> / "cabbage",<XY 0.6,
0.2><bmp>"cucumber";
=10621 "+"<fd 30> / * "fork"<fd 30> / "fork",<XY 0.6, 0.2><bmp>"spoon";
=11021 "+"<fd 30> / * "kettle"<fd 30> / "kettle",<XY 0.6, 0.2><bmp>"bowl";
=11331 "+"<fd 30> / * "hill"<fd 30> / "hill",<XY 0.6, 0.2><bmp>"mountain";
=11841 "+"<fd 30> / * "temple"<fd 30> / "temple",<XY 0.6, 0.2><bmp>"castle";
=12051 "+"<fd 30> / * "car"<fd 30> / "car",<XY 0.6, 0.2><bmp>"train";
=12761 "+"<fd 30> / * "finger"<fd 30> / "finger",<XY 0.6, 0.2><bmp>"thumb";
=13271 "+"<fd 30> / * "cat"<fd 30> / "cat",<XY 0.6, 0.2><bmp>"lion";
=13681 "+"<fd 30> / * "couch"<fd 30> / "couch",<XY 0.6, 0.2><bmp>"television";
=13991 "+"<fd 30> / * "orange"<fd 30> / "orange",<XY 0.6,
0.2><bmp>"watermelon";
=10112 "+"<fd 30> / * "garlic"<fd 30> / "garlic",<XY 0.6, 0.2><bmp>"ant";
=10312 "+"<fd 30> / * "eggplant"<fd 30> / "eggplant",<XY 0.6, 0.2><bmp>"ruler";
=10412 "+"<fd 30> / * "potato"<fd 30> / "potato",<XY 0.6,
0.2><bmp>"motorbike";
```

Table A-8 DMDX Code for language speech production at +500 ms of SOA (Cont.)

DMDX Syntax for Context Word and Picture Distracters at +500 ms of SOA
=10722 "+"<fd 30> / * "knife"<fd 30> / "knife",<XY 0.6, 0.2><bmp>"lemon"; =10822 "+"<fd 30> / * "glass"<fd 30> / "glass",<XY 0.6, 0.2><bmp>"key"; =10922 "+"<fd 30> / * "pot"<fd 30> / "pot",<XY 0.6, 0.2><bmp>"moon"; =11132 "+"<fd 30> / * "tree"<fd 30> / "tree",<XY 0.6, 0.2><bmp>"balloon"; =11232 "+"<fd 30> / * "rain"<fd 30> / "rain",<XY 0.6, 0.2><bmp>"mouse"; =11642 "+"<fd 30> / * "house"<fd 30> / "house",<XY 0.6, 0.2><bmp>"pencil"; =11952 "+"<fd 30> / * "airplane"<fd 30> / "airplane",<XY 0.6, 0.2><bmp>"hand"; =12362 "+"<fd 30> / * "hair"<fd 30> / "hair",<XY 0.6, 0.2><bmp>"telephone"; =12662 "+"<fd 30> / * "ear"<fd 30> / "ear",<XY 0.6, 0.2><bmp>"star"; =12872 "+"<fd 30> / * "camel"<fd 30> / "camel",<XY 0.6, 0.2><bmp>"piano"; =13072 "+"<fd 30> / * "dog"<fd 30> / "dog",<XY 0.6, 0.2><bmp>"axe"; =13172 "+"<fd 30> / * "cow"<fd 30> / "cow",<XY 0.6, 0.2><bmp>"shaw"; =13382 "+"<fd 30> / * "bed"<fd 30> / "bed",<XY 0.6, 0.2><bmp>"fish"; =13482 "+"<fd 30> / * "wardrobe"<fd 30> / "wardrobe",<XY 0.6, 0.2><bmp>"frog"; =13582 "+"<fd 30> / * "table"<fd 30> / "table",<XY 0.6, 0.2><bmp>"giraffe"; =13792 "+"<fd 30> / * "pomegranate"<fd 30> / "pomegranate",<XY 0.6, 0.2><bmp>"eye"; =13892 "+"<fd 30> / * "apple"<fd 30> / "apple",<XY 0.6, 0.2><bmp>"hat"; $ 0 <ln 0>“End of the Experiment.”; $

Note:

- ❖ DMDX Syntax for context picture and word distracters were the same because context word distracters in L1 (Khmer) were converted into picture file (bmp.) as Khmer font was not fully supported by DMDX software.
- ❖ Context word distracters in Khmer (L1) were used in DaunPenh with 42.5 font size and the presenting stimuli in English (L2) were in Time New Roman font 52. This would make both the stimuli and context distracters consistent in size.

APPENDIX B

1. Permission letter and approval of data collections
2. Example of Participants' Consent Form
3. Language History Questionnaire
4. Familiarization Task
5. Evaluation of the Appropriateness and Consistency of the Presenting Stimuli and Context Distracters in DMDX Software Program

College of Research Methodology and Cognitive Science,
Burapha University, Bangsaen, Chunbori 20131, Thailand
Tel: +66 38102077 Fax: +66 38393484 http://rmcs.buu.ac.th/

May 12, 2015

BELTEI International University
No. 21, St. 360, Sangkat Boeung Keng Kang III,
Khan Chamkar Morn, 12304 Phnom Penh, Cambodia

Subject: Asking for permission for data collection

To whom it may concern,

Mr. Dam Soksan is a master degree student at the College of Research Methodology and Cognitive Science, Burapha University, Thailand. Presently, Mr. Dam is in the process of conducting his master thesis entitled: Effects of Language Development on Bilinguals' Concept Selections: A Case Study of Language Speech Production Task in the Khmer-English Bilingual Context under direct supervision of Asst. Prof. Dr. Suchada Kompetpanee.

In this regard, I am writing to ask for your permission to allow Mr. Dam to carry on data collections at your institution where he is planning to conduct an experiment known as Language Stroop Translation Task operated by psychological software program DMDX with 60 participants who are currently pursuing their bachelor degree in your university. Each subject will be asked to translate the presenting stimuli in L2 (English) into L1 (Khmer) under semantically related and unrelated context word and picture distracters. His experiment will begin from May 2015 to July 2015. Should you have further inquiry regarding this project, please directly contact Mr. Dam at damsoksan@gmail.com.

Your kind cooperation for this matter will be highly appreciated.

Yours sincerely,

Suchada Kompetpanee

Asst. Prof. Dr. Suchada Kompetpanee
Dean of College of Research Methodology and Cognitive Science
Burapha University, Thailand
Tel: +66 38102077 Fax: +66 3839 3484
Website: http://rmcs.buu.ac.th/

Seen and approved
Mr. Rathana prepare to him.
18/5/15

Participants' Consent Form

Dear_____,

I am a master degree student in College of Research Methodology and Cognitive Science, Burapha University, Thailand. My research thesis entitled "Effects of Language Development on Bilinguals' Concept Selections: A Case Study of Language Speech Production Task in the Khmer-English Bilingual Context". The main objective is to find out the locus of concept selections of bilinguals during language speech production task.

This study will be an experimental research. If you agree to participate in this study, you will be required to involve in the experiment known as language speech production task. This experiment will be operated in a psychological software program called DMDX version 5.1.2.1. During the experiment, you will be asked to translate the presenting stimuli which are all English words (L2) into Khmer (L1) by ignoring the context distracters. This experiment will take from 40-50 minutes. Prior to the experiment, you will be obliged to take part in the language production test which will last for 10 minutes. Additionally, you will be kindly asked to complete the language history questionnaire to measure you first and second language background.

You can leave from this experiment at any time without any penalty. The researcher ensures to keep your identity confidential.

If you feel doubtful about the experiment, please feel free to consult with Mr. Soksan Dam, a researcher directly via email: damsoksan@gmail.com. Your cooperation is the most precious for this experimental research.

Please sign your name below to ensure that you agree to involve in this study

_____	_____
Signature of Subject	Date
_____	_____
Signature of Witness	Signature of Experimenter

Language History Questionnaire

This questionnaire is designed to find out participants' language competences and experiences. Please give accurate answers which truly define your language history.

General Background Questions

1. Gender

   ☐ Female ☐ Male

2. Age

   ☐ less than 18 years old ☐ 18-20 years old

   ☐ 21-23 years old ☐ more than 23 years old

3. Do you have visual problems with your sight?

   ☐ Yes ☐ No

   (If your answer is "Yes", do not proceed to the next question)

4. Have you ever had past history accident severely affecting your brain?

   ☐ Yes ☐ No

   (If your answer is "Yes", do not proceed to the next question)

Languages

5. What is your first language?

   ☐ Khmer ☐ Other _____(please specify)

6. What is your home spoken language?

   ☐ Khmer ☐ Other _____(please specify)

7. What is the estimated amount of time you use English at school?

   ☐ Never ☐ Rarely ☐ Sometimes

   ☐ Very often ☐ Always

8. What is the estimated amount of time you use English with your friends?

   ☐ Never ☐ Rarely ☐ Sometimes

   ☐ Very often ☐ Always

9. What is the estimated amount of time you have studied English?

☐ Less than 2 years ☐ 2-3 years ☐ 4-5 years

☐ 6-7 years ☐ 8-9 years ☐ More than 10 years

Khmer Skills

10. How is your Khmer reading proficiency?

☐ Very poor ☐ Poor ☐ Barely acceptable

☐ Good ☐ Very good

11. How is your Khmer writing proficiency?

☐ Very poor ☐ Poor ☐ Barely acceptable

☐ Good ☐ Very good

12. How is your Khmer speaking proficiency?

☐ Very poor ☐ Poor ☐ Barely acceptable

☐ Good ☐ Very good

13. How is your speech comprehension ability in Khmer?

☐ Very poor ☐ Poor ☐ Barely acceptable

☐ Good ☐ Very good

14. How comfortable do you feel when expressing yourself in Khmer?

☐ Very poor ☐ Poor ☐ Barely acceptable

☐ Good ☐ Very good

English Skills

15. How is your English reading proficiency?

☐ Very poor ☐ Poor ☐ Barely acceptable

☐ Good ☐ Very good

16. How is your English writing proficiency?

☐ Very poor ☐ Poor ☐ Barely acceptable

☐ Good ☐ Very good

17. How is your English speaking proficiency?

☐ Very poor ☐ Poor ☐ Barely acceptable

☐ Good ☐ Very good

18. How is your speech comprehension ability?

☐ Very poor ☐ Poor ☐ Barely acceptable

☐ Good ☐ Very good

19. How comfortable do you feel when expressing yourself in English?

☐ Very poor ☐ Poor ☐ Barely acceptable

☐ Good ☐ Very good

20. Do you speak any other foreign language?

☐ Yes ☐ No (If “No”, skip question 21)

21. Please specify which language(s): _____.

This is the end of the questionnaire! Thanks for your cooperation!

Familiarization Task

For the following words, provide their Khmer translation equivalence. If you aren't sure of the answer, just leave it blank.

1. bean _____
2. eggplant _____
3. potato _____
4. cabbage _____
5. fork _____
6. knife _____
7. glass _____
8. pot _____
9. kettle _____
10. tree _____
11. rain _____
12. hill _____
13. flower _____
14. bridge _____
15. house _____
16. pagoda _____
17. temple _____
18. airplane _____
19. car _____
20. cart _____
21. ship _____
22. hair _____
23. waist _____
24. leg _____
25. ear _____
26. finger _____
27. camel _____
28. rabbit _____
29. dog _____
30. cow _____
31. cat _____
32. bed _____
33. wardrobe _____
34. table _____
35. couch _____
36. pomegranate _____
37. apple _____
38. orange _____
39. grape _____
40. garlic _____

This is the end of the task! Thank you!

Evaluation of the Appropriateness and Consistency of the Presenting Stimuli and Context Distracters in DMDX Software Program

Direction: Please evaluate the appropriateness and consistency of the presenting stimuli and context distracters in DMDX software program by ticking (☑) your judgments in the most appropriate column below.

DMDX Software Program	Experts' Judgment				
	Very good	**Good**	**Average**	**Poor**	**Very poor**
General views of the stimuli and context distracters					
Appropriateness of using font					
(1) font size					
(2) appropriateness of choosing font					
(3) readability of the font size					
(4) clearness of the font size					
Appropriateness of using the pictures					
(1) size of the pictures					
(2) clearness of the pictures					
(3) position of the pictures					
(4) types of picture (black & white)					
Appropriateness of running the program for the experiment					
(1) The instruction is clear.					
(2) The time set up for the fixation point is consistent for all the trials.					
(3) The time set up between the presenting stimuli and context distracters are consistent from one trial to another.					
(4) The duration of the delay time in this experiment is consistent from one trial to another.					
(5) This experimental program operates smoothly until the last trial.					
(5) The verbal recorded is clear.					
(6) The reaction time being recorded is accurate.					

DMDX Software Program	Experts' Judgment				
	Very good	**Good**	**Average**	**Poor**	**Very poor**
(7) The codes being used to recognize the presenting stimuli and context distracters are distinguishable.					

Additional Comments:

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Reviewed by: _____ Signature: _____

Thank you very much.

APEENDIX C

Table C-1 Results of the Index of Items Objective Congruence (IOC) for Semantically Related between Presenting Stimuli and Context Distracters

Item	Expert A	Expert B	Expert C	Total	IOC	Meaning
1	1	1	1	3	1.00	suitable
2	0	1	0	1	0.33	unsuitable
3	1	1	1	3	1.00	suitable
4	1	1	1	3	1.00	suitable
5	1	1	1	3	1.00	suitable
6	1	1	1	3	1.00	suitable
7	1	1	0	2	0.67	suitable
8	1	1	1	3	1.00	suitable
9	1	1	1	3	1.00	suitable
10	1	1	-1	2	0.67	suitable
11	1	1	1	3	1.00	suitable
12	-1	1	-1	1	0.33	unsuitable
13	1	1	1	3	1.00	suitable
14	1	1	1	3	1.00	suitable
15	1	1	1	3	1.00	suitable
16	1	1	1	3	1.00	suitable
17	1	1	1	3	1.00	suitable
18	1	1	-1	2	0.67	suitable
19	1	1	1	3	1.00	suitable
20	1	1	1	3	1.00	suitable
21	1	1	1	3	1.00	suitable
22	1	1	1	3	1.00	suitable
23	1	1	1	3	1.00	suitable
24	1	1	1	3	1.00	suitable
25	1	1	1	3	1.00	suitable
26	1	1	1	3	1.00	suitable
27	1	1	1	3	1.00	suitable
28	1	1	1	3	1.00	suitable
29	1	1	1	3	1.00	suitable
30	1	1	1	3	1.00	suitable
31	1	1	1	3	1.00	suitable
32	-1	1	1	2	0.67	suitable
33	1	1	1	3	1.00	suitable
34	1	1	1	3	1.00	suitable
35	1	1	1	3	1.00	suitable
36	-1	1	1	2	0.67	suitable
37	1	1	1	3	1.00	suitable

Table C-1 Results of the Index of Items Objective Congruence (IOC) for Semantically Related between Presenting Stimuli and Context Distracters (Cont.)

Item	Expert A	Expert B	Expert C	Total	IOC	Meaning
38	1	1	1	3	1.00	suitable
39	1	1	1	3	1.00	suitable
40	1	1	-1	2	0.67	suitable
Total (mean)					0.92	suitable

$$\text{IOC} = \frac{\sum E}{N}$$

$\sum E$ = Total Score of Experts' Opinion

N = Number of the experts

IOC value $\leq .50$ means unsuitable

IOC value $\geq .50$ means suitable

Table C-2 Results of the Index of Items Objective Congruence (IOC) for Semantically Unrelated between Presenting Stimuli and Context Distracters

Item	Expert A	Expert B	Expert C	Total	IOC	Meaning
1	1	1	1	3	1	suitable
2	1	1	1	3	1	suitable
3	1	1	1	3	1	suitable
4	1	1	1	3	1	suitable
5	1	1	1	3	1	suitable
6	1	1	1	3	1	suitable
7	1	1	1	3	1	suitable
8	1	1	1	3	1	suitable
9	1	1	1	3	1	suitable
10	1	1	1	3	1	suitable
11	1	1	1	3	1	suitable
12	1	1	1	3	1	suitable
13	1	1	1	3	1	suitable
14	1	1	1	3	1	suitable
15	1	1	1	3	1	suitable
16	1	1	1	3	1	suitable
17	1	1	1	3	1	suitable
18	1	1	1	3	1	suitable
19	1	1	1	3	1	suitable
20	1	1	1	3	1	suitable
21	1	1	1	3	1	suitable
22	1	1	1	3	1	suitable
23	1	1	1	3	1	suitable
24	1	1	1	3	1	suitable
25	1	1	1	3	1	suitable
26	1	1	1	3	1	suitable
27	1	1	1	3	1	suitable
28	1	1	1	3	1	suitable
29	1	1	1	3	1	suitable
30	1	1	1	3	1	suitable
31	1	1	1	3	1	suitable
32	1	1	1	3	1	suitable
33	1	1	1	3	1	suitable
34	1	1	1	3	1	suitable
35	1	1	1	3	1	suitable
36	1	1	1	3	1	suitable

Table C-1 Results of the Index of Items Objective Congruence (IOC) for Semantically Related between Presenting Stimuli and Context Distracters (Cont.)

Item	Expert A	Expert B	Expert C	Total	IOC	Meaning
37	1	1	1	3	1	suitable
38	1	1	1	3	1	suitable
39	1	1	1	3	1	suitable
40	1	1	1	3	1	suitable
Total (mean)					1	suitable

$$\text{IOC} = \frac{\sum E}{N}$$

$\sum E$ = Total Score of Experts' Opinion

N = Number of the experts

IOC value $\leq .50$ means unsuitable

IOC value $\geq .50$ means suitable

Table C-3 Language Production Test of Less-proficient Bilinguals

No.	Subjects	Gender	Score
1	subject1	F	85
2	subject2	F	70
3	subject3	F	75
4	subject4	F	78
5	subject5	F	79
6	subject6	F	75
7	subject7	F	85
8	subject8	F	70
9	subject9	F	78
10	subject10	M	72
11	subject11	M	75
12	subject12	M	80
13	subject13	M	87
14	subject14	F	78
15	subject15	M	88
16	subject16	M	77
17	subject17	M	72
18	subject18	F	92
19	subject19	F	78
20	subject20	F	90
21	subject21	M	67
22	subject22	M	81
23	subject23	M	82
24	subject24	F	84
Average Score			79.08

Table C-4 Language Production Test of High-proficient Bilinguals

No.	Name	Gender	Score
1	subject1	M	102
2	subject2	F	117
3	subject3	M	113
4	subject4	F	105
5	subject5	F	108
6	subject6	M	115
7	subject7	F	106
8	subject8	F	107
9	subject9	M	108
10	subject10	M	108
11	subject11	M	105
12	subject12	F	111
13	subject13	F	115
14	subject14	M	108
15	subject15	F	100
16	subject16	M	117
17	subject17	M	112
18	subject18	M	107
19	subject19	M	115
20	subject20	M	114
21	subject21	M	108
22	subject22	F	105
23	subject23	M	109
24	subject24	F	100
Average Score			108.96

APPENDIX D

Descriptive Data from the Language Speech Production Tasks during the Experiment

Table D-24 Descriptive data of language speech productions of less-proficient bilinguals (LPB) (semantically unrelated context word distracters at +500 ms of SOA)

Table D-1 Descriptive data of language speech productions of high-proficient bilinguals (all context picture distracters at 0 ms of SOA)

No	No. of correct response	Reaction time (milliseconds)							
		Range	Minimum	Maximum	Sum	Mean	Mean Std. Error	Std. Deviation	Variance
HPB1	79	942.80	595.0	1537.80	66462.0	841.29	23.14	205.67	42301.61
HPB2	79	1613.5	614.6	2228.10	81282.1	1028.89	41.00	364.39	132783.43
HPB3	78	1774.4	704.3	2478.70	77825.0	997.76	31.24	275.90	76120.87
HPB4	80	1670.50	726.40	2396.90	83801.4	1047.52	32.41	289.85	84011.73
HPB5	77	1584.60	787.70	2372.30	90892.3	1180.42	39.36	345.42	119315.75
HPB6	73	2003.20	705.40	2708.60	85448.9	1170.53	44.88	383.43	147021.67
HPB7	78	1664.00	483.10	2147.10	66076.9	847.14	26.43	233.43	54488.80
HPB8	80	1480.20	823.50	2303.70	100523.3	1256.54	32.09	286.98	82358.98
HPB9	74	1245.50	538.50	1784.00	69628.7	940.93	30.20	259.76	67475.15
HPB10	72	1040.30	583.40	1623.70	64783.2	899.77	27.42	232.66	54131.88
HPB11	80	873.60	656.00	1529.60	71001.9	887.52	18.65	166.78	27815.96
HPB12	80	1652.00	791.00	2443.00	95023.4	1187.79	38.40	343.45	117956.05
HPB13	77	2016.70	708.70	2725.40	95991.4	1246.64	51.82	454.72	206773.39
HPB14	75	1880.40	663.00	2543.40	92565.8	1234.21	52.71	456.44	208338.35
HPB15	80	1096.90	634.20	1731.10	72486.9	906.09	26.58	237.76	56529.22
HPB16	73	1626.50	624.10	2250.60	84827.8	1162.02	40.21	343.53	118012.02
HPB17	72	1395.70	787.50	2183.20	80577.5	1119.13	27.36	232.13	53883.98
HPB18	77	1847.60	662.70	2510.30	85992.1	1116.78	37.73	331.06	109602.98
HPB19	78	1185.40	667.30	1852.70	87179.7	1117.69	21.68	191.45	36653.19
HPB20	78	2015.60	772.10	2787.70	93598.6	1199.98	48.56	428.89	183945.31
HPB21	78	1053.00	721.80	1774.80	79218.3	1015.62	21.37	188.78	35637.26
HPB22	63	1977.60	640.00	2617.60	61438.0	975.21	39.08	310.18	96213.12
HPB23	77	1092.90	654.30	1747.20	71695.3	931.11	24.04	210.99	44515.48
HPB24	75	1889.20	676.90	2566.10	79125.4	1055.01	32.02	277.31	76901.00

Table D-2 Descriptive data of language speech productions of high-proficient bilinguals (semantically related context picture distracters at 0 ms of SOA)

No	No. of correct response	Reaction time (milliseconds)							
		Range	Minimum	Maximum	Sum	Mean	Mean Std. Error	Std. Deviation	Variance
HPB1	39	912.60	625.20	1537.80	32159.8	824.61	33.61	209.87	44047.22
HPB2	39	1403.40	614.60	2018.00	38515.8	987.58	52.92	330.50	109231.04
HPB3	39	1774.40	704.30	2478.70	38532.7	988.02	52.53	328.05	107614.64
HPB4	40	1668.70	728.20	2396.90	41537.7	1038.44	51.54	325.99	106267.13
HPB5	38	1538.70	787.70	2326.40	43235.8	1137.78	56.02	345.31	119239.82
HPB6	36	1780.90	705.40	2486.30	40048.3	1112.45	53.71	322.25	103842.32
HPB7	38	818.70	601.50	1420.20	32043.0	843.24	30.59	188.58	35562.96
HPB8	40	1214.00	823.50	2037.50	49396.6	1234.92	42.06	266.02	70767.62
HPB9	37	1245.50	538.50	1784.00	34649.1	936.46	48.19	293.13	85924.32
HPB10	36	858.80	583.40	1442.20	30315.1	842.09	30.77	184.60	34078.97
HPB11	40	618.20	675.50	1293.70	34414.4	860.36	19.73	124.81	15577.53
HPB12	40	1246.60	820.10	2066.70	46333.8	1158.35	49.00	309.93	96059.29
HPB13	39	1724.60	708.70	2433.30	46868.8	1201.76	69.37	433.20	187666.32
HPB14	37	1880.40	663.00	2543.40	44070.5	1191.09	74.09	450.65	203084.44
HPB15	40	996.40	634.20	1630.60	35145.3	878.63	31.04	196.34	38551.04
HPB16	36	1277.70	807.80	2085.50	41720.1	1158.89	52.94	317.61	100876.85
HPB17	35	898.70	787.50	1686.20	38792.4	1108.35	38.41	227.22	51631.07
HPB18	39	823.60	784.40	1608.00	42534.4	1090.63	36.77	229.66	52743.36
HPB19	38	605.40	667.30	1272.70	39319.0	1034.71	21.96	135.40	18332.61
HPB20	38	2015.60	772.10	2787.70	41856.2	1101.48	59.16	364.69	132996.87
HPB21	38	469.40	721.80	1191.20	34756.7	914.65	19.01	117.20	13736.30
HPB22	30	857.20	640.00	1497.20	26047.1	868.24	32.99	180.67	32641.42
HPB23	37	914.40	654.30	1568.70	30874.9	834.46	26.99	164.15	26944.54
HPB24	35	820.00	676.90	1496.90	34743.6	992.67	30.48	180.30	32506.97

Table D-3 Descriptive data of language speech productions of high-proficient bilinguals (semantically unrelated context picture distracters at 0 ms of SOA)

No	No. of correct response	Reaction time (milliseconds)							
		Range	Minimum	Maximum	Sum	Mean	Mean Std. Error	Std. Deviation	Variance
HPB1	40	902.30	595.00	1497.30	34302.20	857.56	32.07	202.82	41135.88
HPB2	40	1527.50	700.60	2228.10	42766.30	1069.16	62.40	394.67	155767.4
HPB3	39	856.50	729.30	1585.80	39292.30	1007.49	34.51	215.49	46435.63
HPB4	40	924.30	726.40	1650.70	42263.70	1056.59	39.92	252.47	63741.54
HPB5	39	1568.70	803.60	2372.30	47656.50	1221.96	55.22	344.88	118940.6
HPB6	37	1910.90	797.70	2708.60	45400.60	1227.04	70.98	431.78	186430.0
HPB7	40	1664.00	483.10	2147.10	34033.90	850.85	42.96	271.68	73812.30
HPB8	40	1468.00	835.70	2303.70	51126.70	1278.17	48.76	308.39	95102.74
HPB9	37	914.50	609.50	1524.00	34979.60	945.39	37.08	225.52	50859.29
HPB10	36	1009.80	613.90	1623.70	34468.10	957.45	43.74	262.46	68887.20
HPB11	40	873.60	656.00	1529.60	36587.50	914.69	31.33	198.13	39254.04
HPB12	40	1652.00	791.00	2443.00	48689.60	1217.24	59.39	375.63	141098.5
HPB13	38	1993.10	732.30	2725.40	49122.60	1292.70	77.41	477.16	227683.7
HPB14	38	1676.30	795.40	2471.70	48495.30	1276.19	75.29	464.12	215411.9
HPB15	40	1083.50	647.60	1731.10	37341.60	933.54	43.13	272.78	74410.79
HPB16	37	1626.50	624.10	2250.60	43107.70	1165.07	61.06	371.39	137929.9
HPB17	37	1381.10	802.10	2183.20	41785.10	1129.33	39.35	239.35	57288.75
HPB18	38	1847.60	662.70	2510.30	43457.70	1143.62	66.79	411.70	169500.5
HPB19	40	990.80	861.90	1852.70	47860.70	1196.52	32.36	204.68	41891.94
HPB20	40	1929.00	816.20	2745.20	51742.40	1293.56	73.92	467.51	218562.1
HPB21	40	946.00	828.80	1774.80	44461.60	1111.54	30.81	194.83	37958.77
HPB22	33	1927.90	689.70	2617.60	35390.90	1072.45	64.28	369.26	136352.1
HPB23	40	995.30	751.90	1747.20	40820.40	1020.51	33.47	211.70	44816.15
HPB24	40	1753.40	812.70	2566.10	44381.80	1109.55	52.69	333.22	111037.7

Table D-4 Descriptive data of language speech productions of high-proficient bilinguals (all context word distracters at 0 ms of SOA)

No	No. of correct response	Reaction time (milliseconds)							
		Range	Minimum	Maximum	Sum	Mean	Mean Std. Error	Std. Deviation	Variance
HPB1	76	1886.60	500.40	2387.00	74224.90	976.64	45.13	393.44	154793.2
HPB2	80	885.40	633.10	1518.50	72256.10	903.20	21.30	190.49	36285.89
HPB3	80	1609.70	658.80	2268.50	76717.80	958.97	30.39	271.78	73865.01
HPB4	80	1391.20	643.60	2034.80	73206.20	915.08	19.89	177.92	31654.31
HPB5	78	1562.70	710.60	2273.30	83631.30	1072.20	29.09	256.96	66027.53
HPB6	70	1687.80	765.40	2453.20	81862.10	1169.46	45.06	376.96	142098.7
HPB7	79	911.50	668.00	1579.50	75270.60	952.79	22.21	197.38	38960.51
HPB8	80	1644.40	746.70	2391.10	91810.70	1147.63	31.33	280.24	78532.49
HPB9	67	2146.40	586.20	2732.60	69790.30	1041.65	53.31	436.34	190396.0
HPB10	72	2095.30	590.70	2686.00	79702.20	1106.98	50.07	424.86	180506.5
HPB11	80	1591.20	643.60	2234.80	73619.40	920.24	21.46	191.96	36848.62
HPB12	80	1269.90	795.00	2064.90	93355.60	1166.95	28.15	251.82	63411.44
HPB13	75	1605.70	764.40	2370.10	91355.10	1218.07	36.93	319.84	102295.7
HPB14	77	1256.10	500.40	1756.50	72112.54	936.53	25.45	223.35	49883.73
HPB15	80	1338.60	587.80	1926.40	64405.00	805.06	19.48	174.27	30369.80
HPB16	76	1746.40	655.40	2401.80	84839.40	1116.31	43.04	375.24	140808.4
HPB17	75	1345.20	813.40	2158.60	90539.70	1207.20	29.65	256.79	65943.08
HPB18	76	940.60	665.60	1606.20	67188.00	884.05	20.07	175.00	30626.35
HPB19	77	864.90	739.30	1604.20	78374.80	1017.85	18.02	158.09	24991.28
HPB20	80	1393.30	612.30	2005.60	70603.60	882.55	22.37	200.07	40029.58
HPB21	80	969.70	636.50	1606.20	69898.60	873.73	19.40	173.48	30093.91
HPB22	55	1331.20	613.40	1944.60	55913.80	1016.61	38.23	283.55	80399.20
HPB23	74	1349.70	500.40	1850.10	71655.10	968.31	31.60	271.82	73883.84
HPB24	74	960.60	705.30	1665.90	65155.70	880.48	16.63	143.04	20460.33

Table D-5 Descriptive data of language speech productions of high-proficient bilinguals (semantically related context word distracters at 0 ms of SOA)

No	No. of correct response	Reaction time (milliseconds)							
		Range	Minimum	Maximum	Sum	Mean	Mean Std. Error	Std. Deviation	Variance
HPB1	38	1647.20	500.40	2147.60	36508.7	960.76	56.66	349.25	121978.6
HPB2	40	856.70	654.80	1511.50	36490.2	912.26	29.76	188.20	35417.88
HPB3	40	1609.70	658.80	2268.50	38600.3	965.01	49.92	315.73	99685.40
HPB4	40	575.60	810.90	1386.50	38499.2	962.48	17.01	107.58	11573.20
HPB5	39	1484.70	788.60	2273.30	41960.0	1075.90	44.93	280.60	78736.93
HPB6	35	1654.00	799.20	2453.20	42506.0	1214.46	74.83	442.67	195958.3
HPB7	39	848.90	730.60	1579.50	39113.8	1002.92	33.03	206.29	42556.89
HPB8	40	864.40	746.70	1611.10	44340.1	1108.50	35.35	223.56	49979.73
HPB9	34	2116.70	615.90	2732.60	37692.8	1108.61	88.99	518.92	269278.9
HPB10	36	1518.00	590.70	2108.70	40360.3	1121.12	66.47	398.79	159035.9
HPB11	40	475.60	810.90	1286.50	38509.2	962.73	15.36	97.17	9442.17
HPB12	40	1213.70	851.20	2064.90	46563.8	1164.10	37.17	235.07	55255.94
HPB13	39	1166.80	764.40	1931.20	46981.9	1204.66	51.84	323.74	104809.7
HPB14	38	770.20	603.60	1373.80	35247.9	927.58	29.45	181.57	32966.49
HPB15	40	1334.40	592.00	1926.40	32623.7	815.59	33.09	209.27	43794.41
HPB16	38	1746.40	655.40	2401.80	46024.8	1211.18	68.80	424.14	179890.9
HPB17	39	1225.00	873.30	2098.30	47714.4	1223.45	40.90	255.43	65243.07
HPB18	38	940.60	665.60	1606.20	33914.5	892.49	29.19	179.95	32383.43
HPB19	40	783.00	821.20	1604.20	42265.2	1056.63	26.70	168.89	28524.55
HPB20	40	1346.70	658.90	2005.60	37006.6	925.17	38.26	242.00	58564.27
HPB21	40	940.60	665.60	1606.20	35194.1	879.85	27.99	177.03	31339.15
HPB22	27	1319.80	624.80	1944.60	27721.6	1026.73	59.90	311.25	96877.84
HPB23	36	1145.50	603.60	1749.10	34573.0	960.36	41.23	247.38	61197.99
HPB24	36	960.60	705.30	1665.90	31640.6	878.91	28.16	168.96	28547.76

Table D-6 Descriptive data of language speech productions of high-proficient bilinguals (semantically unrelated context word distracters at 0 ms of SOA)

No	No. of correct response	Reaction time (milliseconds)							
		Range	Minimum	Maximum	Sum	Mean	Mean Std. Error	Std. Deviation	Variance
HPB1	38	1738.80	648.20	2387.00	37716.20	992.53	70.95	437.35	191272.97
HPB2	40	885.40	633.10	1518.50	35765.90	894.15	30.79	194.72	37916.16
HPB3	40	895.90	703.70	1599.60	38117.50	952.94	35.31	223.30	49863.89
HPB4	40	1391.20	643.60	2034.80	34707.00	867.68	34.62	218.95	47937.84
HPB5	39	1058.70	710.60	1769.30	41671.30	1068.49	37.56	234.58	55027.57
HPB6	35	1346.60	765.40	2112.00	39356.10	1124.46	50.21	297.07	88249.68
HPB7	40	798.20	668.00	1466.20	36156.80	903.92	28.06	177.46	31493.00
HPB8	40	1619.30	771.80	2391.10	47470.60	1186.77	51.47	325.51	105957.87
HPB9	33	1300.30	586.20	1886.50	32097.50	972.65	56.49	324.54	105324.18
HPB10	36	2071.50	614.50	2686.00	39341.90	1092.83	75.78	454.67	206722.86
HPB11	40	1591.20	643.60	2234.80	35110.20	877.76	39.21	247.99	61496.96
HPB12	40	1136.80	795.00	1931.80	46791.80	1169.80	42.77	270.51	73176.21
HPB13	36	1605.00	765.10	2370.10	44373.20	1232.59	53.25	319.49	102071.89
HPB14	39	1256.10	500.40	1756.50	36864.64	945.25	41.61	259.83	67510.35
HPB15	40	695.10	587.80	1282.90	31781.30	794.53	20.91	132.27	17496.44
HPB16	38	1704.10	684.60	2388.70	38814.60	1021.44	47.86	295.03	87043.93
HPB17	36	1345.20	813.40	2158.60	42825.30	1189.59	43.45	260.72	67974.17
HPB18	38	908.00	673.20	1581.20	33273.50	875.62	27.89	171.90	29550.88
HPB19	37	714.30	739.30	1453.60	36109.60	975.94	22.29	135.58	18381.14
HPB20	40	569.50	612.30	1181.80	33597.00	839.93	21.68	137.10	18795.21
HPB21	40	944.70	636.50	1581.20	34704.50	867.61	27.18	171.88	29543.48
HPB22	28	869.30	613.40	1482.70	28192.20	1006.86	49.03	259.44	67307.80
HPB23	38	1349.70	500.40	1850.10	37082.10	975.84	48.06	296.24	87761.05
HPB24	38	591.40	734.80	1326.20	33515.10	881.98	18.75	115.58	13358.33

Table D-7 Descriptive data of language speech productions of less-proficient bilinguals (all context picture distracters at 0 ms of SOA)

No	No. of correct response	Reaction time (milliseconds)							
		Range	Minimum	Maximum	Sum	Mean	Mean Std. Error	Std. Deviation	Variance
LPB1	80	1975.80	618.10	2593.90	76963.90	962.05	40.01	357.85	128059.33
LPB2	77	1269.00	828.90	2097.90	87383.40	1134.85	27.64	242.54	58824.37
LPB3	77	1129.70	668.40	1798.10	76426.20	992.55	28.60	250.99	62998.19
LPB4	78	1734.90	878.70	2613.60	101829.50	1305.51	37.18	328.36	107821.08
LPB5	70	1865.40	633.80	2499.20	74766.20	1068.09	35.85	299.93	89958.65
LPB6	77	1960.40	632.70	2593.10	93812.00	1218.34	41.04	360.09	129664.22
LPB7	72	1186.30	665.90	1852.20	74911.00	1040.43	21.16	179.57	32243.65
LPB8	78	1688.60	673.30	2361.90	93483.10	1198.50	36.93	326.16	106378.99
LPB9	75	1485.70	695.30	2181.00	82043.10	1093.91	32.91	284.97	81205.46
LPB10	76	1692.00	769.60	2461.60	91327.90	1201.68	36.82	320.98	103029.45
LPB11	73	1454.00	737.20	2191.20	81266.60	1113.24	32.80	280.26	78544.14
LPB12	65	1894.40	892.40	2786.80	89914.20	1383.30	44.00	354.75	125845.77
LPB13	65	2157.20	693.50	2850.70	86206.60	1326.26	59.85	482.54	232849.43
LPB14	66	2153.20	740.50	2893.70	87732.60	1329.28	57.78	469.39	220324.74
LPB15	79	1099.20	585.40	1684.60	69063.60	874.22	21.25	188.91	35688.30
LPB16	78	1294.30	677.30	1971.60	73760.40	945.65	25.44	224.67	50475.55
LPB17	73	1320.00	712.10	2032.10	77072.00	1055.78	30.78	262.98	69158.93
LPB18	70	1184.80	862.00	2046.80	83898.50	1198.55	33.84	283.10	80145.28
LPB19	74	1705.80	766.30	2472.10	84954.80	1148.04	44.65	384.06	147499.65
LPB20	78	1649.00	614.90	2263.90	78938.10	1012.03	34.09	301.11	90666.64
LPB21	78	2125.90	739.70	2865.60	87734.50	1124.80	43.86	387.39	150067.46
LPB22	65	2135.90	728.20	2864.10	83068.00	1277.97	57.74	465.49	216681.18
LPB23	77	1883.10	666.90	2550.00	79971.40	1038.59	38.47	337.58	113959.63
LPB24	73	2019.90	556.90	2576.80	73407.30	1005.58	41.36	353.41	124896.63

Table D-8 Descriptive data of language speech productions of less-proficient bilinguals (semantically related context picture distracters at 0 ms of SOA)

No	No. of correct response	Reaction time (milliseconds)							
		Range	Minimum	Maximum	Sum	Mean	Mean Std. Error	Std. Deviation	Variance
LPB1	40	1935.80	658.10	2593.90	37289.50	932.24	55.04	348.09	121168.23
LPB2	38	1269.00	828.90	2097.90	42503.20	1118.51	42.10	259.53	67354.62
LPB3	38	1129.70	668.40	1798.10	37263.50	980.62	40.13	247.38	61198.69
LPB4	39	1317.50	878.70	2196.20	50684.90	1299.61	48.40	302.27	91366.55
LPB5	36	1155.80	633.80	1789.60	37670.90	1046.41	45.39	272.36	74180.03
LPB6	39	1960.40	632.70	2593.10	47908.80	1228.43	57.92	361.73	130850.40
LPB7	36	1186.30	665.90	1852.20	36666.00	1018.50	33.34	200.05	40019.53
LPB8	38	1270.10	812.40	2082.50	44238.80	1164.18	45.62	281.24	79095.28
LPB9	38	1446.20	734.80	2181.00	41825.80	1100.68	50.12	308.99	95473.26
LPB10	37	1569.20	892.40	2461.60	45676.00	1234.49	60.94	370.71	137426.51
LPB11	37	1454.00	737.20	2191.20	41054.10	1109.57	47.99	291.92	85214.63
LPB12	32	760.70	955.50	1716.20	42175.10	1317.97	33.95	192.05	36882.09
LPB13	34	2157.00	693.70	2850.70	45736.00	1345.18	88.57	516.44	266710.45
LPB14	35	2153.20	740.50	2893.70	46973.30	1342.09	85.66	506.78	256822.70
LPB15	40	1029.40	585.40	1614.80	33872.70	846.82	27.89	176.42	31124.45
LPB16	39	1281.70	689.90	1971.60	36812.10	943.90	38.14	238.19	56735.14
LPB17	37	1320.00	712.10	2032.10	39051.80	1055.45	47.29	287.65	82741.45
LPB18	35	961.20	862.00	1823.20	41755.70	1193.02	50.03	295.98	87603.26
LPB19	37	1705.80	766.30	2472.10	43677.10	1180.46	71.48	434.79	189046.64
LPB20	39	1492.20	633.20	2125.40	39138.80	1003.56	47.63	297.46	88483.67
LPB21	40	2125.90	739.70	2865.60	45073.60	1126.84	65.82	416.31	173312.07
LPB22	33	1821.90	752.20	2574.10	41045.30	1243.80	76.06	436.92	190897.42
LPB23	39	1667.60	666.90	2334.50	40943.40	1049.83	55.55	346.88	120326.23
LPB24	37	1938.00	638.80	2576.80	39349.90	1063.51	62.41	379.61	144101.58

Table D-9 Descriptive data of language speech productions of less-proficient bilinguals (semantically unrelated context picture distracters at 0 ms of SOA)

No	No. of correct response	Reaction time (milliseconds)							
		Range	Minimum	Maximum	Sum	Mean	Mean Std. Error	Std. Deviation	Variance
LPB1	40	1784.30	618.10	2402.40	39674.40	991.86	58.40	369.34	136411.01
LPB2	39	1188.10	875.10	2063.20	44880.20	1150.77	36.35	227.02	51539.20
LPB3	39	1058.30	693.00	1751.30	39162.70	1004.17	41.18	257.15	66127.20
LPB4	39	1631.80	981.80	2613.60	51144.60	1311.40	57.07	356.43	127041.72
LPB5	34	1792.50	706.70	2499.20	37095.30	1091.04	56.46	329.19	108364.43
LPB6	38	1560.40	648.10	2208.50	45903.20	1207.98	58.88	362.95	131732.84
LPB7	36	768.10	828.50	1596.60	38245.00	1062.36	26.03	156.20	24399.65
LPB8	40	1688.60	673.30	2361.90	49244.30	1231.11	57.61	364.35	132752.96
LPB9	37	975.00	695.30	1670.30	40217.30	1086.95	43.09	262.10	68698.94
LPB10	39	1173.40	769.60	1943.00	45651.90	1170.56	42.70	266.67	71112.28
LPB11	36	1302.90	862.50	2165.40	40212.50	1117.01	45.31	271.84	73898.30
LPB12	33	1894.40	892.40	2786.80	47739.10	1446.64	79.31	455.58	207557.01
LPB13	31	1898.70	693.50	2592.20	40470.60	1305.50	80.83	450.01	202513.21
LPB14	31	1730.50	805.30	2535.80	40759.30	1314.82	77.44	431.16	185896.79
LPB15	39	1053.50	631.10	1684.60	35190.90	902.33	31.91	199.27	39710.00
LPB16	39	1092.50	677.30	1769.80	36948.30	947.39	34.17	213.40	45538.02
LPB17	36	963.40	745.00	1708.40	38020.20	1056.12	39.85	239.09	57164.07
LPB18	35	1167.80	879.00	2046.80	42142.80	1204.08	46.29	273.83	74981.55
LPB19	37	1650.30	771.50	2421.80	41277.70	1115.61	54.00	328.46	107888.79
LPB20	39	1649.00	614.90	2263.90	39799.30	1020.49	49.38	308.36	95088.39
LPB21	38	1614.70	767.10	2381.80	42660.90	1122.66	58.40	360.02	129613.03
LPB22	32	2135.90	728.20	2864.10	42022.70	1313.21	87.99	497.76	247761.37
LPB23	38	1850.40	699.60	2550.00	39028.00	1027.05	53.86	332.01	110231.06
LPB24	36	1389.70	556.90	1946.60	34057.40	946.04	53.10	318.62	101517.27

Table D-10 Descriptive data of language speech productions of less-proficient bilinguals (all context word distracters at 0 ms of SOA)

No.	No. of correct response	Reaction time (milliseconds)							
		Range	Minimum	Maximum	Sum	Mean	Mean Std. Error	Std. Deviation	Variance
LPB1	73	1230.50	621.30	1851.80	64591.80	884.82	25.94	221.65	49129.39
LPB2	71	1383.50	672.20	2055.70	79333.10	1117.37	37.41	315.26	99387.26
LPB3	78	1510.60	586.80	2097.40	76322.00	978.49	30.39	268.39	72030.92
LPB4	76	1928.50	705.40	2633.90	90159.90	1186.31	40.24	350.84	123090.85
LPB5	66	1342.90	648.10	1991.00	67103.00	1016.71	36.33	295.18	87129.99
LPB6	77	850.80	746.70	1597.50	78077.50	1013.99	23.65	207.56	43082.37
LPB7	65	679.80	851.00	1530.80	67939.60	1045.22	16.58	133.67	17867.61
LPB8	70	1530.60	662.40	2193.00	75650.80	1080.73	34.14	285.66	81599.40
LPB9	77	1192.90	739.10	1932.00	82427.40	1070.49	30.46	267.25	71420.71
LPB10	71	1005.30	799.20	1804.50	81456.80	1147.28	24.10	203.04	41224.44
LPB11	65	1155.00	788.40	1943.40	70675.30	1087.31	24.82	200.14	40056.38
LPB12	62	1189.80	781.50	1971.30	75580.10	1219.03	37.54	295.62	87389.81
LPB13	65	2094.80	355.50	2450.30	81315.90	1251.01	51.08	411.83	169603.85
LPB14	62	2147.80	282.10	2429.90	77931.50	1256.96	53.13	418.37	175031.06
LPB15	75	734.40	657.50	1391.90	66202.60	882.70	19.66	170.27	28990.25
LPB16	77	914.10	690.10	1604.20	73243.10	951.21	21.27	186.63	34831.57
LPB17	70	936.90	699.70	1636.60	70879.80	1012.57	22.15	185.29	34334.22
LPB18	74	1288.30	745.90	2034.20	80290.40	1085.01	31.80	273.54	74821.90
LPB19	69	1648.30	644.30	2292.60	65768.70	953.17	32.36	268.77	72237.29
LPB20	78	1502.30	659.20	2161.50	73036.30	936.36	24.47	216.13	46712.59
LPB21	66	1656.00	725.60	2381.60	71028.00	1076.18	34.70	281.90	79468.80
LPB22	58	1905.40	639.60	2545.00	61760.20	1064.83	53.54	407.75	166257.74
LPB23	76	1806.30	688.70	2495.00	74398.10	978.92	27.73	241.78	58458.31
LPB24	62	1365.40	509.80	1875.20	61013.10	984.08	40.72	320.62	102794.63

Table D-11 Descriptive data of language speech productions of less-proficient bilinguals (semantically related context word distracters at 0 ms of SOA)

No.	No. of correct response	Reaction time (milliseconds)							
		Range	Minimum	Maximum	Sum	Mean	Mean Std. Error	Std. Deviation	Variance
LPB1	37	860.10	640.20	1500.30	32587.10	880.73	32.60	198.33	39333.99
LPB2	37	1231.70	733.70	1965.40	41518.80	1122.13	47.98	291.83	85163.62
LPB3	39	1510.60	586.80	2097.40	38715.10	992.69	50.00	312.24	97491.88
LPB4	38	1928.50	705.40	2633.90	46020.70	1211.07	69.10	425.95	181437.03
LPB5	34	1267.40	653.30	1920.70	35272.90	1037.44	50.78	296.11	87682.94
LPB6	38	823.80	751.80	1575.60	39044.10	1027.48	34.12	210.31	44231.32
LPB7	34	679.80	851.00	1530.80	36706.70	1079.61	26.73	155.85	24289.77
LPB8	34	1005.80	821.10	1826.90	37245.80	1095.46	45.84	267.28	71436.98
LPB9	38	1165.40	739.10	1904.50	41604.20	1094.85	47.62	293.53	86161.41
LPB10	35	1005.30	799.20	1804.50	41184.70	1176.71	40.53	239.75	57480.59
LPB11	33	1114.30	829.10	1943.40	36504.00	1106.18	39.18	225.08	50659.37
LPB12	30	1064.00	907.30	1971.30	39510.00	1317.00	58.04	317.89	101053.05
LPB13	33	1374.80	822.20	2197.00	42933.40	1301.01	68.36	392.70	154215.27
LPB14	31	1888.90	282.10	2171.00	39862.50	1285.89	78.35	436.22	190290.80
LPB15	37	615.40	679.00	1294.40	33175.00	896.62	28.26	171.87	29538.97
LPB16	38	696.30	712.00	1408.30	36300.70	955.28	29.61	182.54	33322.22
LPB17	34	936.90	699.70	1636.60	34981.30	1028.86	33.59	195.89	38371.59
LPB18	38	1288.30	745.90	2034.20	43838.00	1153.63	49.75	306.70	94063.91
LPB19	35	1597.80	694.80	2292.60	34825.50	995.01	55.08	325.87	106193.95
LPB20	38	779.20	677.40	1456.60	35780.30	941.59	28.64	176.56	31174.69
LPB21	33	1656.00	725.60	2381.60	35648.90	1080.27	55.54	319.06	101799.42
LPB22	31	1905.40	639.60	2545.00	33779.30	1089.65	80.04	445.65	198601.88
LPB23	39	1723.90	771.10	2495.00	40205.80	1030.92	46.33	289.36	83729.91
LPB24	33	1193.60	638.80	1832.40	33325.70	1009.87	54.87	315.18	99338.82

Table D-12 Descriptive data of language speech productions of less-proficient bilinguals (semantically unrelated context word distracters at 0 ms of SOA)

No.	No. of correct response	Reaction time (milliseconds)							
		Range	Minimum	Maximum	Sum	Mean	Mean Std. Error	Std. Deviation	Variance
LPB1	36	1230.50	621.30	1851.80	32004.70	889.02	41.02	246.11	60572.54
LPB2	34	1383.50	672.20	2055.70	37814.30	1112.19	58.88	343.31	117862.59
LPB3	39	816.30	658.00	1474.30	37606.90	964.28	35.10	219.21	48051.17
LPB4	38	1262.20	855.90	2118.10	44139.20	1161.56	41.93	258.48	66812.54
LPB5	32	1342.90	648.10	1991.00	31830.10	994.69	52.55	297.29	88380.28
LPB6	39	850.80	746.70	1597.50	39033.40	1000.86	33.10	206.73	42738.49
LPB7	31	352.90	863.80	1216.70	31232.90	1007.51	16.65	92.68	8589.33
LPB8	36	1530.60	662.40	2193.00	38405.00	1066.81	50.85	305.13	93102.19
LPB9	39	1177.80	754.20	1932.00	40823.20	1046.75	38.49	240.37	57775.65
LPB10	36	681.10	830.10	1511.20	40272.10	1118.67	26.30	157.81	24902.76
LPB11	32	635.20	788.40	1423.60	34171.30	1067.85	30.43	172.14	29633.59
LPB12	32	1038.60	781.50	1820.10	36070.10	1127.19	43.10	243.79	59432.03
LPB13	32	2094.80	355.50	2450.30	38382.50	1199.45	76.15	430.76	185554.57
LPB14	31	1619.60	810.30	2429.90	38069.00	1228.03	72.71	404.82	163876.32
LPB15	38	734.40	657.50	1391.90	33027.60	869.15	27.56	169.87	28857.42
LPB16	39	914.10	690.10	1604.20	36942.40	947.24	30.88	192.83	37185.08
LPB17	36	705.00	758.00	1463.00	35898.50	997.18	29.35	176.09	31007.09
LPB18	36	1162.60	775.00	1937.60	36452.40	1012.57	35.79	214.73	46107.59
LPB19	34	952.60	644.30	1596.90	30943.20	910.09	32.39	188.87	35671.83
LPB20	40	1502.30	659.20	2161.50	37256.00	931.40	39.56	250.20	62599.58
LPB21	33	1199.60	820.80	2020.40	35379.10	1072.09	42.49	244.10	59587.10
LPB22	27	1576.90	691.70	2268.60	27980.90	1036.33	70.38	365.72	133753.80
LPB23	37	588.90	688.70	1277.60	34192.30	924.12	27.21	165.50	27390.59
LPB24	29	1365.40	509.80	1875.20	27687.40	954.74	61.23	329.76	108739.79

Table D-13 Descriptive data of language speech productions of high-proficient bilinguals (all context picture distracters at +500 ms of SOA)

No	No. of correct response	Reaction time (milliseconds)							
		Range	Minimum	Maximum	Sum	Mean	Mean Std. Error	Standard Deviation	Variance
HPB1	80	712.90	537.30	1250.20	64612.30	807.65	17.17	153.60	23592.48
HPB2	80	1129.90	495.80	1625.70	71658.40	895.73	23.15	207.04	42867.26
HPB3	77	2080.10	671.00	2751.10	83192.00	1080.42	52.58	461.36	212852.18
HPB4	78	1391.50	681.50	2073.00	80120.40	1027.18	32.68	288.59	83282.81
HPB5	73	1781.50	799.50	2581.00	91567.90	1254.35	48.75	416.53	173496.90
HPB6	74	1693.50	715.40	2408.90	87287.80	1179.56	44.45	382.40	146230.88
HPB7	77	1310.70	640.60	1951.30	64730.90	840.66	20.69	181.57	32969.40
HPB8	80	1903.90	720.50	2624.40	92300.10	1153.75	36.33	324.94	105586.15
HPB9	71	1161.90	542.50	1704.40	65261.80	919.18	27.23	229.48	52662.08
HPB10	75	1512.40	564.20	2076.60	72766.50	970.22	39.73	344.04	118361.29
HPB11	77	1727.60	730.70	2458.30	77829.80	1010.78	28.28	248.15	61576.50
HPB12	75	1795.60	786.20	2581.80	87672.40	1168.97	42.03	364.03	132515.33
HPB13	74	1598.70	749.10	2347.80	87343.00	1180.31	40.88	351.69	123687.81
HPB14	76	1889.90	613.70	2503.60	78477.00	1032.59	40.18	350.25	122676.40
HPB15	74	1566.30	597.80	2164.10	68783.10	929.50	30.99	266.56	71053.47
HPB16	65	1749.40	815.00	2564.40	77555.70	1193.16	47.24	380.86	145057.49
HPB17	72	1094.70	790.00	1884.70	75544.30	1049.23	25.75	218.53	47755.13
HPB18	78	1462.00	626.70	2088.70	77864.70	998.27	31.44	277.70	77117.40
HPB19	74	1814.40	753.40	2567.80	85384.00	1153.84	38.17	328.34	107809.15
HPB20	78	1526.00	659.30	2185.30	76923.00	986.19	34.58	305.39	93260.99
HPB21	78	906.30	622.30	1528.60	67996.10	871.74	17.57	155.17	24077.49
HPB22	68	1418.50	594.80	2013.30	64613.90	950.20	31.25	257.68	66400.06
HPB23	77	1127.30	672.00	1799.30	75487.20	980.35	30.63	268.80	72251.83
HPB24	71	1445.40	722.90	2168.30	85248.10	1200.68	35.78	301.47	90883.64

Table D-14 Descriptive data of language speech productions of high-proficient bilinguals (semantically related context picture distracters at +500 ms of SOA)

No	No. of correct response	Reaction time (milliseconds)							
		Range	Minimum	Maximum	Sum	Mean	Mean Std. Error	Std. Deviation	Variance
HPB1	40	520.80	543.70	1064.50	31413.70	785.34	21.92	138.65	19224.89
HPB2	40	1039.50	586.20	1625.70	36138.70	903.47	34.42	217.69	47387.88
HPB3	39	2020.70	672.80	2693.50	41644.20	1067.80	70.79	442.08	195435.16
HPB4	39	1391.50	681.50	2073.00	38995.70	999.89	42.24	263.82	69599.19
HPB5	36	1502.10	853.40	2355.50	45699.70	1269.44	67.67	406.04	164870.87
HPB6	37	1693.50	715.40	2408.90	44168.30	1193.74	61.92	376.65	141866.91
HPB7	38	1299.40	651.90	1951.30	32169.70	846.57	34.89	215.09	46262.67
HPB8	40	1265.30	720.50	1985.80	44634.90	1115.87	42.77	270.53	73184.81
HPB9	36	1161.90	542.50	1704.40	34272.60	952.02	40.94	245.66	60351.24
HPB10	38	1504.20	572.40	2076.60	37142.00	977.42	56.28	346.92	120350.57
HPB11	39	1727.60	730.70	2458.30	40174.80	1030.12	46.88	292.75	85702.30
HPB12	38	1691.80	801.10	2492.90	44084.50	1160.12	58.87	362.89	131691.32
HPB13	36	1590.20	757.60	2347.80	43883.70	1218.99	62.70	376.19	141518.94
HPB14	38	1618.60	613.70	2232.30	38918.60	1024.17	57.01	351.45	123518.06
HPB15	37	1278.50	655.00	1933.50	34707.80	938.05	38.96	236.97	56156.95
HPB16	32	1133.40	815.00	1948.40	36299.10	1134.35	43.86	248.10	61553.59
HPB17	36	1077.50	807.20	1884.70	38044.30	1056.79	37.14	222.86	49667.58
HPB18	39	1284.80	626.70	1911.50	37926.90	972.48	43.38	270.89	73382.33
HPB19	36	1814.40	753.40	2567.80	40909.60	1136.38	64.73	388.37	150827.77
HPB20	40	1387.40	659.30	2046.70	40670.10	1016.75	51.16	323.56	104688.71
HPB21	39	882.70	645.90	1528.60	34084.10	873.95	25.26	157.73	24878.62
HPB22	34	1339.70	673.60	2013.30	31822.50	935.96	46.33	270.16	72985.56
HPB23	37	998.50	693.40	1691.90	35634.50	963.09	39.73	241.64	58390.95
HPB24	37	1342.70	825.60	2168.30	45023.90	1216.86	48.80	296.82	88103.68

Table D-15 Descriptive data of language speech productions of high-proficient bilinguals (semantically unrelated context picture distracters at +500 ms of SOA)

No	No. of correct response	Reaction time (milliseconds)							
		Range	Minimum	Maximum	Sum	Mean	Mean Std. Error	Std. Deviation	Variance
HPB1	40	712.90	537.30	1250.20	33198.60	829.97	26.24	165.96	27543.89
HPB2	40	1058.10	495.80	1553.90	35519.70	887.99	31.35	198.30	39322.99
HPB3	38	2080.10	671.00	2751.10	41547.80	1093.36	78.83	485.96	236152.78
HPB4	39	1268.40	710.00	1978.40	41124.70	1054.48	50.03	312.46	97628.85
HPB5	37	1781.50	799.50	2581.00	45868.20	1239.68	70.95	431.57	186253.94
HPB6	37	1563.40	837.10	2400.50	43119.50	1165.39	64.57	392.74	154243.91
HPB7	39	653.10	640.60	1293.70	32561.20	834.90	23.11	144.31	20824.61
HPB8	40	1900.70	723.70	2624.40	47665.20	1191.63	58.68	371.15	137751.66
HPB9	35	889.10	596.40	1485.50	30989.20	885.41	35.45	209.71	43979.73
HPB10	37	1467.90	564.20	2032.10	35624.50	962.82	56.83	345.68	119493.61
HPB11	38	1038.00	731.90	1769.90	37655.00	990.92	31.48	194.07	37663.48
HPB12	37	1795.60	786.20	2581.80	43587.90	1178.05	60.82	369.97	136875.74
HPB13	38	1424.10	749.10	2173.20	43459.30	1143.67	53.15	327.61	107328.52
HPB14	38	1852.80	650.80	2503.60	39558.40	1041.01	57.36	353.56	125004.76
HPB15	37	1566.30	597.80	2164.10	34075.30	920.95	48.71	296.27	87773.52
HPB16	33	1748.90	815.50	2564.40	41256.60	1250.20	82.33	472.94	223670.71
HPB17	36	961.60	790.00	1751.60	37500.00	1041.67	36.17	217.00	47089.55
HPB18	39	1382.00	706.70	2088.70	39937.80	1024.05	45.72	285.51	81517.60
HPB19	38	1273.00	846.00	2119.00	44474.40	1170.38	42.75	263.54	69452.00
HPB20	38	1505.20	680.10	2185.30	36252.90	954.02	46.36	285.77	81663.67
HPB21	39	790.60	622.30	1412.90	33912.00	869.54	24.76	154.60	23899.98
HPB22	34	1365.60	594.80	1960.40	32791.40	964.45	42.50	247.81	61408.34
HPB23	40	1127.30	672.00	1799.30	39852.70	996.32	46.46	293.86	86355.11
HPB24	34	1353.30	722.90	2076.20	40224.20	1183.06	53.15	309.93	96057.07

Table D-16 Descriptive data of language speech productions of high-proficient bilinguals (all context word distracters at +500 ms of SOA)

No	No. of correct response	Reaction time (milliseconds)							
		Range	Minimum	Maximum	Sum	Mean	Mean Std. Error	Std. Deviation	Variance
HPB1	80	1342.40	556.40	1898.80	69589.90	869.87	27.62	247.03	61022.55
HPB2	80	1248.00	530.80	1778.80	66121.20	826.52	18.88	168.88	28519.54
HPB3	76	1452.60	677.30	2129.90	76504.90	1006.64	38.15	332.58	110608.47
HPB4	78	1547.40	674.20	2221.60	86422.60	1107.98	39.17	345.97	119696.66
HPB5	74	1820.90	297.20	2118.10	83438.80	1127.55	31.89	274.37	75276.79
HPB6	67	1846.00	723.70	2569.70	83637.40	1248.32	49.12	402.10	161682.71
HPB7	80	1057.90	611.70	1669.60	66634.80	832.94	22.47	200.99	40398.59
HPB8	78	1863.60	712.40	2576.00	85116.70	1091.24	36.64	323.62	104730.04
HPB9	69	1812.30	529.90	2342.20	69668.20	1009.68	48.99	406.91	165571.91
HPB10	64	2069.00	739.40	2808.40	82009.60	1281.40	62.55	500.42	250422.23
HPB11	80	993.80	614.70	1608.50	67500.90	843.76	16.21	144.98	21018.85
HPB12	77	2210.10	632.60	2842.70	75857.90	985.17	35.93	315.30	99413.88
HPB13	77	621.50	611.70	1233.20	64154.80	833.18	14.10	123.70	15302.80
HPB14	73	1697.10	694.00	2391.10	86503.20	1184.98	46.78	399.71	159765.87
HPB15	79	1477.90	609.30	2087.20	69176.60	875.65	23.05	204.87	41972.40
HPB16	73	1186.90	742.80	1929.70	74178.80	1016.15	27.34	233.59	54563.75
HPB17	75	1187.80	792.70	1980.50	85090.10	1134.53	27.37	237.07	56204.27
HPB18	77	1737.10	685.60	2422.70	84679.10	1099.73	39.19	343.87	118243.42
HPB19	77	1353.70	700.10	2053.80	85653.20	1112.38	26.26	230.45	53104.99
HPB20	80	1229.20	412.50	1641.70	67478.20	843.48	22.62	202.35	40944.65
HPB21	79	1392.00	458.00	1850.00	73593.50	931.56	25.21	224.08	50209.74
HPB22	78	621.50	611.70	1233.20	64758.20	830.23	13.12	115.88	13428.85
HPB23	61	1634.70	625.30	2260.00	63000.50	1032.80	41.93	327.48	107240.53
HPB24	78	1944.50	514.50	2459.00	82600.00	1058.97	49.83	440.09	193678.52

Table D-17 Descriptive data of language speech productions of high-proficient bilinguals (semantically related context word distracters at +500 ms of SOA)

No	No. of correct response	Reaction time (milliseconds)							
		Range	Minimum	Maximum	Sum	Mean	Mean Std. Error	Std. Deviation	Variance
HPB1	40	1169.30	590.50	1759.80	34295.60	857.39	36.18	228.82	52360.32
HPB2	40	1248.00	530.80	1778.80	33903.80	847.60	31.30	197.98	39198.04
HPB3	37	1452.60	677.30	2129.90	37816.60	1022.07	57.61	350.43	122799.71
HPB4	38	1373.80	674.20	2048.00	41618.40	1095.22	55.68	343.26	117829.18
HPB5	37	1773.60	297.20	2070.80	41139.80	1111.89	47.65	289.82	83997.08
HPB6	35	1819.80	749.90	2569.70	44576.70	1273.62	73.36	433.99	188346.65
HPB7	40	1038.50	631.10	1669.60	34320.50	858.01	30.92	195.59	38253.69
HPB8	40	1814.10	761.90	2576.00	45512.20	1137.81	60.02	379.62	144107.91
HPB9	35	1812.30	529.90	2342.20	38458.80	1098.82	82.46	487.85	237997.12
HPB10	33	1932.30	739.40	2671.70	41693.60	1263.44	77.11	442.96	196210.55
HPB11	40	944.00	664.50	1608.50	33602.30	840.06	25.15	159.04	25294.46
HPB12	39	2132.80	709.90	2842.70	40147.50	1029.42	64.33	401.74	161391.48
HPB13	38	530.40	640.10	1170.50	30921.10	813.71	18.14	111.83	12506.80
HPB14	36	1288.20	694.00	1982.20	43369.30	1204.70	64.01	384.06	147504.47
HPB15	39	1477.90	609.30	2087.20	34321.60	880.04	38.86	242.70	58904.22
HPB16	37	1186.90	742.80	1929.70	38415.50	1038.26	44.55	270.99	73434.83
HPB17	38	1187.80	792.70	1980.50	43497.90	1144.68	39.20	241.64	58389.38
HPB18	38	1409.90	685.60	2095.50	39590.80	1041.86	48.00	295.87	87539.77
HPB19	38	1225.20	828.60	2053.80	42270.10	1112.37	42.30	260.75	67990.71
HPB20	40	1229.20	412.50	1641.70	33933.90	848.35	36.27	229.40	52623.68
HPB21	40	1392.00	458.00	1850.00	37311.60	932.79	41.66	263.46	69411.88
HPB22	39	530.40	640.10	1170.50	31930.90	818.74	17.33	108.22	11712.02
HPB23	32	1511.90	626.80	2138.70	32566.10	1017.69	53.68	303.69	92224.66
HPB24	40	1906.50	514.50	2421.00	42805.20	1070.13	77.03	487.15	237316.77

Table D-18 Descriptive data of language speech productions of high-proficient bilinguals (semantically unrelated context word distracters at +500 ms of SOA)

No	No. of correct response	Reaction time (milliseconds)							
		Range	Minimum	Maximum	Sum	Mean	Mean Std. Error	Std. Deviation	Variance
HPB1	40	1342.40	556.40	1898.80	35294.30	882.36	42.11	266.33	70929.77
HPB2	40	576.40	579.20	1155.60	32217.40	805.44	21.01	132.89	17660.78
HPB3	39	1407.30	718.70	2126.00	38688.30	992.01	51.02	318.62	101518.05
HPB4	40	1493.50	728.10	2221.60	44804.20	1120.11	55.73	352.46	124228.11
HPB5	37	1336.40	781.70	2118.10	42299.00	1143.22	42.92	261.04	68143.11
HPB6	32	1633.70	723.70	2357.40	39060.70	1220.65	65.23	368.97	136140.77
HPB7	40	756.10	611.70	1367.80	32314.30	807.86	32.52	205.64	42289.34
HPB8	38	1128.00	712.40	1840.40	39604.50	1042.22	40.15	247.47	61242.54
HPB9	34	1093.70	553.80	1647.50	31209.40	917.92	48.16	280.83	78866.91
HPB10	31	2010.90	797.50	2808.40	40316.00	1300.52	100.94	562.02	315863.09
HPB11	40	595.40	614.70	1210.10	33898.60	847.47	20.77	131.35	17254.03
HPB12	38	857.50	632.60	1490.10	35710.40	939.75	30.03	185.11	34264.90
HPB13	39	621.50	611.70	1233.20	33233.70	852.15	21.29	132.97	17679.80
HPB14	37	1600.60	790.50	2391.10	43133.90	1165.78	68.84	418.76	175356.79
HPB15	40	693.40	663.00	1356.40	34855.00	871.38	25.75	162.83	26512.91
HPB16	36	793.70	771.60	1565.30	35763.30	993.43	31.48	188.85	35664.65
HPB17	37	1033.10	854.30	1887.40	41592.20	1124.11	38.66	235.16	55299.39
HPB18	39	1707.00	715.70	2422.70	45088.30	1156.11	60.90	380.32	144639.78
HPB19	39	953.50	700.10	1653.60	43383.10	1112.39	32.03	200.02	40008.51
HPB20	40	895.90	579.80	1475.70	33544.30	838.61	27.51	173.97	30266.82
HPB21	39	828.70	681.40	1510.10	36281.90	930.31	28.56	178.38	31820.37
HPB22	39	621.50	611.70	1233.20	32827.30	841.73	19.76	123.40	15227.97
HPB23	29	1634.70	625.30	2260.00	30434.40	1049.46	66.21	356.58	127146.82
HPB24	38	1805.60	653.40	2459.00	39794.80	1047.23	63.38	390.69	152639.85

Table D-19 Descriptive data of language speech productions of less-proficient bilinguals (all context picture distracters at +500 ms of SOA)

No	No. of correct response	Reaction time (milliseconds)							
		Range	Minimum	Maximum	Sum	Mean	Mean Std. Error	Std. Deviation	Variance
LPB1	80	1436.40	612.70	2049.10	71829.20	897.87	25.25	225.80	50987.14
LPB2	76	1546.80	673.00	2219.80	84631.10	1113.57	38.08	331.97	110206.48
LPB3	79	1539.70	601.20	2140.90	72917.40	923.01	25.62	227.68	51836.04
LPB4	79	1184.90	849.80	2034.70	97150.50	1229.75	28.25	251.12	63060.43
LPB5	65	1514.20	768.00	2282.20	70246.90	1080.72	41.05	330.94	109524.39
LPB6	79	1267.50	701.40	1968.90	85846.60	1086.67	29.94	266.12	70818.20
LPB7	75	872.60	680.80	1553.40	67086.10	894.48	17.65	152.89	23375.77
LPB8	74	1648.80	815.60	2464.40	85949.60	1161.48	34.96	300.78	90468.46
LPB9	75	1485.70	695.30	2181.00	82043.10	1093.91	32.91	284.97	81205.46
LPB10	72	1361.50	797.70	2159.20	92555.90	1285.50	44.72	379.47	144001.09
LPB11	71	1764.90	817.80	2582.70	80926.50	1139.81	41.19	347.04	120439.27
LPB12	68	1370.70	873.40	2244.10	90106.30	1325.09	41.85	345.12	119106.81
LPB13	70	1774.50	769.10	2543.60	83199.00	1188.56	48.12	402.63	162113.67
LPB14	67	2051.50	791.00	2842.50	81725.50	1219.78	56.77	464.67	215917.58
LPB15	79	1984.60	574.10	2558.70	63602.60	805.10	26.88	238.92	57082.81
LPB16	77	1091.10	673.60	1764.70	75080.30	975.07	24.03	210.84	44451.92
LPB17	72	1469.00	691.60	2160.60	73798.70	1024.98	30.14	255.73	65396.06
LPB18	75	1627.80	741.60	2369.40	85849.50	1144.66	36.48	315.90	99794.54
LPB19	71	1723.00	749.10	2472.10	80844.60	1138.66	46.60	392.65	154176.54
LPB20	77	1022.80	569.10	1591.90	70055.20	909.81	22.92	201.11	40443.44
LPB21	77	1871.20	469.40	2340.60	74531.50	967.94	27.14	238.17	56725.10
LPB22	67	2167.40	694.50	2861.90	84238.30	1257.29	66.42	543.69	295602.23
LPB23	76	1991.20	540.00	2531.20	83108.90	1093.54	42.56	371.06	137684.24
LPB24	72	1556.80	571.10	2127.90	71212.30	989.06	46.73	396.55	157254.08

Table D-20 Descriptive data of language speech productions of less-proficient bilinguals (semantically related context picture distracters at +500 ms of SOA)

No	No. of correct response	Reaction time (milliseconds)							
		Range	Minimum	Maximum	Sum	Mean	Mean Std. Error	Standard Deviation	Variance
LPB1	40	790.90	646.80	1437.70	35086.00	877.15	28.19	178.31	31795.64
LPB2	38	1546.80	673.00	2219.80	43840.60	1153.70	59.06	364.07	132547.03
LPB3	39	690.60	601.20	1291.80	35010.40	897.70	27.84	173.84	30221.29
LPB4	40	959.00	849.80	1808.80	49246.10	1231.15	38.25	241.91	58522.28
LPB5	33	1064.80	768.00	1832.80	34859.00	1056.33	48.83	280.50	78679.97
LPB6	39	1261.10	707.80	1968.90	43548.90	1116.64	45.75	285.68	81612.00
LPB7	37	519.60	705.80	1225.40	32958.70	890.78	20.06	122.05	14896.12
LPB8	38	1509.10	837.40	2346.50	43951.80	1156.63	46.29	285.37	81434.03
LPB9	38	1446.20	734.80	2181.00	41825.80	1100.68	50.12	308.99	95473.26
LPB10	36	1331.80	827.40	2159.20	48049.90	1334.72	71.47	428.85	183908.35
LPB11	36	1747.10	835.60	2582.70	42082.20	1168.95	65.14	390.82	152743.85
LPB12	36	1207.20	929.60	2136.80	46981.40	1305.04	53.76	322.55	104038.91
LPB13	35	1551.00	769.10	2320.10	40138.70	1146.82	61.94	366.46	134291.42
LPB14	34	2022.50	820.00	2842.50	40993.00	1205.68	83.14	484.77	235006.13
LPB15	39	528.80	574.10	1102.90	29885.90	766.31	19.86	124.04	15385.84
LPB16	39	1056.00	708.70	1764.70	38842.80	995.97	36.73	229.37	52609.19
LPB17	36	1138.20	691.60	1829.80	36480.70	1013.35	42.25	253.48	64251.59
LPB18	38	1535.90	833.50	2369.40	43652.10	1148.74	51.14	315.23	99367.29
LPB19	35	1694.60	777.50	2472.10	41533.60	1186.67	74.43	440.33	193893.79
LPB20	39	960.10	631.80	1591.90	35390.90	907.46	31.32	195.62	38268.35
LPB21	39	1871.20	469.40	2340.60	37691.80	966.46	45.30	282.90	80032.62
LPB22	35	2108.20	753.70	2861.90	43360.60	1238.87	86.44	511.39	261524.71
LPB23	38	1806.20	725.00	2531.20	42165.70	1109.62	63.77	393.08	154511.23
LPB24	36	1533.20	594.70	2127.90	34546.30	959.62	70.81	424.88	180526.42

Table D-21 Descriptive data of language speech productions of less-proficient bilinguals (semantically unrelated context picture distracters at +500 ms of SOA)

No	No. of correct response	Reaction time (milliseconds)							
		Range	Minimum	Maximum	Sum	Mean	Mean Std. Error	Std. Deviation	Variance
LPB1	40	1436.40	612.70	2049.10	36743.20	918.58	42.01	265.72	70605.78
LPB2	38	1197.20	748.30	1945.50	40790.50	1073.43	48.00	295.87	87536.12
LPB3	40	1507.90	633.00	2140.90	37907.00	947.68	42.71	270.11	72961.28
LPB4	39	1069.30	965.40	2034.70	47904.40	1228.32	42.18	263.39	69373.32
LPB5	32	1474.20	808.00	2282.20	35387.90	1105.87	66.99	378.96	143610.73
LPB6	40	1001.40	701.40	1702.80	42297.70	1057.44	38.84	245.65	60342.75
LPB7	38	872.60	680.80	1553.40	34127.40	898.09	29.12	179.53	32230.92
LPB8	36	1648.80	815.60	2464.40	41997.80	1166.61	53.37	320.24	102551.36
LPB9	37	975.00	695.30	1670.30	40217.30	1086.95	43.09	262.10	68698.94
LPB10	36	1158.80	797.70	1956.50	44506.00	1236.28	53.55	321.29	103224.33
LPB11	35	1407.90	817.80	2225.70	38844.30	1109.84	50.40	298.17	88903.00
LPB12	32	1370.70	873.40	2244.10	43124.90	1347.65	65.90	372.79	138968.71
LPB13	35	1767.50	776.10	2543.60	43060.30	1230.29	73.90	437.17	191117.52
LPB14	33	1794.30	791.00	2585.30	40732.50	1234.32	78.34	450.06	202550.65
LPB15	40	1952.10	606.60	2558.70	33716.70	842.92	49.04	310.17	96202.41
LPB16	38	902.90	673.60	1576.50	36237.50	953.62	30.93	190.64	36342.58
LPB17	36	1454.40	706.20	2160.60	37318.00	1036.61	43.50	261.02	68130.79
LPB18	37	1471.80	741.60	2213.40	42197.40	1140.47	52.75	320.89	102970.11
LPB19	36	1695.00	749.10	2444.10	39311.00	1091.97	56.63	339.78	115451.72
LPB20	38	807.00	569.10	1376.10	34664.30	912.22	33.93	209.19	43758.60
LPB21	38	831.00	776.30	1607.30	36839.70	969.47	30.05	185.25	34316.04
LPB22	32	1960.10	694.50	2654.60	40877.70	1277.43	103.34	584.56	341711.61
LPB23	38	1547.00	540.00	2087.00	40943.20	1077.45	57.13	352.20	124046.98
LPB24	36	1363.60	571.10	1934.70	36666.00	1018.50	61.62	369.72	136691.72

Table D-22 Descriptive data of language speech productions of less-proficient bilinguals (all context word distracters at +500 ms of SOA)

No	No. of correct response	Reaction time (milliseconds)							
		Range	Minimum	Maximum	Sum	Mean	Mean Std. Error	Std. Deviation	Variance
LPB1	80	1838.60	632.40	2471.00	73534.60	919.18	30.96	276.94	76694.14
LPB2	78	1887.20	710.00	2597.20	86749.60	1112.17	39.79	351.43	123501.09
LPB3	78	1412.00	613.30	2025.30	75265.60	964.94	31.50	278.20	77395.59
LPB4	78	1306.20	758.00	2064.20	84236.80	1079.96	27.84	245.90	60467.07
LPB5	55	2168.00	589.80	2757.80	63111.60	1147.48	58.17	431.37	186083.29
LPB6	79	1143.80	710.90	1854.70	79369.10	1004.67	20.04	178.10	31718.86
LPB7	73	853.60	706.30	1559.90	72629.00	994.92	20.92	178.77	31958.02
LPB8	67	1714.30	671.30	2385.60	73925.70	1103.37	40.37	330.45	109194.18
LPB9	74	1373.50	510.30	1883.80	78527.90	1061.19	35.93	309.05	95509.32
LPB10	74	1715.20	744.60	2459.80	82044.50	1108.71	37.85	325.58	106002.72
LPB11	66	1223.90	846.40	2070.30	76300.30	1156.07	33.21	269.77	72776.39
LPB12	66	1482.80	730.70	2213.50	80532.50	1220.19	37.76	306.76	94101.55
LPB13	67	1824.30	790.80	2615.10	87480.90	1305.69	63.04	516.04	266299.43
LPB14	70	1890.20	746.00	2636.20	90400.00	1291.43	57.19	478.51	228975.31
LPB15	79	824.50	589.30	1413.80	65741.40	832.17	17.54	155.86	24293.76
LPB16	78	1332.30	745.20	2077.50	77447.90	992.92	25.04	221.16	48911.74
LPB17	59	1297.00	701.10	1998.10	61335.30	1039.58	31.68	243.31	59198.16
LPB18	74	1241.10	656.00	1897.10	73852.20	998.00	26.23	225.68	50929.39
LPB19	67	1846.10	751.40	2597.50	81147.50	1211.16	39.27	321.47	103346.15
LPB20	72	1125.00	471.30	1596.30	66987.20	930.38	23.12	196.19	38491.26
LPB21	75	1408.80	740.20	2149.00	74335.00	991.13	27.32	236.57	55965.47
LPB22	61	2098.40	647.90	2746.30	67110.10	1100.17	57.28	447.38	200145.10
LPB23	76	1495.90	744.70	2240.60	77127.60	1014.84	32.22	280.88	78892.95
LPB24	75	1495.70	603.50	2099.20	72252.70	963.37	36.97	320.20	102527.43

Table D-23 Descriptive data of language speech productions of less-proficient bilinguals (semantically related context word distracters at +500 ms of SOA)

No	No. of correct response	Reaction time (milliseconds)							
		Range	Minimum	Maximum	Sum	Mean	Mean Std. Error	Std. Deviation	Variance
LPB1	40	1066.10	647.00	1713.10	36714.90	917.87	40.41	255.55	65307.62
LPB2	39	1699.20	729.50	2428.70	42550.70	1091.04	52.86	330.10	108968.49
LPB3	39	1400.70	624.60	2025.30	38210.40	979.75	46.99	293.44	86108.62
LPB4	40	1099.30	758.00	1857.30	42832.80	1070.82	36.54	231.08	53396.00
LPB5	28	2034.10	723.70	2757.80	33516.40	1197.01	89.67	474.48	225132.42
LPB6	39	1022.20	832.50	1854.70	41102.30	1053.91	33.00	206.11	42481.66
LPB7	37	616.70	761.30	1378.00	36800.00	994.59	26.20	159.39	25406.44
LPB8	35	1600.20	785.40	2385.60	41537.60	1186.79	65.59	388.04	150572.00
LPB9	38	1128.40	684.20	1812.60	40839.30	1074.72	47.54	293.04	85873.19
LPB10	39	1647.60	812.20	2459.80	44776.00	1148.10	56.18	350.84	123085.40
LPB11	31	1223.90	846.40	2070.30	35583.00	1147.84	42.91	238.92	57081.28
LPB12	34	1410.60	730.70	2141.30	42251.50	1242.69	55.72	324.88	105547.97
LPB13	33	1743.20	871.90	2615.10	42473.40	1287.07	81.97	470.88	221730.95
LPB14	34	1768.00	868.20	2636.20	42686.70	1255.49	73.46	428.37	183499.94
LPB15	40	824.50	589.30	1413.80	33531.50	838.29	24.84	157.12	24687.91
LPB16	38	842.70	748.20	1590.90	37137.60	977.31	30.28	186.66	34841.08
LPB17	32	1250.70	747.40	1998.10	34219.40	1069.36	47.52	268.82	72265.22
LPB18	37	1188.40	708.70	1897.10	36617.70	989.67	37.59	228.65	52281.12
LPB19	33	1846.10	751.40	2597.50	41216.40	1248.98	66.63	382.74	146493.57
LPB20	35	855.60	471.30	1326.90	31911.10	911.75	34.43	203.69	41490.08
LPB21	37	719.70	774.60	1494.30	36143.30	976.85	26.48	161.08	25947.08
LPB22	31	1379.60	676.50	2056.10	35308.20	1138.97	75.00	417.60	174385.62
LPB23	38	1495.90	744.70	2240.60	39450.50	1038.17	51.44	317.07	100531.48
LPB24	38	1495.70	603.50	2099.20	36140.40	951.06	51.60	318.10	101187.45

Table D-24 Descriptive data of language speech productions of less-proficient bilinguals (semantically unrelated context word distracters at +500 ms of SOA)

No	No. of correct response	Reaction time (milliseconds)							
		Range	Minimum	Maximum	Sum	Mean	Mean Std. Error	Std. Deviation	Variance
LPB1	40	1838.60	632.40	2471.00	36819.70	920.49	47.45	300.07	90043.65
LPB2	39	1887.20	710.00	2597.20	44198.90	1133.31	59.99	374.66	140367.20
LPB3	39	1049.90	613.30	1663.20	37055.20	950.13	42.45	265.08	70269.05
LPB4	38	1275.20	789.00	2064.20	41404.00	1089.58	42.73	263.38	69369.26
LPB5	27	1537.70	589.80	2127.50	29595.20	1096.12	73.86	383.81	147307.48
LPB6	40	565.20	710.90	1276.10	38266.80	956.67	20.77	131.37	17258.16
LPB7	36	853.60	706.30	1559.90	35829.00	995.25	33.17	199.02	39609.65
LPB8	32	1172.50	671.30	1843.80	32388.10	1012.13	39.88	225.58	50884.26
LPB9	36	1373.50	510.30	1883.80	37688.60	1046.91	54.78	328.66	108016.35
LPB10	35	1295.70	744.60	2040.30	37268.50	1064.81	49.65	293.71	86264.55
LPB11	35	1149.60	875.70	2025.30	40717.30	1163.35	50.33	297.74	88649.16
LPB12	32	1362.50	851.00	2213.50	38281.00	1196.28	51.18	289.49	83806.82
LPB13	34	1786.70	790.80	2577.50	45007.50	1323.75	96.54	562.94	316904.38
LPB14	36	1852.60	746.00	2598.60	47713.30	1325.37	87.55	525.31	275954.75
LPB15	39	690.80	619.90	1310.70	32209.90	825.89	25.04	156.36	24448.75
LPB16	40	1332.30	745.20	2077.50	40310.30	1007.76	39.70	251.10	63051.61
LPB17	27	894.20	701.10	1595.30	27115.90	1004.29	40.14	208.59	43510.73
LPB18	37	941.70	656.00	1597.70	37234.50	1006.34	37.07	225.50	50849.55
LPB19	34	989.60	817.20	1806.80	39931.10	1174.44	42.64	248.63	61818.54
LPB20	37	972.10	624.20	1596.30	35076.10	948.00	31.22	189.92	36071.46
LPB21	38	1408.80	740.20	2149.00	38191.70	1005.04	47.65	293.74	86282.25
LPB22	30	2098.40	647.90	2746.30	31801.90	1060.06	87.64	480.02	230420.78
LPB23	38	1407.80	765.30	2173.10	37677.10	991.50	39.16	241.39	58268.26
LPB24	37	1203.10	625.40	1828.50	36112.30	976.01	53.63	326.23	106428.59

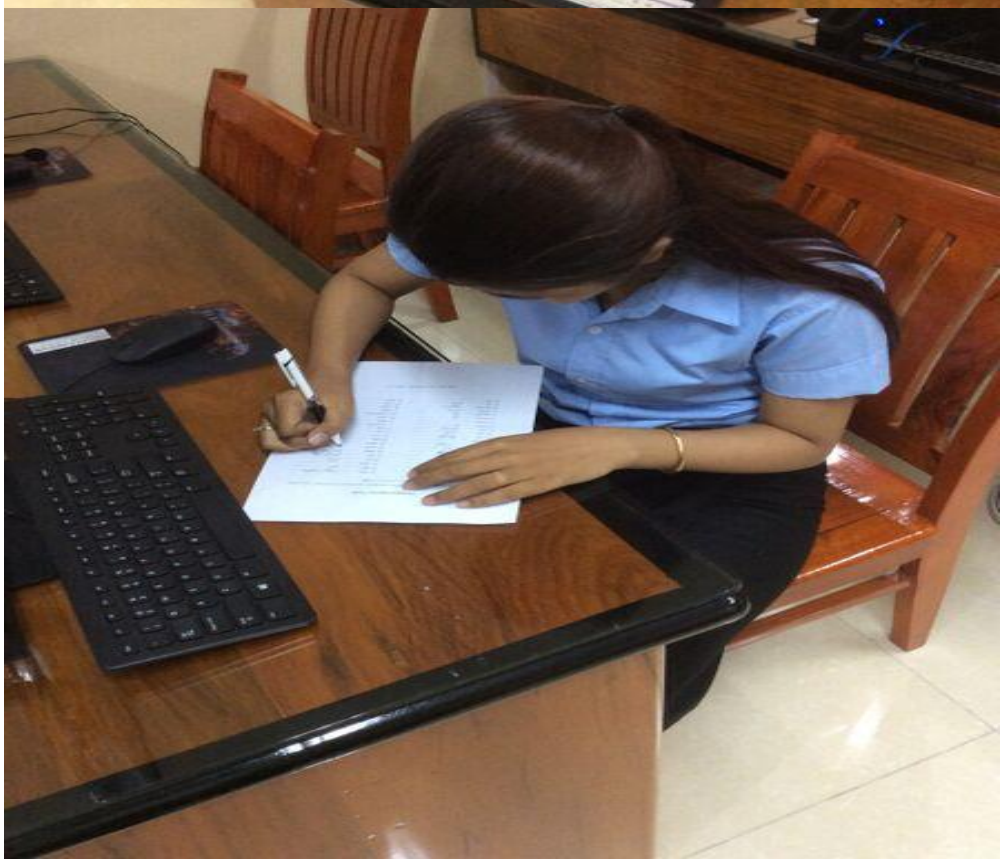
APPENDIX E

Images (examples) during the experiment

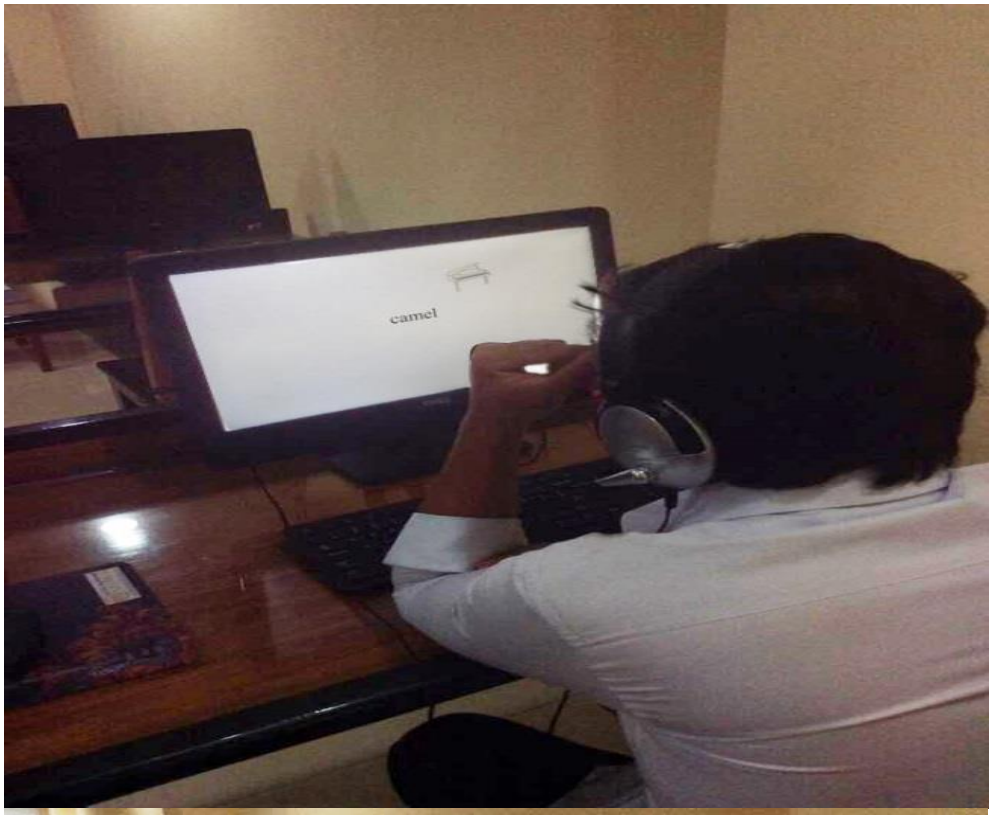
Computer Lab for Conducting the Experiment

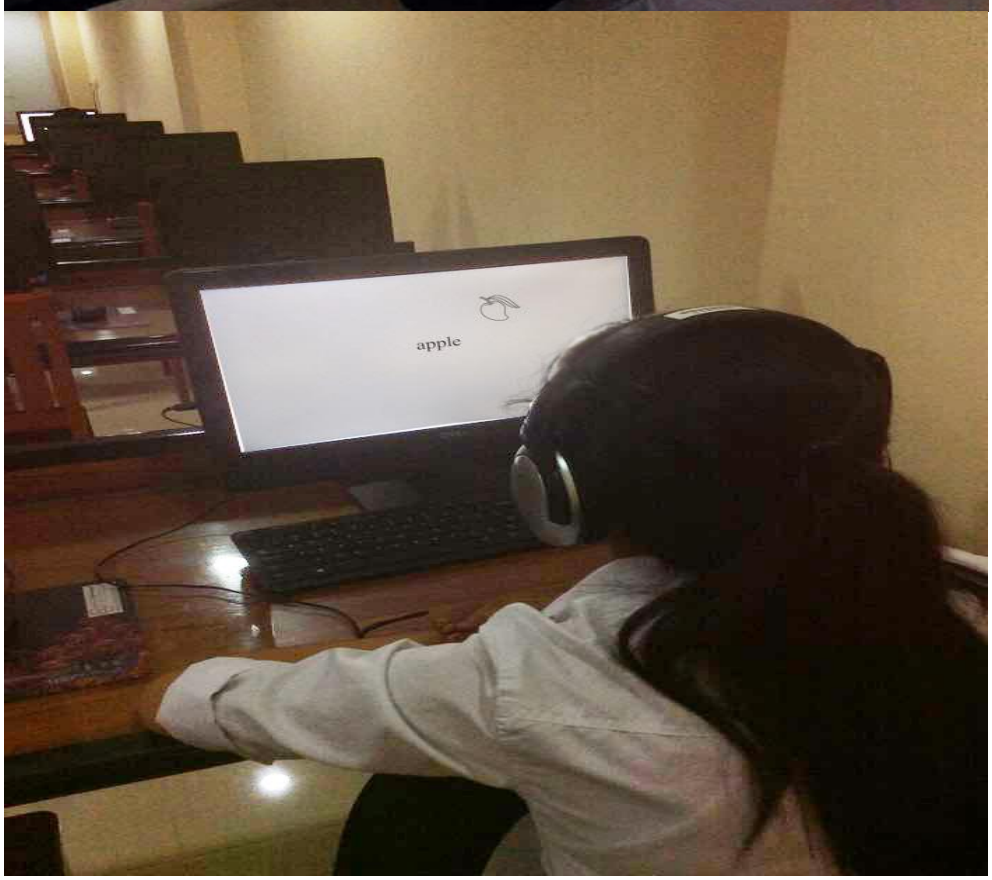
Language Production Test

Familiarization Test



Language Speech Production Task (Main Activity)





Language Speech Production Task (Main Activity) (Cont.)