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COGNITIVE MECHANISMS UNDERLYING SECOND LANGUAGE LISTENING COMPREHENSION

by

GUILING HU

Under the Direction of Stephanie Lindemann

ABSTRACT

This dissertation research investigates the cognitive mechanisms underlying second language (L2) listening comprehension. I use three types of sentential contexts, congruent, neutral and incongruent, to look at how L2 learners construct meaning in spoken sentence comprehension. The three types of contexts differ in their context predictability. The last word in a congruent context is highly predictable (e.g., Children are more affected by the disease than adults), the last word in a neutral context is likely but not highly predictable (e.g., Children are more affected by the disease than nurses), and the last word in an incongruent context is impossible (e.g., Children are more affected by the disease than chairs). The study shows that, for both native speakers and L2 learners, a consistent context facilitates word recognition. In contrast, an inconsistent context inhibits native speakers' word recognition but not that of L2 learners. I refer to this new discovery as the facilitation-without-inhibition phenomenon in L2 listening comprehension. Results from follow-up experiments show that this facilitation-without-inhibition phenomenon is a result of insufficient suppression by L2 learners.

INDEX WORDS: Second language, Listening comprehension, Suppression, Activation, Cognitive processes

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GUILING HU

A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree of

Doctor of Philosophy

in the College of Arts and Sciences

Georgia State University

2009

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2009

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TABLE OF CONTENTS

ACKNOWLEDGEMENTS iv

LIST OF TABLES viii

LIST OF FIGURES x

CHAPTER

1. INTRODUCTION 1

Models of Language Comprehension 4

Meaning Integration in First Language Comprehension 15

Meaning Integration in Second Language Comprehension 19

The Present Study 23

2. THE CONTEXT EFFECT IN L2 LISTENING COMPREHENSION: EXPERIMENTS 1 TO 3 26

Experiment 1: Cued Shadowing 27

Experiment 2: Cued Shadowing in a Slower Speed 37

Experiment 3: Cued Shadowing Without Comprehension Questions 40

3. FACILITATION-WITHOUT-INHIBITION IN OTHER LISTENING TASKS: EXPERIMENTS 4 AND 5 44

Experiment 4: Cross-modal Priming 45

Experiment 5: Word Monitoring Task 50

Discussion of Experiments 1 to 5 57

4. SENTENCE CONTEXT IN A LESS CONSTRAINED CONTEXT: EXPERIMENT 6 59

Experiment 6: Cross-modal Priming in a Less Constrained Context 59

Discussion of Experiments 1 to 6 66

5. SUPPRESSION AND ACTIVATION IN A NON-LINGUISTIC TASK: EXPERIMENTS 7 AND 8 70

Experiment 7: Object Absent 71

Experiment 8: Object Present 75

6. GENERAL DISCUSSION AND CONCLUSION 78

Comparison with Previous Studies 81

Possible Explanations for the Less Efficient Suppression Mechanism 83

Future Studies 86

Contributions 88

REFERENCES 91

APPENDICES

APPENDIX A: SENTENCE COMPLETION NORM (NS) 101

APPENDIX B: SENTENCE COMPLETION NORM (NNS) 105

APPENDIX C : ACCEPTANCE RATE FOR NEUTRAL TARGET 1 109

APPENDIX D: ACCEPTANCE RATE FOR NEUTRAL TARGET 2 112

APPENDIX E: MATERIALS USED IN EXPERIMENTS 1-4 115

APPENDIX F: ACCEPTANCE RATE IN THE WORD MONITORING TASK 118

APPENDIX G: NON-CONSTRAINING COMPLETION NORM (NS) 121

APPENDIX H: NON-CONSTRAINING COMPLETION NORM (NNS) 125

APPENDIX I: CRITICAL MATERIALS FOR NON-CONSTRAINING CONTEXT 129

APPENDIX J: CRITICAL MATERIALS IN PICTURE RECOGNITION 131

LIST OF TABLES

Table 1 Materials Used in Kieras (1978, p. 16) 11

Table 2 Materials Used in Gernsbacher & Hargreaves (1988, p. 702) 12

Table 3 Participant Information for Chinese Learners of English in Experiment 1 28

Table 4 Analysis of Variance for Experiment 1 35

Table 5 Pairwise Comparison (Bonferroni) for Experiment 1 36

Table 6 Participant Information for Chinese Learners of English in Experiment 2 37

Table 7 Analysis of Variance for Experiment 2 39

Table 8 Pairwise Comparison (Bonferroni) for Experiment 2 40

Table 9 Participant Information for Chinese Learners of English in Experiment 3 41

Table 10 Analysis of Variance for Experiment 3 42

Table 11 Pairwise Comparison (Bonferroni) for Experiment 3 43

Table 12 Participant Information for Chinese Learners of English in Experiment 4 46

Table 13 Analysis of Variance for Experiment 4 49

Table 14 Pairwise Comparison (Bonferroni) for Experiment 4 49

Table 15 Participant Information for Chinese Learners of English in Experiment 5 50

Table 16 Analysis of Variance for Experiment 5 55

Table 17 Pairwise Comparison (Bonferroni) for Experiment 5 56

Table 18 Participant Information for Chinese Learners of English in Experiment 6 60

Table 19 Analysis of Variance for Experiment 6 64

Table 20 Analysis of Variance for Low Probability Sentences 65

Table 21 Analysis of Variance for High Probability Sentences 65

Table 22 Participant Information for Chinese Learners of English in Experiment 7 71

Table 23 Analysis of Variance for Experiment 7 74

Table 24 Participant Information for Chinese Learners of English in Experiment 8 75

Table 25 Analysis of Variance for Experiment 8 77

LIST OF FIGURES

Figure 1 Processes Involved in Semantic Integration 15

Figure 2 N400 of English Native Speakers 20

Figure 3 N400 of Japanese Learners of English 20

Figure 4 Stimuli Presentation in the Spoken Word Recognition Task 54

Figure 5 Object Arrangement in Experiments 7 and 8 70

Figure 6 Example of a Category Set 72

CHAPTER 1

INTRODUCTION

Comprehending spoken language may seem effortless for native listeners. Successful comprehension, however, is actually the result of a myriad of complex cognitive processes. Within milliseconds, the auditory input must be decoded, segmented into words and phrases, and integrated into a coherent meaning representation. At the same time, relevant information from long-term memory needs to be retrieved to help the listener choose between alternate meanings and draw inferences. Many of these processes are believed to function less efficiently in second language (L2) listening comprehension. Studies have found that L2 learners tend to have great difficulty in perceiving certain nonnative sounds. One of the well-known examples perhaps is the difficulty that Japanese learners of English face in distinguishing the English approximants *r* and *l* (Goto, 1971). Second language learners also show less accuracy in processing spoken words in the L2. They have a tendency to accept L2 non-words as words (Broersma & Cutler, 2008), segment L2 auditory input based on L1 phonotactics (Al-jasser, 2008; Weber & Cutler, 2006), and persist a wrong interpretation even when the incoming evidence does not support it (Field, 2008).

Most of these previous studies on L2 listening comprehension have been on the areas of decoding or word recognition. Meaning integration, the ability to integrate information from lower processors and general knowledge, and build a coherent mental representation of the meaning of the received message, has attracted less attention in L2 comprehension in general. Researchers who did study L2 meaning integration tended to focus on reading comprehension. This lack of interest was probably due to two reasons. Firstly, meaning integration is a more abstract component in language comprehension. Compared to sounds or words, the concept of

meaning is even less clear and straightforward. Studying how it is constructed in the human brain thus becomes difficult. Second, the transient nature of spoken language makes it hard to manipulate, present, or analyze in a study.

Nevertheless, understanding meaning integration in L2 listening comprehension is of paramount importance. Research has shown that people with comprehension difficulty do not necessarily have lower-level processing (e.g., decoding or word monitoring) problems. Comprehension difficulty can and often does happen at higher levels such as meaning integration (Perfetti, 1999; Perfetti, Yang, & Schmalhofer, 2008; Yang, Perfetti, & Schmalhofer, 2005). Failure in the integration process in L2 listening is reflected in this common experience: L2 listeners "may understand all the words of a lecture (including lexical connectives and other discourse markers) and yet fail to understand the lecturer's main points or logical argument" (Olsen & Huckin, 1990, p. 33). On the other hand, comprehension difficulty can be reduced if meaning integration is successful. In studies of listening to speech in noise, researchers consistently found that words in a predictable sentence context (where building a meaningful representation is easier) are more intelligible than words spoken in isolation or in an unpredictable sentence context (Kalikow, Stevens, & Elliott, 1977; Mayo, Florentine, & Buus, 1997; Miller, Heise, & Lichten, 1951). In Mayo, Florentine, & Buus (1997), for example, the researchers tested the performance of English native speakers, early Spanish learners of English (before age 6) and late Spanish learners of English (after age 14) in the Speech Perception in Noise (SPIN) test (Kalikow, et al., 1977). The researchers presented sentences with high predictability (e.g., The watch dog gave a warning growl) and low predictability (e.g., The old man discussed the dive), and found that speech was more intelligible for all the three groups in the high predictable sentences than in the low predictable sentences in all noise levels.

Moreover, using results from studies of decoding or word recognition to understand meaning integration can be misleading because these processes are independent. In reading research, a hyperlexic reader can decode but not comprehend, whereas a dyslexic reader can comprehend without knowing how to decode (McNamara & O'Reilly, in press). In L2 listening research, it has been found that "fairly accurate processing at a lower level of representation, where access to the full-blown hierarchy of category labels is irrelevant, does not fully determine processing accuracy when more complex input is encountered" (Bradlow, 2007, p. 55). Similarly, results from L2 reading comprehension cannot be applied directly to L2 listening comprehension because listening appears to be a more difficult task for L2 learners. L2 listeners comprehend less informational content and are less capable of attending to grammatical forms when comprehending content than L2 readers (Johnson, 1992; Leeser, 2004; Leow, 1995; Lund, 1991; Murphy, 1997; Wong, 2001). For example, in an earlier study, Lund (1990) compared L2 learners' performance in reading and listening using the recall procedure, in which participants were asked to report the content of the materials that they read or listened to. His participants were English learners of German. His readers showed advantage over the listeners in the number of propositions they reported in the recall procedure. The listeners, but not the readers, also revealed a tendency to invent possible ideas that did not appear in the text. In a more recent study, Leaser (2004) investigated whether the mode of input (listening or reading) affected the comprehension of Spanish passages and focusing on Spanish future tense by English learners of Spanish. Leeser asked the participants to listen to or read passages in Spanish. The participants then received a series of tests, including a recall of passage content task, a multiple-choice comprehension test, a recognition of new word task, and a translation task focusing on tense. He found that the readers consistently outperformed the listeners in all of the tasks, indicating a

reading advantage in comprehension and focusing on vocabulary and grammatical forms. It is thus possible that L2 listening is more difficult than L2 reading and involves cognitive processes that are somewhat different from those of reading.

The aim of the present study is to reveal the mechanisms by which meaning is constructed during L2 spoken language processing. Meaning integration is the process in language comprehension that selects incoming meaning input from lower processes such as word recognition and parsing and integrates these inputs into a coherent meaning representation in the mind of the comprehender. Before I report the current project, I will summarize the major factors that are thought to be involved in L1 meaning construction and then give an overview of the findings from research into L2 meaning processing. In the following sections of this chapter, I will discuss two prominent psycholinguistic models of language comprehension (Gernsbacher, 1990; Kintsch, 1998) and relevant empirical research in first language comprehension. I will then review studies in L2 comprehension.

This dissertation is composed of three major components. The present chapter provides a theoretical background of the dissertation study and proposes research questions. Chapters 2 to 5 present a series of experiments that are designed to answer the research questions. In Chapter 6, I discuss the results of these experiments and draw conclusions from the results.

Models of Language Comprehension

There are two dominant models of language comprehension in psycholinguistics: Kintsch and van Dijk's Construction-Integration Model (Kintsch, 1988, 1998; van Dijk & Kintsch, 1983), and Gernsbacher's Structure Building Framework (Gernsbacher, 1990). Most of the empirical studies the researchers cited to support their models are from the reading literature. The researchers argue that, in general, reading and listening have shown comparable results in

L1 processing although under some circumstances there were small advantages for reading (Gernsbacher, Varner, & Faust, 1990; Kintsch & Keenan, 1973).

Construction-integration Model

The Construction-Integration Model has been revised several times since it was first proposed in the 1970s. The latest Construction-Integration Model (Kintsch, 1988) proposes a two-step comprehension process. During the first step of construction, word meanings are activated without regard to the context. During the second step, the model uses context to choose between those meanings that are appropriate for the context and those that are not.

In the Construction-Integration Model, meaning is believed to be activated and coded as propositions in the mind. In a study by Kintsch & Keenan (1973), the researchers asked participants to read a sentence and recall the sentence immediately in writing. The number of words in each sentence was about the same but the number of propositions varied from 2 to 23. For example, the following two sentences (taken from Kintsch & Keenan, 1973, p. 259) contained about the same number of words, 14 and 16 respectively. The number of propositions (capitalized words in parentheses) in each sentence, however, differed greatly. The first sentence contained four propositions while the second contained eight.

Romulus, the legendary founder of Rome, took the women of the Sabine by force.

(TOOK, ROMULUS, WOMEN, BY FORCE)

(FOUND, ROMULUS, ROME)

(LEGENDARY, ROMULUS)

(SABINE, WOMEN)

Cleopatra's downfall lay in her foolish trust in the fickle political figures of the Roman world.

(BECAUSE, α, β)

(FELL DOWN, CLEOPATRA) = α

(TRUST, CLEOPATRA, FIGURES) = β

(FOOLISH, TRUST)

(FICKLE, FIGURES)

(POLITICAL, FIGURES)

(PART OF, FIGURES, WORLD)

(ROMAN, WORLD)

The researchers argued that sentences with more propositions should take longer reading time if meanings were represented as propositions in the mind. Moreover, longer reading time should also be connected to the number of propositions that a participant was able to recall: the longer the reading time, the more propositions and vice versa. The researchers found that reading time was positively correlated with the number of propositions being processed. Their findings support their notion that propositions are a basic unit of meaning for comprehension.

The first step of construction is weakly constrained for it to be flexible enough to produce all possible outputs based on the input. There are certain rules responsible for producing the outputs. These production rules are over-powerful in that they can generate the right propositions, as well as irrelevant or entirely inappropriate propositions.

It is only during the second step of integration that context comes into play, and the model chooses between those propositions that are appropriate for the context and those that are not. During the integration phase, an activation vector passes through the network, and the weights on the interconnections are updated so that positively interconnected items (right propositions) are strengthened, while unrelated or implausible items lose activation and drop out of the network.

The two-step construction-integration process occurs in cycles corresponding to short sentences or phases. In each cycle, a new net of associations is constructed from whatever was held over in working memory from the previous cycle. Once this net of associations is constructed, the integration process steps in and activation vectors are passed through the system until the weights on the interconnections stop changing and the system stabilizes. The highly activated nodes that remain are the discourse representation that is then held over in working memory to aid in the construction processes of the next cycle. However, the integration does not necessarily need to wait for a clause or sentence boundary.

Kintsch also proposed the concept of the situation model, which refers to a deeper understanding of the message. The situation model includes the new representation of meaning based on the just received information and its inference. For example, by reading or listening to this sentence "Lucy weeded the vegetable garden", comprehenders may generate the inference "Lucy does not like weeding the vegetable garden" by integrating information of this sentence with previous information such as "Lucy does not like gardening" and "Mother nagged her". Not every comprehender will construct exactly the same textbase or situation model. Readers or listeners build their own structures based on their understanding of the message, their prior knowledge, and their inferencing habits.

Evidence for the construction and integration process comes from studies of homonyms. In a study using a cross-modal priming paradigm (Swinney, 1979), participants completed a lexical decision task while they were listening to a sentence (also called a *prime*). In a lexical decision task, participants need to decide whether a visually presented letter string (also called *target*) was a word or a nonword (e.g., *brane*). In the cross-modal priming paradigm, the letter strings appeared simultaneously with an English homonym (e.g., *bug*) in the spoken sentence

(see the example below). If the letter string was a word, it was sometimes related to one of the meanings of the homonym (e.g., *ant* or *spy*). Participants made the lexical decision more quickly when the target was related to either meaning of the homonym, indicating initial activation of alternative meanings of the homonyms, but if the target appeared 200 ms later, they reacted more slowly to the unrelated meaning of the homonym, showing that they could use contextual meaning to eliminate the inappropriate meaning of a homonym within that time.

Rumor had it that, for years, the government building had been plagued with problems. The man was not surprised when he found several spiders, roaches, and other <u>*bugs*</u> *Δ in the corner of his room.*

Visual words displayed at "Δ"

ANT contextually related

SPY contextually inappropriate

SEW unrelated.

In another cross-modal priming study, Zwitserlood (1989) presented visual targets at the end of spoken sentences that contained ambiguous fragments of words, such as /kæp/, which could be the first part of *capital* or *captain*. The spoken sentences contained semantic information that biased listeners towards one of the possible continuations of the fragment (e.g., *In dampened spirits the men stood around the grave. They mourned the loss of their cap...*). The visual targets were either related to the word which fitted the context (*ship*, related to *captain*) or to the inappropriate word (*town*, related to *capital*). Neutral contexts were also included (*The next word is cap...*). Participants again showed initial activation of both possibilities of /kæp/, even when the meaning was inappropriate. When the fragment was around 410ms, the context-

inappropriate possibility was no longer active. Thus the data again provide evidence for multiple meaning constructions at the early stage of language comprehension.

Using a series of rapid reading tasks, Till, Mross, and Kintsch (1988) studied the time course in meaning activation, meaning selection, and inference construction. Their participants read sentences like *The townspeople were amazed to find that all the buildings had collapsed except the mint. Obviously, it had been built to withstand natural disasters*. After the word "mint" the participants were given a lexical decision task, with the word being *money*, *candy*, or *earthquake*. That is, the target was a context-appropriate target of the prime (money), a context inappropriate target (candy), or a topical inference word (earthquake), respectively. In addition, the researchers manipulated the interval between the presentation of the prime and the target word (stimulus-onset asynchrony, or SOA). They used SOAs of 200, 300, 400, 500, 1,000, and 1,500 ms.

The researchers found that targets that are contextually appropriate were active at all SOAs. Contextually inappropriate targets, however, were active only when the target was still in its initial processing stages, that is, SOAs of 200 and 300 ms. By 400 ms inappropriate targets were no longer active. Inference words were active only if there was enough time, more than 500 ms. The results revealed again that the initial activation of lexical knowledge is independent of the context. This stage of meaning activation, however, was quickly followed by a process of meaning selection in which the context becomes effective. By 500 ms, context-inappropriate meanings were deactivated. If given more time, context effects grew even stronger: contextually appropriate inference words were strongly active. This experiment thus provided evidence for the two-step construction-integration process and the situation model.

The Structure Building Framework

The Structure Building Framework is a cognitive model of language comprehension. It has been empirically tested for more than two decades and used to explain language comprehension in normal native comprehenders (Gernsbacher, 1997), less skilled comprehenders (Gernsbacher & Faust, 1991; Gernsbacher, et al., 1990), older adults (Faust, Balota, Duchek, Gernsbacher, & Smith, 1997), brain-damaged patients (Tompkins, Lehman, & Baumgaertner, 1999), and schizophrenic patients (Gernsbacher, Tallent, & Bolliger, 1999). The framework consists of three sub-processes: laying a foundation, mapping and shifting. In the first process, comprehenders lay foundations of their mental structures for the incoming text or discourse. In the process of *mapping*, comprehenders develop their mental structures by mapping incoming information on the foundation. In cases when the incoming information is incoherent or unrelated, comprehenders shift to initiate a new substructure, a process called *shifting*.

Gernsbacher proposed that the initial places of a sentence or a paragraph are where comprehenders lay foundations. Comprehenders thus should spend more time processing the first sentence of a paragraph or the first word of a sentence. In Kieras (1978), for example, the researcher asked participants to read paragraphs formed by the same seven sentences (see Table 1). For some paragraphs, the topic sentence "the ants ate the jelly" appeared as the first sentence while in others the topic sentence was the last one. He found that participants' reading time of the first sentence, whether it is the topic sentence or not, was always longer when it was the first sentence of the paragraph.

In a study of word reading in sentences (Aaronson & Scarborough, 1976), participants read sentences in a word by word manner. The researchers found that participants' reading time of the first content word of a sentence or clause was longer than their reading time of the same

word when it did not appear phrase or sentence initially. For example, in the following two sentences (Aaronson & Scarborough, 1976, p. 58), participants spent longer time reading *boat* in the first sentence than in the second sentence.

Because of its lasting construction as well as its motor's power, the boat was of high quality.

The newly designed outboard motor whose large rotary blades power the boat was of high quality.

Table 1 Materials Used in Kieras (1978, p. 16)

Topic sentence last	Topic sentence first
The kitchen was spotless.	The ants ate the jelly.
The table was wooden.	The ants were hungry.
The ants were hungry.	The jelly was grape.
The ants were in the kitchen.	The ants were in the kitchen.
The jelly was grape.	The jelly was on the table.
The jelly was on the table.	The kitchen was spotless
The ants ate the jelly.	The table was wooden.

A psycholinguistic effect in reading and listening, the advantage of first mention, provides further evidence for the process of laying a foundation. This advantage refers to the phenomenon that the participant mentioned first in a sentence is more accessible than when the same participant is mentioned later. For example, in a 1988 study, Gernsbacher & Hargreaves (1988) asked their participants to read sentences that have two English names. The sentences were constructed in such a way that one name served at either the agent or the patient in either the first- or second-mentioned positions (see Table 2). After reading one sentence, participants needed to decide whether the name, e.g., Tina, had appeared in the sentence or not. It was found that participants' reaction to "Tina" was always faster when it was first mentioned, regardless of its thematic role. The authors argued that first-mentioned names are more accessible because

they lay the foundations for sentence-level presentations. Subsequent information is mapped onto developing representations though the foundations.

Table 2 Materials Used in Gernsbacher & Hargreaves (1988, p. 702)

Thematic roles	First mention	Second mention
Agent	*Tina* beat Lisa in the match.	Lisa was beaten by *Tina* in the match.
Patient	*Tina* was beaten by Lisa in the match.	Lisa beat *Tina* in the match.

After comprehenders lay a foundation for their mental representations, they develop these representations through the process of mapping. Incoming information that coheres with previous comprehended information is added to the developing representation. According to this view, incoming information should be processed faster if it is related to the old information than if it is unrelated. This is what researchers found when they studied sentences of different coherence relationship. In a study of causal coherence, for example, Keenan, Baillet, & Brown (1984) asked participants to read sentences arranged in a way that the second sentence often was the result of the first one. For example, *Joey's big brother punched him again and again. The next day his body was covered with bruises.* Compared to sentences in which no causal relationship was present, for example, *Joey went to a neighbor's house to play. The next day his body was covered with bruises*, the same second sentence was read significantly faster when it followed a cause, as in the first pair.

As mentioned above, comprehenders start a new structure when the incoming information is not coherent. In empirical studies, researchers found that comprehenders slowed down after they encountered a stimulus that signaled a change. For example, in Black, Turner, & Bower (1979), participants read groups of sentences that had a consistent continuation or a

change of continuation, as shown below. The first two sentences introduced a character in the subject position (e.g., Alan). In a consistent continuation, the verbal phrase in the third sentence described a motion from Alan's position; while in a changed continuation, the third sentence described a motion from someone else's position (e.g., Liz in the example below). Participants' reading time of the consistent statements was faster than that of the changed ones.

Alan hated to lose at tennis.

Alan played a game of tennis with Liz.

After winning, she <u>came up</u> and shook his hand. (consistent continuation, Alan's position)

After winning, she <u>went up</u> and shook his hand. (changed continuation, someone else's position)

According to the Structure Building Framework, the building blocks of mental structures are *memory nodes*, which represent previously stored information in the brain. Incoming stimuli can activate these memory nodes. Once memory nodes are activated, the information they represent can be used in building mental representations. Activated memory nodes transmit signals that either suppress or enhance the activation of other memory nodes. Their own levels of activation are also controlled by the mechanisms of *suppression* and *enhancement*. Suppression decreases the activation of memory nodes when the information they represent becomes irrelevant and enhancement increases the activation of memory nodes when the information they represent is relevant to the representation being built. Based on this framework, comprehension difficulty may come from two sources. Less skilled comprehenders may be unable to suppress irrelevant information. As a result, too many mental representations are constructed and maintained in the brain. On the other hand, less skilled comprehenders may fail to activate enough memory nodes for building a mental representation.

Although Kintch's Construction-Integration Model and Gernsbacher's Structure Building Framework share similar components, they differ at the level of processing that each model is able to explain. The Construction-Integration model focuses more on how word meaning is constructed. Word meanings are first activated and the Integration component suppresses unwanted meanings using the context and long-term memory.

The Structure Building Framework is more concerned with how the meaning of a sentence, or even a discourse, is constructed. It can explain how a comprehender resolves incongruity at the sentence or discourse level. Incoming information is mapped onto the processed information and forms a meaning representation. When a mismatch occurs, the suppression mechanism will deactivate the unwanted meaning and a new meaning representation is constructed.

Similar to the Construction-Integration Model, the Structure Building Framework is able to explain the processing of homonyms in a sentence. The activation mechanism first activates the multiple meanings of a homonym. Meanings that cannot be mapped onto the representation being built are then suppressed.

Compared to the Construction-Integration Model, the Structure Building Framework is able to explain the processes involved in disambiguating homonyms and resolving sentential incongruity. The Structure Building Framework thus has more explanatory power. I will use this framework as the theoretical basis for this dissertation. To facilitate future discussion, the processes involved in the Structure Building Framework are visualized in Figure 1.

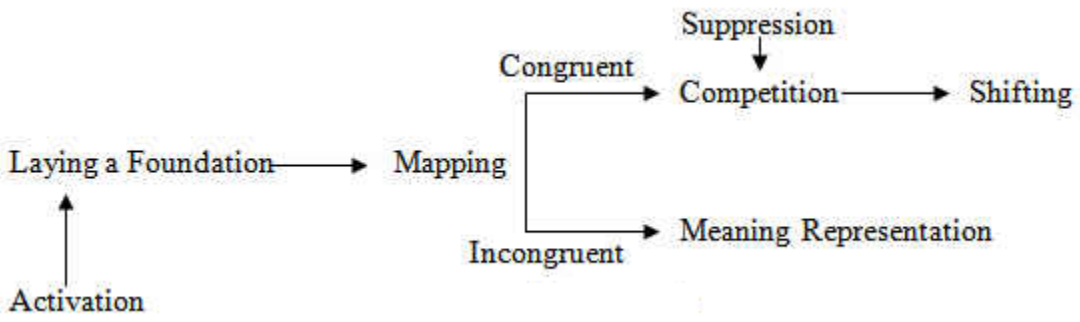

Figure 1 Processes Involved in Semantic Integration

As we can see in Figure 1, meaning integration involves three steps: laying a foundation, mapping and shifting. The mechanism of activation mainly plays a role at the stage of laying a foundation. If there is no incongruity, incoming information will be integrated to the already constructed meaning representation. If an incongruity appears, the incongruent information and the processed information are in a competition. The mechanism of suppression comes to play and meaning shifting is initiated.

Previous studies have revealed that native comprehenders' difficulty in semantic processing is a result of an inefficient suppression mechanism. In the next section, I will discuss previous L1 studies in meaning integration, especially the role that suppression plays in comprehension.

Meaning Integration in First Language Comprehension

Differences in semantic processing between skilled and less skilled comprehenders are seen in event-related brain potentials (ERP) studies looking at the N400, an electrophysiological component that has been closely linked to semantic processing (Kutas & Hillyard, 1980). N400 means that a negative brain potential occurs in centro-parietal position of the brain around 400 milliseconds after a participant processes a grammatically correct but semantically anomalous

sentences, for example, *He spread his warm bread with socks*. The amplitude of the N400 is reduced when the context is moderately incongruent (e.g., *He took a sip from the waterfall)*.

In a recent study of less skilled language users (Perfetti, et al., 2008; Yang, et al., 2005) using the ERP, participants were asked to read four types of two-sentence passages in a word-by-word format. The connection between the first sentence and the first content word of the second sentence (the critical word) varied. In an *explicit* condition, a word from the first sentence was repeated (with morphological variation); in a *paraphrase* condition, the first sentence contained a word or phrase that was semantically similar to the critical word; and in an *inference* condition, the situation described by the first sentence could trigger an inference that established an antecedent for the critical word. In a baseline condition, the first sentence contained no apparent antecedent for the critical word. These four conditions are illustrated below.

After being dropped from the plane, the bomb hit the ground and ***exploded****. The* ***explosion*** *was quickly reported to the commander.* (Explicit)

After being dropped from the plane, the bomb hit the ground and ***blew up****. The* ***explosion*** *was quickly reported to the commander.* (Paraphrase)

After being dropped from the plane, the bomb hit the ground. The ***explosion*** *was quickly reported to the commander.* (Inference)

Once the bomb was stored safely on the ground, the plane dropped off its passengers and left. The ***explosion*** *was quickly reported to the commander.* (Baseline)

For skilled comprehenders, an N400 effect after the onset of the critical word (observed for the baseline condition) was reduced in the explicit and paraphrase conditions, but not reliably in the inference condition. The pattern of results suggested that lexico-semantic (explicit condition) and conceptual processes (paraphrase condition) facilitate meaning integration of the

critical word. Less skilled comprehenders showed a later N400 effect than skilled comprehenders. Compared with skilled comprehenders, the results suggested that less skilled comprehenders are slower in integrating meaning.

In another study comparing semantic processing between skilled and less skilled comprehenders, Landi & Perfetti (2007) asked participants to complete a semantic-word task, a semantic-picture task, and a phonological task. In the semantic-word task and the semantic-picture task, participants decided whether two words (in the word task) or two pictures (in the picture task) were semantically related. The purpose of including a picture task was to investigate whether a semantic processing difficulty extended beyond verbal semantic processing. In the semantic-word task, the stimuli were either categorically related (lemon–pear), associatively and categorically related (cat–dog), or unrelated (bear–truck). In the semantic-picture task, the picture pairs were semantically related (e.g., bear–tiger) or unrelated (e.g., sheep–desk). In the phonological task, participants decided whether two visually presented words are homophones (e.g., boar-bore) or not (mint-move). Participants' ERPs and reaction time data were collected. No differences were found in ERP waveforms between the two groups in the phonological task, suggesting that the participants did not differ in meaning processing (if meaning is involved) in this task. There was also a lack of differences in the semantic-picture task, indicating that differences in semantic processing between skilled and less skilled comprehenders were primarily limited to the verbal semantic domain. In the semantic-word task, a reduced N400 was observed for the categorically related pairs for skilled comprehenders. The magnitude of N400 was even smaller for the associative pairs. Less skilled comprehenders showed smaller categorical N400 and associative N400 reductions relative to unrelated pairs, compared with skilled comprehenders. Less skilled comprehenders also differed from skilled

comprehenders in that there were no additional N400 reductions for associatively related pairs compared to categorical pairs. The results again revealed that less skilled comprehenders differed from skilled comprehenders in the area of semantic processing.

Researchers believe that inefficient suppression is the cause of this difference between skilled and less skilled comprehenders in semantic processing. Less skilled comprehenders are found to be less efficient in suppressing irrelevant information. In a study using a sentence picture matching task, Madden & Zwaan (2006) asked their participants to listen to an English sentence (e.g., In the box/pot, there was spaghetti), and look at a picture. The picture either matched or mismatched the sentence in a subtle way. If the sentence was "in the box", for example, a mismatching picture showed spaghetti in a pot. The participants were required to decide whether the sentence matched the picture. The interval between the sentence and the picture was either 0ms or 750ms. The researchers found that skilled readers showed a matching advantage in both time intervals. Less skilled readers, on the other hand, showed a matching advantage only at the 750 ms interval. The researchers believed that less skilled readers' performance in the 0ms interval condition revealed immediate activation of multiple representations of the stimulus sentences. Skilled readers showed an immediate use of context to select the appropriate meaning representation while less skilled readers needed more time to do so.

In a study comparing skilled and less skilled comprehenders, (Gernsbacher, et al., 1990), the participants read a sentence (e.g., *He dug with the spade*), and then saw a test word (e.g., *ace*). The task was to decide whether the test word matched the meaning of the sentence they just read. The last word of the sentences was a homonym (e.g., *spade*) and the test word was a meaning of the homonym that was inappropriate to the context (i.e., *ace*). The time that

participants used to decide that a word like *ace* was not related to the sentence was compared to the time that they used to decide that *ace* was not related to a similar sentence (e.g., *He dug with the shovel.*) This comparison is a measure of how active the inappropriate meaning of the homonym was. The slower the participants rejected *ace* after the "spade" sentence, the more active the inappropriate meaning was. The researchers found that both skilled and less skilled comprehenders were slower in rejecting the inappropriate meaning immediately after the homonym than after the unambiguous word. After 750 ms, less skilled comprehenders were still slower in rejecting the inappropriate meaning after the homonym, while skilled comprehenders showed no difference. This result suggested that the inappropriate meaning was still active for less skilled comprehenders after a longer delay. They are less efficient than skilled comprehenders at suppressing inappropriate meanings of homonyms not implied by sentence context. Using similar materials and design, inability to suppress irrelevant information was found in patients with dementia of the Alzheimer Type (Faust, et al., 1997) and brain-damaged older adults (Tompkins, et al., 1999) when they were compared with normal controls.

To sum up these previous studies, it has been found that people with comprehension difficulty tended to suppress irrelevant information less efficiently than people who did not have the difficulty. The mechanism of suppression thus plays an important role in successful meaning integration in L1 comprehension.

Meaning Integration in Second Language Comprehension

Differences in semantic processing between L1 and L2 are also seen in event-related ERP studies looking at the N400. N400 responses have consistently been found to be delayed for second language learners in comprehending semantically unacceptable sentences (e.g., *The volcano was eaten*) in reading (e.g., Ardal, Donald, Neuter, Muldrew, & Luce, 1990; Hahne &

Friederici, 2001; Mueller, 2006; Mueller, Hahne, Fujii, & Friederici, 2005; Ojima, Nakata, & Kakigi, 2005; Peroverbio, Cok, & Zani, 2002; Weber-Fox, Davis, & Cuadrado, 2003) as well as in listening (e.g., FitzPatrick & Indefrey, 2006), indicating certain difficulty in L2 semantic integration. For example, Ojima, Nakata, and Kakigi (2005) asked Japanese learners of English to listen to English sentences that are semantically correct (e.g., The house has ten rooms in total), or incorrect (e.g., The house has ten cities in total). It can be seen from the two pictures below (taken from Ojima et al 2005, p. 1215) that the N400 of Japanese learners of English was smaller in magnitude and slower in appearance time than those of English native speakers.

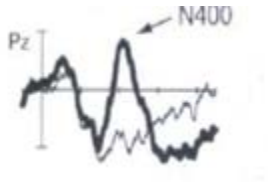

Figure 2 N400 of English Native Speakers

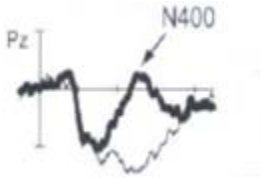

Figure 3 N400 of Japanese Learners of English

According to previous studies in L1 comprehension and the Structure Building Framework, the semantic difficulty in language comprehension most likely comes from an inefficient suppression mechanism. Comprehending a second language also poses difficulty for many learners. Is it possible that the suppression mechanism plays a role in the difficulty in L2 comprehension? Studies of L2 learners' processing of homonyms in sentential contexts have provided relatively consistent results.

In a study comparing the processing of homonyms in context between a group of native speakers and a group of L2 learners, Elston-Guttler and Friederici (2005) asked participants to read a contextual sentence (e.g., *Mary liked the sound of the*). The participants then saw a homonym (e.g., *sentence*) which was presented for either 200 or 500ms. A target (e.g., *prison* or *grammar*) then appeared for 3000ms or until the participants made a lexical decision. Participants' reaction time (RT) and ERP N400 data were collected. At the 200 ms interval, priming effects for both meanings of the homonym were observed from the RT and ERP N400 data with both native speakers and L2 learners, indicating early access to both meanings. The priming effect refers to the phenomenon that a previously presented stimulus decreases the reaction time or reduces the ERP amplitude of a later stimulus (also called target) (Gleason & Ratner, 1998). At the 500 ms interval, the RT data revealed that the contextually inappropriate meanings were no longer active for either group. On the other hand, the ERP data showed that the inappropriate meanings were still active for the L2 learners, but not for the native speakers. Results from this study suggested that L2 learners were similar to native speakers in their initial multiple access of word meaning, but different from the native speakers at later stages in using the context information to suppress inappropriate meanings.

A study by Frey (2005) also revealed that nonnative speakers had no difficulty in activating the multiple meanings of a homonym but were slower than native speakers in suppressing context-inappropriate meaning. Frey used materials similar to the ones in Gernbacher, Varner and Faust (1990) (e.g., *He dug with the spade*) to determine the degree to which Estonian learners of English were able to suppress the irrelevant meaning of a homonym at SOAs (stimulus-onset asynchrony) of 200ms, 450ms, 800ms, and 1000ms. Context-inappropriate meaning was active for both native speakers and L2 learners at the 200ms SOA.

This activation disappeared at 450 ms SOA for native speakers, but at 800 ms SOA for nonnative speakers.

In the only study that involved listening, Love, Maas and Swinney (2003) compared the performance of two groups of L2 learners, less proficient and more proficient, with a group of native speakers. The researchers believed that their results suggested an initial access of multiple meanings of homonyms for L2 learners and a difference at the later suppression stage between L1 and L2 processing. Their participants listened to sentences and completed a naming task when they saw a visual target. The researchers tested lexical access at three positions in a sentence: first encounter of a homonym (Position 1), later in the sentence (Position 2), and immediately after a verb (Position 3) (e.g., *"The professor insisted that the exam be completed in ink, so Jimmy used the new pen (1)* that *his mother-in-law recently (2) purchased (3) because the multiple colors allowed for more creativity."*) In an earlier study, Love and Swinney (1996) had found that multiple meanings (e.g., "writing object" or "jail") of the homonym (e.g., *pen*) were initially active for native speakers. This was revealed by faster naming of both meanings of the homonym at Position 1 even though the context was biased towards the meaning of "writing object". Later in the sentence (Position 2), the priming effects of both meanings of the homonym disappeared. Only the contextually relevant meaning was reactivated at Position 3. In Love et al. (2003), initial access to both meanings of the homonym at Position 1 was obtained again in native speakers and when the two groups of nonnative speakers were combined. When the nonnative speaking groups were analyzed separately, neither group showed activation for both meanings. The primary meaning (e.g., "writing object") was active only in the more proficient group, and the secondary meaning (e.g., "jail") was active only in the less proficient group. The rest of the data were even more difficult to interpret. Only the secondary meaning was active at

Position 3 when the two groups were combined or the less proficient group was analyzed alone. Neither meaning was active for the more proficient group at Position 3.

In sum, although L2 learners are less efficient at suppressing the inappropriate meaning of a homonym in reading tasks, it is not clear that this inefficiency exists in the suppression of sentential incongruity. In reality L2 learners also encounter incongruent sentences. Studying how L2 learners process sentential incongruity will thus provide us with more information on how L2 learners integrate meaning in language comprehension. Furthermore, most previous studies are conducted in the reading modality. It is not clear whether there is a difference between L2 listening and reading comprehension. In the current study, I attempt to address this question. Unlike previous studies, I focus not on homonyms but on L2 learners' interpretation and processing of sentential contexts. The experimental items are sentences, and by manipulating the predictability of each sentence I investigate whether L2 learners are able to suppress the unwanted interpretation of a sentential context that they have just listened to. The purpose of using sentences is two-fold. First, L2 learners are more likely to readjust their interpretations of sentences in actual L2 use. Second, if suppression is indeed inefficient in L2 comprehension, I should not only observe it in homonyms but the single-meaning words that L2 learners encounter more frequently.

The Present Study

In the present study, my goal is to investigate whether there is a difference between native speakers and L2 learners in the process of meaning integration during L2 listening comprehension. The specific research questions I plan to answer are:

Do Chinese learners of English activate relevant interpretations of an auditory message like native English speakers?

Do Chinese learners of English suppress unwanted interpretations of an auditory message like native English speakers?

The resulting design investigated the mechanism of suppression in native speakers and L2 learners given three types of sentential contexts: congruent, neutral and incongruent. In the congruent context, the last word (target) is highly predictable from listening to the lead-in sentence (e.g., *Children are more affected by the disease than* <u>*adults*</u>.) The target in the neutral context is appropriate but not highly predictable (e.g., *Children are more affected by the disease than* <u>*nurses*</u>.) In the incongruent context, the target is semantically unacceptable for the lead-in sentence (e.g., *Children are more affected by the disease than* <u>*letters*</u>.) Participants listened to a lead-in sentence (e.g., *Children are more affected by the disease than*) and then a target (e.g., *adults*). Their task was to name the target or decide whether it is a word or non-word in English.

Note that the lead-in sentences in all three contexts have highly predictable candidates. In the neutral and incongruent contexts, listeners have to suppress this candidate while activating the real target. If suppression is successful, I would expect a faster reaction time to the neutral target than to the incongruent target because the neutral target is semantically appropriate and mapping to an already constructed presentation is easier. If suppression is unsuccessful, I would see a competition between the highly predictable candidate and the real target. Since this competition exists in both the neutral context and the incongruent context, I expect no difference between these two contexts in participants' reaction time to the targets. Although the neutral target also receives some activation from the lead-in sentence, the competition is too strong that it overrides the advantage that the neutral target has. As to the congruent context, I predict that participants' reaction time to the congruent target is always the fastest because no obvious

suppression is involved in this context. This prediction of course assumes no difference between native speakers and L2 learners in other processes involved in comprehension.

In Chapter 2, I report three experiments investigating the suppression mechanism in L2 listening comprehension through the use of three types of sentential context. The three experiments employed the same listening materials but the presentation of them differed slightly to test the robustness of the findings.

CHAPTER 2

THE CONTEXT EFFECT IN L2 LISTENING COMPREHENSION: EXPERIMENTS 1 TO 3

This chapter presents three experiments investigating the suppression mechanism in L2 listening comprehension through the use of three types of sentential context: congruent, neutral and incongruent. All three experiments were conducted using the cued shadowing paradigm, a psycholinguistic method for studying auditory language processing. In the cued shadowing paradigm, participants listen to a sentence and then repeat the last word as quickly as they can.

In these experiments, each context had a highly predictable last word. As I have predicted, if suppression is successful, I will observe a faster reaction time to the neutral target than to the incongruent target because it is more likely that learner will map the neutral target onto the constructed representation. If suppression is unsuccessful, we will find no difference between the neutral and the incongruent conditions in participants' reaction time. This is because there will be competition between the highly predictable candidate and the real target. As to the congruent context, we will always observe a quickest response time because no obvious suppression is involved in this context.

Results from Experiment 1 revealed an interesting phenomenon in L2 listening comprehension. For native speakers, their reaction to the congruent context was faster than that to the neutral context, and their reaction time to the neutral context was faster than that to the incongruent context. If the neutral context is considered as the baseline, this suggests both a facilitative effect and an inhibitive effect for native speakers. For nonnative speakers, however, I observed a facilitative effect but not an inhibitive effect. I refer to this phenomenon as the facilitation-without-inhibition phenomenon. The nonnative speakers' result is consistent with the

prediction of a less efficient suppression mechanism. Experiments 2 and 3 were designed to test the robustness of this facilitation-without-inhibition phenomenon.

In Experiment 1, L2 learners may not have enough time to activate the neutral target. The neutral target thus is as surprising as the incongruent target. In Experiment 2, the listening materials were slowed down to give L2 learners more processing time to activate the neutral targets.

These first two experiments included comprehension questions in order to encourage participants to pay attention to the meaning of each sentence. In Experiment 3, comprehension questions were excluded so the task was more similar to a natural listening activity. The facilitation-without-inhibition phenomenon was found in both of these follow-up experiments as well. Based on results from these three experiments, it is clear that the facilitation-without-inhibition phenomenon is robust at least when using the shadowing paradigm.

Experiment 1: Cued Shadowing

Participants completed a cued shadowing task (Bates & Liu, 1996; Liu, Bates, Powell, & Wulfeck, 1997) in Experiment 1. In this task, the prime was a lead-in sentence spoken by a male while the target was a word spoken by a female. Participants listened to the lead-in sentence and repeated the target as quickly as possible without making a mistake.

Method

Participants

Thirty native speakers of American English and twenty-seven Chinese learners of English, who were not involved in any of the norming procedures described below, participated in Experiment 1. The native speakers of English were undergraduate students at a U.S. university who participated in the study in exchange for introductory psychology course credit. The

Chinese learners of English were graduate students at the same university. Each Chinese learner of English was paid $10 for their participation. Their demographic information is summarized in Table 3.

Table 3 Participant Information for Chinese Learners of English in Experiment 1

	Mean	Range
Age	27	22-35
TOEFL	612.78	571-643
Age at beginning of English instruction	12	7-15
Years of formal instruction	12	8-18
Years of residence in the US	2yrs 6m	6m – 6yrs
Self-evaluation of English proficiency (1-10)		
Speaking	5.8	2-9
Listening	6.3	3-8
Reading	7.2	4-9
Writing	6.2	3-8

Note: The information was obtained through a questionnaire the participants filled out before the experiment. The self-evaluated proficiency scores are on a 10-point scale, in which 10 represents native-speaker level and 1 represents complete ignorance of English.

Materials

Stimulus materials consisted of 48 lead-in sentences which were completed by different targets in the congruent, neutral, and incongruent conditions. The target for a congruent sentence is a highly predicable last word, the target for a neutral sentence is not highly predicable but semantically acceptable, and the target for an incongruent sentence is semantically unacceptable.

To find the target words for the congruent condition, 64 sentential contexts were first constructed. Eighteen of these contexts were taken and modified from published sources that reported cloze probabilities for sentences (Bloom & Fischler, 1980; Federmeier & Kutas, 2001; Griffin & Bock, 1998). A cloze probability is the percentage of participants that continue a sentence fragment with a particular item when the participants are given as much time as they need (DeLong, Urbach, & Kutas, 2005). I constructed the remaining 46 sentences such that the

last word of each sentence was highly predictable by reading the preceding context. After the 64 sentences were identified, I took out the last word of each sentence. Cloze probabilities for these sentences were then obtained from 21 native speakers of American English (see Appendix A) and 38 Chinese learners of English (see Appendix B). The participants were instructed to complete each sentential context with the first word that came to their minds and a second most acceptable word if there was one. The frequency of each word provided for each sentential context was calculated. Contexts and target words fell below the cutoff of 60% agreement rate, altogether 12, were removed.

Target words used in the congruent and incongruent conditions were actually the same words but in different sentences. For example, the word *money* was used in the sentence *Before going to the airport, she stopped at the bank to get some money* in the congruent condition, but in the sentence *Many soldiers and civilians lost their lives during the four-year-long money* in the incongruent condition. This was to ensure that the possible difference in word naming time was not a result of using different target words. The incongruent target matched the congruent targets of the same lead-in sentence in terms of parts of speech (e.g., nouns for nouns, verbs for verbs). In the rare cases where an incongruent target could not be found from among the congruent targets (e.g., in the sentence *By the time he got to the station, the train had already left*), a word that was closest to the congruent target in its initial sound and number of syllables was chosen, in this case, *leaped*.

The target words for completing the neutral condition were different from those used in the congruent and incongruent conditions. This was due to the difficulty of using the targets from the congruent condition to form a neutral sentence. The neutral targets were obtained from searching the British National Corpus (2001) or one of the acceptable answers provided by the

native speakers when they were completing the sentential contexts for the congruent condition. Two possible neutral targets were selected for each sentence first. After the possible neutral targets were identified, 24 native speakers of American English (who did not participate in the cloze completion task) were invited to judge whether the complete sentences were grammatically well-formed and semantically plausible on a 1 to 7 Likert Scale (1 representing highly acceptable and 7 representing extremely unacceptable). Participants' selections were then averaged for each target (see Appendix C and D). The targets whose ratings were higher than the 3.5 benchmark were excluded from the study. In the four cases where neither of the two targets was acceptable, the sentences were excluded from the study. In cases where both targets were acceptable, the target that was closer in naming time to the congruent target was selected. (See the single-word naming task below.)

Since the remaining neutral targets and congruent/incongruent targets were different words, there was the possibility that any difference between the neutral condition and the congruent/incongruent condition was caused by the time difference in producing the words, not the contexts. To test such a possibility, a single-word naming task was conducted. Seven Chinese learners of English and 7 native speakers of American English were invited to participate in this task. In this task, the participants listened to the target words from the congruent condition and the candidate words from the neutral condition one at a time. The order of the words was randomized and different for each participant. They needed to say this word as fast and accurately as possible into a microphone (Optimus Nova 79). The participant's naming time was measured from the end of the presentation of the word until the microphone was triggered or 2000ms after the word was presented. The neutral candidate that was closer in naming time to the congruent target was selected as the target word for the neutral condition in cases where both

neutral candidates were semantically acceptable. The naming time of the congruent targets, *Mean (M)* = 924 ms, *Standard Derivation (SD)* = 114.24, and the remaining neutral targets, *M* = 935 ms, *SD* = 110.29, were compared using a paired sample t-test. No difference was found between these two groups of targets ($t = .62$, $p = .54$) in terms of naming time.

To further ensure that there were semantic differences among the three contexts, 20 native speakers of American English were invited to judge the acceptability of the remaining sentences on a 1 to 7 Likert Scale (1 representing highly acceptable and 7 representing extremely unacceptable). Each informant rated 144 sentences (48 contexts * 3 targets) that were presented randomly. Informants' selections indicated a difference among sentences in the congruent (*M* = 1.02), neutral (*M* = 2.51) and incongruent condition (*M* = 6.29). Because one of the criteria for choosing the neutral sentences is that they are acceptable ones, it is unsurprising that the rating between the congruent and the neutral sentences is not extremely different.

After the norming and selecting procedures, the remaining sentential contexts and their corresponding targets were subject to recording. A list of the 48 contexts and the 144 targets used in the experiment are presented in Appendix E.

Recording

The 48 congruent sentences and 144 targets used for Experiment 1 were recorded by two native speakers of American English in a quiet room at the normal articulation rate of about 300 syllables per minute after removing silent intervals. The speakers wore a Special Project headset microphone connected to a Telex WT-150 transmitter. The voice signals were received by a Telex FMR-150 receiver and recorded into a Sony Digital Audio Tape-corder (TCD-D100). The recorded signals were then transferred to a Dell computer using Kay Elemetrics CSL (Computer Speech Lab) 4500 hardware. The target words were recorded in the same manner that the

sentences were recorded. Both speakers read all the sentences in a neutral tone of voice, with falling intonation at the end. The male voice was chosen as the voice for the lead-in sentences while the female voice was chosen as the voice for the targets. The decision was based on some colleagues' comments after they listened to the recordings. They felt that the male lower-pitched voice was nicer and more comfortable to listen to for an experiment.

Praat phonetic analysis software (Boersma & Weenink, 2005) was used to edit the original recorded materials. The targets were produced individually, while the contexts were segmented from the congruent sentences. The lead-in sentence was the same for the three conditions while the targets varied. There was no interval between the offset of the lead-in sentence and the onset of the target. Each target and lead-in sentence was an individual wave file. Once the process was completed, the files were put together with DMDX (Forster & Forster, 2003) item file for experimental presentation.

Design

The 48 lead-in sentences and the three sets of targets were used to construct three test lists. Each list contained the 48 lead-in sentences followed by 16 congruent, 16 neutral and 16 incongruent targets. The congruent, neutral and incongruent targets of a sentence always appeared in different lists so that no sentence or target was repeated in the same list. All sentences were followed by a comprehension question.

Procedures

Participants were assigned to a test list based on the order in which they arrived in the laboratory. Overall, ten native speakers and nine Chinese learners of English were assigned to each list. Participants were tested one at a time in a quiet booth. Stimuli were presented on a Dell E172FPb desktop computer, using DMDX presentation software. Participants wore headphones

with a microphone (Optimus Nova 79). Both the headphones and the microphone were connected to the computer.

At the beginning of each session, instructions were presented on the monitor visually to the participants in English. The experiment began when the participants pressed the space bar, an indication that they had read and understood the instructions. The sentences were randomly presented in a continuous sequence. The male lead-in sentence was followed immediately (0ms from offset of the lead-in sentence) by the auditory target word in the female voice. Participants were instructed to repeat the target word (signaled by the female voice) as quickly as possible without making a mistake. The timer started just at the beginning of the target word and stopped after 2500ms or until the participant responded, whichever came first. During the listening and naming periods, nothing visually appeared on the screen.

After the participant repeated the target word, a short statement appeared on the computer screen. The participant was asked to decide whether the statement was true or false according to the sentence that they just heard by pressing either *shift* button to indicate *true* (right shift) or *false* (left shift).

Prior to the experiment, participants were given a brief practice session with twelve stimuli (which were not used in the main experiment). Participants were instructed to speak directly into the microphone, as clearly and loudly as possible, to repeat the target word, and to avoid any other sounds, e.g., filler sounds. I was with the participant during this practice session. After the practice session and when participants were ready, they could continue by pressing the space bar. I left the testing booth at this point in order to minimize extraneous influences on the participants. I listened to the participants' recordings afterwards and checked all reaction times and errors using the software CheckVocal (Protopapas, 2007). The first two stimuli in the

experiment session were also practice ones, unknown to the participants. The addition of these two stimuli was to diminish the nervousness that some participants had when the formal experiment started. The entire experimental session lasted approximately 20 minutes.

Results and Discussion

For each participant, invalid reaction times due to extraneous noises, false starts, failures to respond within the time window, and erroneous responses were checked using CheckVocal. 2.33% of the native speaker RTs and 4.53% L2 learners RTs were invalid and thus removed prior to the identification of outliers. Traditionally, extremely fast and slow responses are identified as outliers and removed before data analysis. When a reaction time is too fast, this may be because participants are not following the instructions correctly, e.g., they keep responding without paying attention to the stimulus. On the other hand, if a reaction time is too slow, this may be because participants' attention is distracted. In Experiment 1, outliers were identified as RTs more than 2 standard deviations from the relevant cell mean of the relevant participant (NS= 4.6%; NNS= 4.3%) and RTs less than 200 ms (NS= 0%; NNS= 0%) or more than 2300 ms (NS= 0%; NNS= 0%). The total exclusion rate (erroneous responses + outliers) was thus 6.9% for native speakers and 8.8% for L2 learners. There is not a generally accepted exclusion rate for reaction time data. Since the acceptable error rate is usually 20% (e.g., Jiang, 2007; Jiang & Nekrasova, 2007), the 6.9% and 8.8% exclusion rates are within the normal range. The mean percentage of errors in the comprehension test was 8% for the native speakers and 12% for the L2 learners. No RT data were eliminated as a result of a wrong answer to a comprehension question. Since the purpose of using comprehension questions was to help participants focus on meaning, these comprehension questions were not subject to analysis.

Because the main purpose of the study was to find out whether there was a difference between native speakers and L2 learners in responding to the targets in different contexts, NSs' and L2 learners' data were analyzed separately. To assess the effect of context, I calculated a repeated measure analysis of variance (ANOVA). Analyses were conducted by participants (*F1*) and by items (*F2*); *context* was a repeated measure variable in both analyses. Effect size, Partial Eta squared (η_p^2) is also reported. The details of this ANOVA are given in Table 4.

Table 4 Analysis of Variance for Experiment 1

	Subject RT Mean (SD)	
	NS (N=30) *F1* (2, 58) = 52.39 ($p < .001$, $\eta_p^2 = .644$)	NNS (N=27) *F1* (2, 52) = 20.85 ($p < .001$, $\eta_p^2 = .445$)
Congruent	803.97 (109.28)	897.87 (113.73)
Neutral	859.65 (111.00)	953.06 (119.65)
Incongruent	906.00 (117.10)	972.87 (153.56)
	Item RT Mean (SD)	
	F2 (2, 94) = 20.72 ($p < .001$, $\eta_p^2 = .306$)	*F2* (2, 94) = 12.67 ($p < .001$, $\eta_p^2 = .212$)
Congruent	803.00 (73.74)	900.24 (77.50)
Neutral	863.66 (90.02)	966.50 (93.34)
Incongruent	911.96 (84.90)	976.27 (80.71)

It is clear from the ANOVAS that there was a significant effect for *context* in both groups. A set of pairwise comparisons comparing RTs among the three conditions (see Table 5) revealed a significant difference between the congruent condition and neutral condition for both groups of participants. When comparing the neutral condition and the incongruent condition, however, significance was found only for native speakers.

The observed pattern of responses from the native-speaking participants was consistent with previous studies using the cued shadowing paradigm (e.g., Liu, et al., 1997; Lu, et al., 2001): a faster naming time in the congruent condition than in the neutral condition, and a faster

naming time in the neutral condition than in the incongruent condition. If I treat the neutral condition as the baseline, the faster response from the congruent condition can be seen as facilitation; and the slower response from the incongruent condition is then inhibition. The L2 results showed a similar facilitative effect, but not an inhibitive effect. I thus call this finding the facilitation-without-inhibition phenomenon. Results from Experiment 1 revealed that L2 learners, compared to native speakers, were less efficient in suppressing unwanted targets in auditory language processing.

Table 5 Pairwise Comparison (Bonferroni) for Experiment 1

		NS		NNS	
		Subject			
		Mean RT difference	Significance	Mean RT difference	Significance
Congruent	Neutral	55.68	.000 *	55.19	.000 *
Neutral	Incongruent	46.35	.000 *	19.81	.517
		Item			
Congruent	Neutral	60.66	.004 *	66.25	.001 *
Neutral	Incongruent	48.30	.023 *	9.78	1

A potential problem of Experiment 1 was that our observed pattern from L2 learners may be a result of the insufficient processing of the neutral sentences rather than inefficient suppression. Recall that the neutral target was a possible candidate to complete the lead-in sentence. It is possible that the L2 learners needed more processing time to activate the neutral target using the lead-in sentence. If they were not given enough processing time in Experiment 1, the neutral target, like the incongruent target, would be an unexpected word for them. No difference in naming time would thus be observed. To address this issue, I conducted another experiment in which the speed of the auditory input was slowed down to give L2 learners more processing time.

Experiment 2: Cued Shadowing in a Slower Speed

Experiment 2 investigated whether an inhibitive effect will be observed if L2 learners are given more processing time. The design of Experiment 2 is exactly the same as Experiment 1 except that the speed of the auditory materials was slowed down.

Method

Participants

Twenty-seven native speakers of American English and twenty-four Chinese learners of English from the same participant population as those in Experiment 1 participated in Experiment 2. These participants were not involved in Experiment 1 or the norming and material selection procedures. Their demographic information, which was obtained in the same way as Experiment 1, is summarized in Table 6.

Table 6 Participant Information for Chinese Learners of English in Experiment 2

	Mean	Range
Age	30	24-42
TOEFL	600	550-643
Age at beginning of English instruction	12	6-16
Years of formal instruction	13	10-28
Years of residence in the US	2yrs 3m	6m – 5yrs
Self-evaluation of English proficiency (1-10)		
Speaking	5.4	2-8
Listening	5.8	3-9
Reading	6.7	4-10
Writing	6.1	4-9

Materials

The stimuli were the same sentences used in Experiment 1, except that each sentence was manipulated acoustically using the software Praat to slow down its speed. Several speeds (1.5, 2 and 2.5 times the original speed) of each sentence were created initially and played to two native

speakers of English and two Chinese learners of English who did not participate in the present project. All of them felt that the manipulated sentence sounded the least unnatural when it was 1.5 times slower than the original one. I thus used this speed for all the lead-in sentences.

Since I was only interested in the effects of the lead-in sentences on the targets, the target words still retained their original speed. Each target and lead-in sentence was an individual wave file. Once the process was completed, the wave files were put together with DMDX item file for experimental presentation.

Design

The design of Experiment 2 was exactly the same as that of Experiment 1.

Procedures

Participants were assigned to a test list based on the order in which they arrived in the laboratory. Overall, nine native speakers and eight Chinese learners of English were assigned to each list. The procedures for conducting Experiment 2 were exactly the same as those used in Experiment 1.

Results and Discussion

For each participant, invalid reaction times due to extraneous noises, false starts, failures to respond within the time window, and erroneous responses were checked using CheckVocal. 4.37% of the native speaker RTs and 7.58% L2 learners RTs were removed prior to the identification of outliers. Outliers were identified as RTs more than 2 standard deviations from the relevant cell mean of the relevant participant (NS= 4.5%; NNS= 3.9%); and RTs less than 200 ms (NS= 0%; NNS= 0%) or more than 2300 ms (NS= 0%; NNS= 0%). The total exclusion rate was thus 8.87% for native speakers and 11.48% for L2 learners. The mean percentage of

errors in the comprehension test was 8.3% for the native speakers and 12.5% for the L2 learners. These comprehension questions were not subject to analysis.

Data were analyzed in the same way as described in Experiment 1. The details of the ANOVA are given in Table 7.

Table 7 Analysis of Variance for Experiment 2

	Subject RT Mean (SD)	
	NS (N=27) F1 (2, 52) = 36.96 ($p < .001$; $\eta_p^2 = .587$)	NNS (N=24) F1 (2, 46) = 16.63 ($p < .001$; $\eta_p^2 = .42$)
Congruent	746.82 (143.00)	894.06 (78.29)
Neutral	804.51 (150.56)	957.19 (101.12)
Incongruent	841.87 (158.06)	968.57 (124.56)
	Item RT Mean (SD)	
	F2 (2, 94) = 19.80 ($p < .001$; $\eta_p^2 = .296$)	F2 (2, 94) = 10.16 ($p < .001$; $\eta_p^2 = .178$)
Congruent	748.93 (68.70)	895.90 (95.40)
Neutral	810.13 (82.59)	960.80 (90.76)
Incongruent	846.36 (83.75)	975.80 (87.48)

Since the effects of *context* were significant in both groups, a set of pairwise comparisons comparing RTs among the three conditions was conducted. The details of these pairwise comparisons are given in Table 8. As can be seen from Table 8, the pattern of data from Experiment 2 was very similar to that from Experiment 1. Native speakers' reaction time to the congruent targets was faster than that to the neutral targets, which was, in turn, faster than that to the incongruent targets. L2 learners' reaction time to the congruent targets was faster than that to the neutral targets. However, no reliable difference in reaction time between the neutral and incongruent targets was found for the L2 learners.

Experiment 2 replicated the results of Experiment 1. I observed both a facilitative effect and an inhibitive effect for the native speakers, but only a facilitative effect for the L2 learners.

The facilitation-without-inhibition phenomenon is thus unlikely to be a result of insufficient processing of the neutral materials, as giving more processing time made no difference in the results.

Table 8 Pairwise Comparison (Bonferroni) for Experiment 2

		NS		NNS	
Subject					
		Mean difference	Significance	Mean difference	significance
Neutral	Congruent	57.69	.000 *	63.13	.000 *
Neutral	Incongruent	37.37	.006*	11.38	1
Item					
Neutral	Congruent	61.19	.000 *	64.89	.006 *
Neutral	Incongruent	36.24	.124	15	1

However, there was still a concern about the results from these two experiments: there was the possibility that the facilitation-without-inhibition phenomenon was an artifact of using the comprehension questions. It has been proposed that facilitation is an automatic process, while inhibition is a post-lexical or strategic process (Liu, et al., 1997). When native speakers are not required to pay attention to meaning, we might only observe the automatic process, that is, the facilitative effect. In other words, native speakers might show the facilitation-without-inhibition effect when they are not focusing on meaning. Experiment 3 was designed to test this possibility.

Experiment 3: Cued Shadowing Without Comprehension Questions

The design of Experiment 3 was to test participants' performance when they were not explicitly asked to pay attention to the meaning of the sentences. The task was exactly the same as that used in Experiment 1 except that all the comprehension questions were removed.

Method

Participants

Twenty-seven native speakers of American English and twenty-seven Chinese learners of English from the same participant population as those in Experiment 1 participated in Experiment 3. These participants were not involved in the norming and material selection procedures or Experiment 1 and 2. Their demographic information, which was obtained in the same way as Experiment 1, is summarized in Table 9.

Table 9 Participant Information for Chinese Learners of English in Experiment 3

	Mean	Range
Age	31	23-42
TOEFL	609.48	550-650
Age at beginning of English instruction	12	10-16
Years of formal instruction	12	4-22
Years of residence in the US	3yrs 4m	6 m – 8yrs
Self-evaluation of English proficiency (1-10)		
Speaking	6	5-9
Listening	6.3	5-9
Reading	7.6	5-10
Writing	6.6	5-10

Materials

The listening materials used in Experiment 3 were exactly the same as those used in Experiment 1 except that all comprehension questions were removed.

Design

The design of Experiment 3 was exactly the same as used in Experiment 1.

Procedures

Participants were assigned to a test list based on the order in which they arrived in the laboratory. Overall, nine native speakers and nine nonnative speakers were assigned to each

counter-balanced list. The procedures for conducting Experiment 3 were exactly the same as those used in Experiment 1.

Results and Discussion

For each participant, invalid reaction times due to extraneous noises, false starts, failures to respond within the time window, and erroneous responses were checked using CheckVocal. 2.67% of the native speaker RTs and 3.11% nonnative speaker RTs were removed prior to the identification of outliers. Outliers were identified as RTs more than 2 standard deviations from the relevant cell mean of the relevant participant (NS= 4%; NNS= 4.23%) and RTs less than 200 ms (NS= 0%; NNS= 0%) or more than 2300 ms (NS= 0%; NNS= 0%). The total exclusion rate was thus 6.67% for native speakers and 7.34% for nonnative speakers.

Data were analyzed in the same way as described in Experiment 1. The details of the ANOVA are given in Table 10.

Table 10 Analysis of Variance for Experiment 3

	Subject RT (SD)	
	NS (N=27) F1 (2, 52) = 60.69 ($p < .001$, $\eta_p^2 = .70$)	NNS (N=27) F1 (2, 52) = 17.88 ($p < .001$, $\eta_p^2 = .407$)
Congruent	665.70 (93.80)	754.38 (92.35)
Neutral	724.80 (101.89)	817.84 (94.48)
Incongruent	745.28 (95.82)	800.11 (124.29)
	Item RT (SD)	
	F2 (2, 94) = 23.94 ($p < .001$, $\eta_p^2 = .337$)	F2 (2, 94) = 7.85 ($p = .001$, $\eta_p^2 = .143$)
Congruent	667.42 (55.14)	759.44 (97.58)
Neutral	728.81 (70.70)	827.92 (95.34)
Incongruent	756.41 (72.72)	804.59 (87.91)

It is clear from the ANOVAs that there was a significant effect for *context* in both groups. A set of pairwise comparisons comparing RTs among the three conditions was thus conducted

(Table 11). As can be seen from Table 11, the difference in RT between the congruent and neutral conditions was significant for both native speakers and nonnative speakers for both subject and item analyses. When comparing the neutral and the incongruent conditions, significance was found for native speakers in the subject analysis. No significance was found for nonnative speakers in either subject or item analysis.

Experiments 1 to 3 established a finding in adult L2 listening comprehension. L2 learners showed the facilitation-without-inhibition phenomenon. That is, their reaction to congruent sentences was faster than that to neutral sentences, but there was no difference in reaction time between neutral and incongruent sentences. This effect was not influenced by the amount of processing time given to the L2 learners or whether attention to meaning was explicitly required. In contrast, native speakers did not show this facilitation-without-inhibition effect no matter how testing materials were presented. However, since all of the three experiments were conducted using the shadowing paradigm, there was the possibility that the effect was an artifact caused by the paradigm. To exclude such a possibility, I conducted a set of experiments to see whether the facilitation-without-inhibition phenomenon could also be found when using other listening tasks.

Table 11 Pairwise Comparison (Bonferroni) for Experiment 3

		NS		NNS	
		Subject			
		Mean difference	significance	Mean difference	significance
Neutral	Congruent	59.10	.000 *	63.46	.000 *
Neutral	Incongruent	20.49	.026 *	-17.73	.31
		Item			
Neutral	Congruent	61.39	.000 *	68.48	.002 *
Neutral	Incongruent	27.60	.175	-23.33	.45

CHAPTER 3

FACILITATION-WITHOUT-INHIBITION IN OTHER LISTENING TASKS: EXPERIMENTS 4 AND 5

This chapter presents two experiments investigating the context effect in second language listening comprehension using tasks other than cued shadowing. The first experiment was conducted using the cross-modal priming paradigm. The second experiment used the word monitoring paradigm. Like those in Experiments 1 to 3, the materials of the two experiments in this chapter used three types of context: congruent, neutral and incongruent. The main purpose of conducting these two experiments was to examine whether the facilitation-without-inhibition phenomenon was unique to the shadowing paradigm.

The reason for choosing the cross-modal priming paradigm and the word monitoring paradigm is two-fold. First, the cross-modal priming paradigm and the word monitoring paradigm tap into different processes in lexical access. The naming task, as is used in the cued shadowing paradigm, is thought to assess the lexical access process at its early stage (Balota & Chumbley, 1984), and is more sensitive to automatic processes such as the facilitative effect than post-lexical processes such as the inhibitive effect. In contrast, the lexical decision task and the word identification task that are used in the cross-modal priming paradigm and the word monitoring paradigm respectively, tap processes that occur relatively late in the course of lexical processing, and thus are more able to assess post-access influences such as the inhibitive effect. We are thus more likely to observe any inhibitive effect from L2 learners when we use these two paradigms.

Second, the cross-modal priming paradigm and the word monitoring paradigm are similar to the cued shadowing paradigm in that all of them are online tasks. We can record and analyze

participants' reaction times while the participants are completing the task. This allows comparison across paradigms.

In Experiments 4 and 5, the facilitation-without-inhibition phenomenon was observed in the cross-modal priming and the word monitoring paradigms. The results suggest that this phenomenon is robust in second language listening comprehension.

Experiment 4: Cross-modal Priming

Experiment 4 was identical to Experiment 1 except that instead of repeating the auditory target, participants saw a visual target and decided whether the target was an English word or not. I chose the cross-modal priming paradigm instead of asking participants to listen to an auditory target because nonnative speakers tend to treat an auditory non-word as a word (Broersma & Cutler, 2008). The accuracy of the experimental data thus will be compromised. The format of Experiment 3 followed the cross-modal priming paradigm.

Method

Participants

Thirty native speakers of American English and twenty-seven Chinese learners of English from the same participant population as those in Experiment 1 participated in Experiment 4. These participants were not involved in Experiments 1 to 3, or any of the norming and material selection procedures. Their demographic information is summarized in Table 12.

Materials

Because the 48 sentential contexts and their 144 targets were originally used for a shadowing task, I was not sure if there was a difference between the congruent/incongruent targets and the neutral targets in terms of the time that participants needed to complete a lexical decision task. I thus asked ten native speakers (not involved in Experiment 4) to complete a

lexical decision task on the congruent and neutral targets without a sentential context. The incongruent targets were not included because they were congruent targets attached to a different lead-in sentence. A paired-sample t-test (t = -4.478, p = .001) revealed a significant difference between the congruent (M = 583.4, SD= 89.02) and neutral (M = 602.8, SD = 94.37) targets.

Table 12 Participant Information for Chinese Learners of English in Experiment 4

	Mean	Range
Age	27	22-37
TOEFL	601	560-632
Age at beginning of English instruction	12	9-14
Years of formal instruction	13	12-22
Years of residence in the US	3yrs 6m	6m-6yrs
Self-evaluation of English proficiency (1-10)		
Speaking	5.7	3-8
Listening	6.1	4-9
Reading	6.6	5-9
Writing	5.8	4-9

I thus deleted nine lead-in sentences that had significantly longer reaction time for neutral targets than congruent targets. A new paired-sample t-test showed no difference (t = -1.44, p =.175) between the congruent (M = 587.23, SD = 94.91) and the neutral targets (M = 593.32, SD = 94.73).

The experimental materials were the remaining 39 sentences from the shadowing task. Different from the cued-shadowing task, the targets were presented visually to the participants for a lexical decision task. A real English word (i.e., the target) always appeared at the sentence-final position of each critical lead-in sentence. Thus the participants always chose the “yes” answer for the critical materials.

Another 39 sentences were created to serve as fillers. A non-word always appeared at the sentence-final position of each filler sentence. The participants thus always needed to select "no" for the filler sentences.

Design

After their construction, the materials were divided into three counter-balanced lists. Each list contained the 39 targets preceded by 13 congruent, 13 neutral and 13 incongruent lead-in sentences, together with 39 filler sentences. Each participant thus would listen to 78 sentences. The congruent, neutral and incongruent lead-in sentences and their targets always appeared in different lists so that no critical lead-in sentence or target was repeated in the same list.

Procedure

Participants were assigned to a test list based on the order in which they arrived in the laboratory. Overall, ten native speakers and nine Chinese learners of English were assigned to each list. Participants were tested one at a time in a quiet booth. Stimuli were presented on a Dell E172FPb desktop computer, using DMDX presentation software. Participants wore headphones (Optimus Nova 79) that were connected to the computer. I was not present in the room during the experiment. This was to minimize extraneous influences on the participants.

At the beginning of each session, instructions were presented on the monitor visually to the participants in English. The experiment began when the participants pressed the space bar, an indication that they had read and understood the instructions. The auditory lead-in sentence was followed immediately (0ms from offset of the lead-in sentence) by a visual letter sequence. Participants were instructed to indicate whether the sequence was an English word by pressing the right shift key (*yes* answer) or the left shift key (*no* answer). The timer started when the target

word was presented and stopped after 2500ms or until the participant responded, whichever came first.

After the lexical decision task, a short statement appeared on the computer screen. The participant was asked to decide whether the statement was true or false according to the sentence that they just heard by pressing either *shift* button to indicate *true* (right shift) or *false* (left shift).

Prior to the experiment, participants were given a brief practice session with twelve practice stimuli (which were not used as experimental stimuli). I was with the participant during this practice session. After the practice session and when participants were ready, they could continue by pressing the space bar and I left the room at this point. The first two stimuli in the experiment session were also practice ones, unknown to the participants. The addition of these two stimuli was to diminish the nervousness that some participants had when the formal experiment started. The entire experimental session lasted approximately 20 minutes.

Results and Discussion

For each participant, invalid reaction times due to failures to respond within the time window and erroneous responses, 2.4% of the native speaker RTs and 4.88% of the L2 learner RTs, were removed prior to the identification of outliers. Outliers were RTs more than 2.5 standard deviations from the relevant cell mean of the relevant participant (NS= 2.46%; NNS= 1.3%) and RTs less than 200 ms (NS= NNS= 0%) or more than 1500 ms (NS= 1.41%; NNS= 2.4%). The total exclusion rate was thus 6.27% for native speakers and 8.58% for L2 learners. The mean percentage of errors in the comprehension test was 7.5% for the native speakers and 11.7% for the L2 learners. These comprehension questions were not subject to analysis.

I conducted an Analysis of Variance (ANOVA) for the reaction time results for the native speakers and the L2 learners. The effect of *context* was significant in both the analysis over

subjects and the analysis over items. Pairwise comparisons indicated significant differences between congruent and neutral conditions as well as between neutral and incongruent conditions for native speakers. A significant difference was found only between the congruent and neutral conditions for the L2 learners. Details of this analysis and pairwise comparisons are given in Table 13 and Table 14. These results clearly replicate the findings from Experiments 1 to 3. I again observed the facilitation-without-inhibition phenomenon in L2 learners. This phenomenon was thus not task-specific.

Table 13 Analysis of Variance for Experiment 4

	Subject RT Mean (SD)	
	NS (N=30) F1 (2, 58) = 25.07 ($p < .001$, $\eta_p^2 = .464$)	NNS (N=27) F1 (2, 52) = 7.64 ($p = .001$, $\eta_p^2 = .227$)
Congruent	656.33 (152.33)	734.21 (166.99)
Neutral	699.17 (167.34)	790.20 (162.28)
Incongruent	738.91 (173.57)	789.97 (179.57)
	Item RT Mean (SD)	
	F2 (2, 76) = 15.91 ($p < .001$, $\eta_p^2 = .295$)	F2 (2, 76) = 6.61 ($p = .002$, $\eta_p^2 = .148$)
Congruent	654.15 (60.65)	727.36 (83.92)
Neutral	697.25 (80.23)	802.46 (112.69)
Incongruent	743.81 (94.28)	783.29 (101.21)

Table 14 Pairwise Comparison (Bonferroni) for Experiment 4

		NS		NNS	
		Subject			
		Mean RT difference	significance	Mean RT difference	significance
Neutral	Congruent	42.84	.005*	55.99	.002*
Neutral	Incongruent	39.73	.002*	.23	1.000
		Item			
Neutral	Congruent	43.11	.015*	75.10	.007*
Neutral	Incongruent	46.55	.031*	19.17	1.000

Experiment 5: Word Monitoring Task

Experiment 5 uses a word monitoring task to test whether the facilitation-without-inhibition phenomenon could be found in tasks other than cued shadowing and cross-modal priming. This task has two steps. First, the participants see or listen to the target word. Second, a carrier sentence is played to the participants. The participants need to detect the target word (part of the word, or homophone, depending on the task) as quickly as possible. It has been found in previous studies that the time participants need to detect the target is influenced by the context that the target is embedded in. A congruent context facilitates its detection while an incongruent context deters it (Kilborn & Moss, 1996).

Method

Participants

Twenty-seven native speakers of American English and 27 Chinese learners of English from the same participant population as those in Experiment 1 participated in Experiment 5. These participants were not involved in any of the previous experiments, or any of the norming or material selection procedures. Their demographic information is summarized in Table 15.

Table 15 Participant Information for Chinese Learners of English in Experiment 5

	Mean	Range
Age	33	24-42
TOEFL	610.03	580-630
Age at beginning of English instruction	12	11-13
Years of formal instruction	15	12-25
Years of residence in the US	4yrs 4 m	6months-8yrs
Self-evaluation of English proficiency (1-10)		
Speaking	6.1	6-9
Listening	6.3	5-10
Reading	6.9	7-10
Writing	6.2	7-9

Materials

The target words used in this word monitoring task are kept constant across the three conditions and appear in the same position. If we were to use different words appearing at different positions in the three conditions, we might encounter one potential problem. Participants may be slower at processing the target word that appears at a later position in a sentence because they have forgotten the target word at that stage. I thus kept the target words constant for the three conditions: congruent, neutral, and incongruent, and controlled the number of words in each sentence so the target words appear in the same position for a given matching set of congruent, neutral and incongruent sentences. I also tried to control the structure of the sentences so that the lead-in sentences did not vary greatly.

My materials were based on the 48 congruent sentences used in the shadowing task. After the neutral and incongruent sentences were created, two native speakers of American English were invited to read the sentences. Twenty-one sentences were excluded because their neutral lead-in sentences were semantically strange. 15 native speakers of American English were invited to judge the acceptability of the rest of the sentences in three conditions. The mean acceptability was 6.27 for the congruent context, 5.14 for the neutral context, and 2.46 for the incongruent context (see Appendix F for the ratings of each sentence).

A second section was then added to each sentence just after the target word to avoid placing the target word at the very end (as in the shadowing task). The participants thus would not find a pattern of the words that they needed to recognize in terms of their positions. Below are examples of completed sentences for the target word "electricity" in three sentential contexts:

More power stations have been built in this part of China to meet the increasing demand for <u>electricity</u> in the past 20 years.

More big stations have been built in this part of China to meet the increasing demand for electricity in the past 20 years.

More grocery stores have been built in this part of China to meet the increasing demand for electricity in the past 20 years.

After construction of the sentences, the materials were divided into three counter-balanced lists. Each list contained the 27 targets embedded in 9 congruent, 9 neutral and 9 incongruent lead-in sentences, as well as 27 filler sentences. Each participant thus would listen to 54 sentences. The targets were always present in the critical lead-in sentence but were absent in the filler sentences. Thus, the critical items required a "yes" answer while the filler items a "no" answer. The congruent, neutral and incongruent sentences of a target always appeared in different lists so that no target was repeated in the same list. There was also a comprehension statement after each sentence that required a "yes" or "no" answer.

Recording

Sentences used for the present study were recorded by a male native speaker of American English in a quiet room at a normal articulation rate of 300 syllables per minute after removing silent intervals (Robb, Maclagan, & Chen, 2004). The speakers wore a Special Project headset microphone connected to a Telex WT-150 transmitter. The voice signals were received by a Telex FMR-150 receiver and recorded in a Sony Digital Audio Tape-corder (TCD-D100). The recorded signals were then transferred to a Dell computer using Kay CSL (Model 4500) sound processing hardware. The speaker read all the sentences in a neutral tone of voice, with falling intonation at the end.

Praat phonetic-analysis software (Boersma & Weenink, 2005) was used to manipulate the original recorded materials. Each sentence was spliced into two parts in order for a timer to be

placed before the target word. The first part started from the beginning of the sentence and ended just before the target word. The second part was from the onset of the target word to the end of the sentence. There was no interval between the offset of the first part and the onset of the second part. Each part was an individual wave file. Once the process was completed, they were put together with DMDX item file for experimental presentation.

Procedure

Participants were tested one at a time in a quiet room. Stimuli were presented on a Dell E172FPb desktop computer, using DMDX presentation software. At the beginning of each session, instructions were presented on the computer monitor visually to the participants in English. The experiment began when the participants pressed the space bar, an indication that they had read and understood the instructions.

The sentences were randomly presented in a continuous sequence. The visual target was presented to participants first for 1000ms. This visual target was followed by the lead-in sentence which was followed immediately (0ms from offset of the lead-in sentence) by the auditory target word that started the second half of the sentence. Participants were instructed to press the "yes" button (*Right* shift key) as quickly as possible when hearing the target word or the "no" button (*Left* shift key) if the target word did not appear. The timer started just as the beginning of the target word and stopped after 8000ms or until the participant responded, whichever came first (also see the example below). While the auditory materials were presented, nothing visually appeared on the screen.

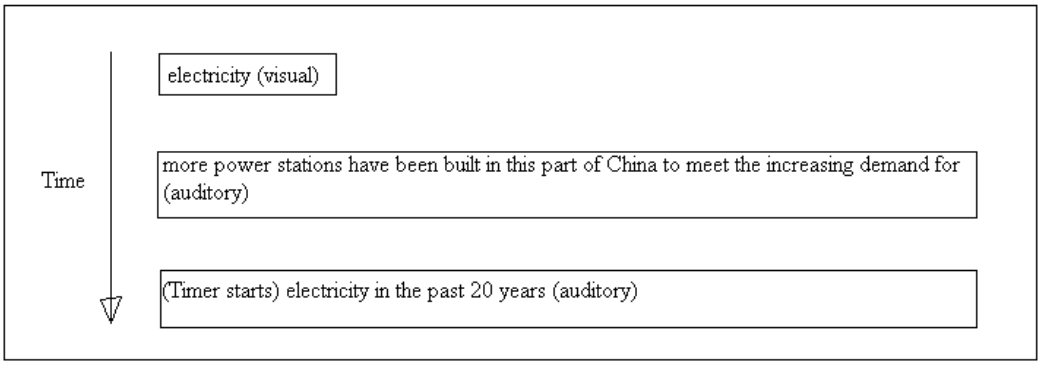

Figure 4 Stimuli Presentation in the Spoken Word Recognition Task

Participants then pressed the spacebar for a yes-or-no comprehension question. They pressed the right shift key for a "yes" answer and the left shift key for a "no" answer.

Prior to the experiment, participants were given a brief practice session with eight stimuli that were not used in the main experiment. I was with the participant during this practice session. After the practice session and when participants were ready, they could continue by pressing the space bar and I left the room at this point. The first two stimuli in the experiment session were also practice ones, unknown to the participants. The addition of these two stimuli is to diminish the nervousness that some participants have when the formal experiment starts. The entire experimental session lasted approximately 15 minutes.

Results and Discussion

For each participant, invalid reaction times due to failures to respond within the time window and erroneous responses, 1.81% of the native speaker RTs and 3.78% of the nonnative speaker RTs, were removed prior to the identification of outliers. Outliers were RTs more than 2.5 standard deviations from the relevant cell mean of the relevant participant (NS= 2.47%; NNS= 3.51%) and RTs less than 200 ms or more than 4000 ms (NS= 0%; NNS= 2.24%). The total exclusion rate was thus 4.28% for native speakers and 9.53% for nonnative speakers. The

mean percentage of errors in the comprehension test was 8.5% for the native speakers and 12.5% for the L2 learners. These comprehension questions were not subject to analysis.

The same repeated measure analysis of variance (ANOVA) was conducted for Experiment 5 as was used in Experiments 1 to 4. Analyses were conducted by participants (F1) and by items (F2); context was a repeated measure variable in both analyses. Effect size, Partial Eta squared (η_p^2) is also reported. The details of this ANOVA are given in Table 16.

Table 16 Analysis of Variance for Experiment 5

	Subject RT (SD)	
	NS (N=27) F1 (2, 52) = 15.73 ($p < .001$, $\eta_p^2 = .377$)	NNS (N=27) F1 (2, 52) = 4.88 ($p = .011$, $\eta_p^2 = .158$)
Congruent	995.36 (424.20)	764.81 (466.29)
Neutral	1083.25 (460.11)	841.52 (519.78)
Incongruent	1170.83 (450.05)	857.89 (534.54)
	Item RT (SD)	
	F2 (2, 52) = 8.59 ($p = .001$, $\eta_p^2 = .248$)	F2 (2, 52) = 2.26 ($p = .115$, $\eta_p^2 = .080$)
Congruent	1012.20 (182.25)	760.78 (168.24)
Neutral	1081.45 (186.18)	833.65 (171.99)
Incongruent	1183.55 (139.98)	857.50 (206.43)

Table 16 shows that the native speakers took longer to complete this task than the nonnative speakers do. This difference is not important to Experiment 5 because individuals differ greatly in terms of their reaction time (Der & Deary, 2006; Jevas & Yan, 2001). Researchers using reaction time data thus usually do not compare reaction time across groups of participants, but within the participants. The native speakers' long reaction time in Experiment 5 simply indicates that I happened to recruit a group of participants who were relatively slow in completing the word monitoring task.

It is clear from the ANOVAs that there was a significant effect for *context* in both groups. A set of pairwise comparisons revealed that the difference between the congruent and neutral conditions was significant for both native speakers and nonnative speakers in subject analysis, but not in item analysis (see Table 17). An item analysis is used in psycholinguistics to see whether an effect obtained from an experiment can be generated beyond the test items (Bedny, Aguirre, & Thompson-Schill, 2007; Jiang & Nekrasova, 2007). A significant subject analysis and an insignificant item analysis suggest that the pattern observed from an experiment may be unique to the particular test items used in the particular experiment.

Because the subject analysis was significant, we can still say that a facilitative effect was found for both native and nonnative speakers in Experiment 5, at lease for the items used in this experiment. When comparing the neutral and the incongruent conditions, significance was found for native speakers in subject analysis and item analysis. No significance was found for nonnative speakers in either the subject or item analysis. This indicates that an inhibitive effect was found only in native speakers. The word monitoring task thus replicated the facilitation-without-inhibition effect found in Experiments 1 to 4.

Table 17 Pairwise Comparison (Bonferroni) for Experiment 5

		NS		NNS	
		Subject			
		Mean RT difference	significance	Mean RT difference	significance
Neutral	Congruent	29.51	.019 *	76.72	.057*
Neutral	Incongruent	25.59	.006 *	16.37	1.000
		Item			
Neutral	Congruent	69.25	.537	72.87	.264
Neutral	Incongruent	102.10	.039 *	23.85	1.000

Discussion of Experiments 1 to 5

In five experiments, I observed both a facilitative effect and an inhibitive effect for the native speakers, but only a facilitative effect for the L2 learners. The facilitation-without-inhibition phenomenon was not a task-specific finding. These experiments revealed a quite robust phenomenon in L2 auditory comprehension.

How could these results be explained within a framework of language comprehension? As I discussed in the introduction, less skilled comprehenders may be less efficient at suppressing irrelevant information compared to their more skilled counterparts. In my experiments, the lead-in sentences in all three conditions have highly predictable candidates. In the neutral and incongruent contexts, listeners have to suppress this candidate while activating the real target. If suppression is successful, we would observe a faster reaction time to the neutral target than to the incongruent target because the activation of a semantically appropriate neutral target is easier than that of an incongruent target. If suppression is unsuccessful, there would be a competition between the highly predictable candidate and the real target. Since this competition exists in both the neutral context and the incongruent context, we expect no difference between these two contexts in participants' reaction time to the targets. Although the neutral target receives some activation from the lead-in sentence compared to the incongruent target, the activation is so weak that the competition overrides the small advantage gained from activation. As to the congruent context, I predicted that participants' reaction time to the congruent target would always be the fastest because no obvious suppression was involved in this context.

The experimental results from L2 learners in Experiments 1 to 5 were consistent with what I have predicted using an insufficient suppression explanation. These same experimental results could also be accounted for by an insufficient activation explanation, however. In other

words, the L2 participants may not be able to activate relevant meaning candidates. It is quite possible that the lead-in sentences activate the neutral targets to some degree for native speakers, but not those for L2 learners. In both the neutral and incongruent conditions, therefore, L2 learners would need to suppress the highly predictable candidate and activate a new candidate. As a result, no difference would be found in their processing of sentences in these two conditions.

Is the facilitation-without-inhibition phenomenon caused by insufficient activation or insufficient suppression? One way to answer this question is to develop testing materials that are less constraining than those used in Experiment 1 to 5; i.e., the lead-in sentences should not contain highly predictable targets.

When using this type of materials, we should observe an inhibitive effect from L2 learners if the insufficient suppression explanation is correct. Without a highly predictable competitor, the L2 learners only need to activate the real targets. Since the neutral target is a possible but less predictable last word, L2 learners' response to the neutral target should be faster than that to the incongruent target, which is an impossible completion to the lead-in sentence.

In contrast, if the insufficient activation explanation is correct, we will not observe any inhibitive effect from L2 learners. If the context cannot help L2 learners activate the neutral target, the neutral target is like an incongruent target to the L2 learners. Their reaction time to these two types of targets will not differ, whether the context provides a highly predictable competitor or not. These predictions are tested in Experiment 6.

CHAPTER 4

SENTENCE CONTEXT IN A LESS CONSTRAINED CONTEXT: EXPERIMENT 6

The experiment reported in this chapter tested whether suppression or activation can better explain the facilitation-without-inhibition phenomenon observed from Experiments 1 to 5. The materials were designed in a way that tried to minimize the function of the suppression mechanism in the comprehension process. This was achieved by using sentential contexts that do not have a highly predictable target (e.g., *The little girl decided that her father must have really enjoyed the*). The resulting design of this experiment had two contexts: neutral and incongruent. The neutral target was a context-appropriate word (e.g., *party* for the above example). The incongruent target was a word matched in frequency and length to the neutral target, but it was inappropriate for the context (e.g., *level*).

Since the context is not constrained, no strong suppression is required. The suppression explanation would thus predict a difference between the neutral context and the incongruent context in L2 learners' performance. Accessing the neutral target should be faster than accessing the incongruent target if no competition between a strong target and the real target is involved. In contrast, if L2 learners' activation of meaning is not efficient, I would expect no difference between the neutral and the incongruent context.

Experiment 6: Cross-modal Priming in a Less Constrained Context

Method

Participants

Twenty-six native speakers of American English and thirty-six Chinese learners of English who were not involved in any of the norming procedures described below participated in

Experiment 6. These participants were from the same participant population as those in Experiments 1 to 5. Their demographic information is summarized in Table 18.

Table 18 Participant Information for Chinese Learners of English in Experiment 6

	Mean	Range
Age	25	23-35
TOEFL	610.45	575-640
Age at beginning of English instruction	12	9-14
Years of formal instruction	12	11-24
Years of residence in the US	4yrs 5 m	1yr-9yrs
Self-evaluation of English proficiency (1-10)		
Speaking	6.4	5-9
Listening	6.9	5-9
Reading	7.4	7-10
Writing	6.7	6-9

Materials and Design

Experiment 6 employed the same cross-modal priming task used in experiment 4. Forty-one sentential contexts without the final words were first constructed. Thirteen Chinese learners of English and fourteen native speakers of American English were asked to provide the last word of each sentence. The 28 sentences that had a cloze predictability of lower than 30% for both groups were chosen as the test materials (see Appendix G & H).

The target words for the neutral condition were those chosen by both native speakers and nonnative speakers. The target words for the incongruent condition were chosen from the Brown corpus (Kucera & Francis, 1967). The incongruent targets were inappropriate to in the lead-in sentences, but matched the neutral targets in terms of frequency, number of letters per word, and parts of speech. Since the participants were asked to complete a lexical decision task on the target, I need to ensure that there was no difference between participants' reaction time in making a lexical decision on the two groups of targets. A single-word lexical decision task was

conducted with nine native speakers of American English. The neutral and incongruent targets and 28 non-words were presented to this group of participants randomly using DMDX. Participants needed to decide whether the letter sequence they saw was an English word or not. No difference was found between the neutral targets, *Mean* (*M*) = 653.84, *Standard Deviation* (*SD*) = 77.73, and the incongruent targets (*M* = 661.31, *SD* = 75.37) in a paired-sample t-test (t = -1.13, p = .292).

The 28 lead-in sentences and the two sets of targets were used to construct two test lists. Each list contained the 28 lead-in sentences followed by 14 neutral and 14 incongruent targets (see Appendix I). The neutral and incongruent targets of a sentence always appeared in different lists so that no sentence was repeated in the same list. A real English word (i.e., the target) always appeared at the sentence-final position of each critical lead-in sentence. Thus the participants always chose the "yes" answer for the critical materials. A non-word always appeared at the sentence-final position of each filler sentence. The participants thus always needed to select "no" for the filler sentences. The participants thus needed to listen to 56 sentences altogether. All of the sentences were followed by a comprehension question.

Recording

28 neutral sentences and 28 filler sentences were recorded by a male native speaker of American English in a quiet room at the normal articulation rate of about 300 syllables per minute after removing silent intervals. The speakers used the same recording equipment as for previous recordings. Praat phonetic analysis software (Boersma & Weenink, 2005) was used to edit the original recorded materials. The critical lead-in sentences were segmented from the neutral sentences and were the same for both the neutral and the incongruent conditions. The targets were not recorded because they were presented visually to the participants. There was no

interval between the offset of the lead-in sentence and the presentation of the target. Each lead-in sentence was an individual wave file. Once the process was completed, the files were put together with DMDX item file for experimental presentation.

Procedure

Participants were assigned to a test list based on the order in which they arrived in the laboratory. Overall, 13 native speakers and 18 Chinese learners of English were assigned to each list. Participants were tested one at a time in a quiet booth. Stimuli were presented on a Dell E172FPb desktop computer, using DMDX presentation software. Participants wore headphones (Optimus Nova 79) that were connected to the computer. I was not present in the room during the experiment. This was to minimize extraneous influences on the participants.

At the beginning of each session, instructions were presented on the monitor visually to the participants in English. The experiment began when the participants pressed the space bar, an indication that they had read and understood the instructions. The auditory lead-in sentence was followed immediately (0ms from offset of the lead-in sentence) by a visual letter sequence. Participants were instructed to decide whether the sequence was an English word by pressing the right shift key (*yes* answer) or the left shift key (*no* answer). The timer started when the target word was presented and stopped after 2500ms or when the participant responded, whichever came first.

After the lexical decision task, a short statement appeared on the computer screen. The participant was asked to decide whether the statement was true or false according to the sentence that they just heard by pressing either *shift* button to indicate *true* (right shift) or *false* (left shift).

Prior to the experiment, participants were given a brief practice session with twelve practice stimuli (which were not used as experiment stimuli). I was with the participant during

this practice session. After the practice session and when participants were ready, they could continue by pressing the space bar and I left the room at this point. The first two stimuli in the experiment session were also practice ones, unknown to the participants. The addition of these two stimuli was to diminish the nervousness that some participants had when the formal experiment started. The entire experimental session lasted approximately 20 minutes.

Results

For each participant, invalid reaction times due to failures to respond within the time window and erroneous responses, 3.5% of the native speaker RTs and 4.6% of the L2 learner RTs, were removed prior to the identification of outliers. Outliers were identified as RTs more than 2 standard deviations from the relevant cell mean of the relevant participant (NS= 4.79%; NNS= 3.8%) and RTs less than 200 ms (NS= 0.01%, NNS= 0%) or more than 2300 ms (NS=NNS= 0%). The total exclusion rate was thus 8.3% for native speakers and 8.4% for nonnative speakers. The mean percentage of errors in the comprehension test was 6.1% for the native speakers and 6.3% for the nonnative speakers.

The same ANOVA procedure used in Experiments 1 to 5 was used to analyze the NS and NNS data. Analyses were conducted by participants (F1) and by items (F2); *context* was a repeated measure variable in both analyses. Effect size, Partial Eta squared (η_p^2) is also reported (see Table 19). It was clear from the results that both native speakers and L2 learners showed a significant difference in processing the neutral and incongruent contexts.

Although all the lead-in sentences used in Experiment 6 were less constraining than those used in Experiments 1-5, some sentences were still more constraining than others. That is, some sentences might have a more predicable last word than other sentences. If failing to suppress a strong candidate is indeed the reason for not observing differences between the neutral and

incongruent conditions, I should observe an inhibitive effect for incongruent targets in low probable contexts but not for these targets in higher probable ones when we regroup the sentences according to their probabilities. A reanalysis was then conducted to test this possibility.

Table 19 Analysis of Variance for Experiment 6

	Subject RT Mean (SD)	
	NS (N=26) *F1* (1, 25) = 27.46 ($p < .001$, $\eta_p^2 = .523$)	NNS (N=36) *F1* (1, 35) = 7.31 ($p = .011$, $\eta_p^2 = .173$)
Neutral	746.47 (190.83)	872.37 (189.08)
Incongruent	806.73 (222.03)	913.73 (195.17)
	Item RT Mean (SD)	
	F2 (1, 27) = 13.45 ($p = .001$, $\eta_p^2 = .332$)	*F2* (1, 27) = 4.61 ($p = .041$, $\eta_p^2 = .146$)
Neutral	747.00 (63.14)	874.63 (98.54)
Incongruent	833.40 (140.20)	941.19 (140.39)

Re-analysis

The cloze probability of our experiment materials ranged from 7% to 21% for native speakers and 8% to 24% for nonnative speakers. In this re-analysis, I arranged the materials from lowest probability to highest probability for both native and nonnative speakers according to results from the norming procedure. I then found the median and divided the critical materials into two groups, low-probability and high-probability, according to this median. Each group contained 14 sentences. The same analysis of variance (ANOVA) procedure was used to analyze the re-arranged data.

In the group of low probability sentences, the effect of *context* was still significant for both the native speakers and the L2 learners (see Table 20). Both groups of participants performed significantly faster in the neutral context than in the incongruent context.

Table 20 Analysis of Variance for Low Probability Sentences

	Subject RT Mean (SD)	
	NS (N=26) *F1* (1, 25) = 7.69 (p = .010, η_p^2 = .235)	NNS (N=36) *F1* (1, 35) = 9.03 (p = .005, η_p^2 = .205)
Neutral	731.71 (192.82)	872.66 (164.16)
Incongruent	779.40 (224.93)	952.97 (263.23)
	Item RT Mean (SD)	
	F2 (1, 13) = 4.47 (p = .054, η_p^2 = .256)	*F2* (1, 13) = 5.03 (p = .043, η_p^2 = .279)
Neutral	732.14 (54.35)	876.72 (95.57)
Incongruent	806.84 (100.76)	991.09 (153.08)

The picture was quite different for the sentences of high probability (see Table 21). An effect of context was found for native speakers but not L2 learners. The analysis showed a difference between the neutral and the incongruent condition for native speakers. No such difference was found for L2 learners.

Table 21 Analysis of Variance for High Probability Sentences

	Subject RT Mean (SD)	
	NS (N=26) F1 (1, 25) = 6.48 (p = .017, η_p^2 = .206)	NNS (N=36) F1 (1, 35) = .006 (p = .937, η_p^2 = .000)
Neutral	763.13 (200.31)	875.16 (233.21)
Incongruent	824.98 (236.62)	877.27 (165.97)
	Item RT Mean (SD)	
	F1 (1, 13) = 5.63 (p = .034, η_p^2 = .302)	F2 (1, 13) = .417 (p = .53, η_p^2 = .031)
Neutral	761.86 (69.65)	872.53 (104.99)
Incongruent	859.97 (170.75)	891.29 (110.18)

Results from the re-analysis were exactly what I would expect from a suppression explanation: for the NNSs, a difference between neutral and incongruent contexts was found only in the low-probability sentences. In the low-probability sentences, the function of the

suppression mechanism is artificially reduced through employing sentences that do not have a predictable target. There are no predictable competitors to compete with the real targets. We thus can observe an inhibitive effect for the L2 learners responding to incongruent contexts. This re-analysis strengthens my hypothesis that insufficient suppression is the cause of the facilitation-without-inhibition phenomenon.

Discussion of Experiments 1 to 6

The most important finding in the experiments is the facilitation-without-inhibition phenomenon observed for L2 learners. When processing auditory input in three sentential contexts, L2 learners showed a facilitative effect (shorter reaction time in responding to a congruent word than to a neutral word), but not an inhibitive effect (no difference in reaction to a neutral word and an incongruent one). In contrast, the native speakers showed both a facilitative effect (reaction to congruent words was faster than reaction to neutral words) and an inhibitive effect (reaction to incongruent words was slower than reaction to neutral words) in processing the same types of contexts.

This finding was consistent with the findings of a recent study comparing younger and older adults' processing of three types of contexts. Federmeier, McLennan, De Ochoa, & Kutas (2002) recorded event-related potentials as the participants listened to sentences ending with an expected word, an unexpected word from the same semantic category, or an unexpected word from a different category. Half of the contexts were highly constraining (e.g., *At the zoo, my sister asked if they painted the black and white stripes on the animal. I explained to her that they were natural features of a zebra/donkey/poodle,*) while the other half were weakly constraining (e.g., *By the end of the day, the hiker's feet were extremely cold and wet. It was the last time he*

would ever buy a cheap pair of <u>*boots/sandals/jeans*</u>). The ERP activity that they were most interested in was the N400.

The results from their highly constraining sentences were the most similar to mine because my sentential contexts in Experiments 1 to 5 were highly constrained. What they found from the highly constraining sentences was that the expected ending words elicited a smaller N400 than unexpected ones for both groups. Young adults' N400 was largest when the ending words were the cross-category unexpected ones. In contrast, older adults showed smaller N400 from the cross-category unexpected word. In fact, N400 was similar for both the within- and cross-category unexpected word for the older adults. If we consider their within-category unexpected word as the baseline, their young adults, similar to our native speakers, showed both a facilitative effect and inhibitive effect. Their older adults were like my L2 learners who only showed a facilitative effect. This comparison thus suggests that the same mechanisms are involved in the process of semantic integration in L2 learners as well as older adults.

This conclusion is in line with the results of numerous previous studies. Recall the studies of homonyms in my literature review. Results from L2 learners are similar to those from less skilled comprehenders, older adults, and brain-damaged patients. All these participants revealed an initial access to the multiple meanings of a homonym, but they failed to or were slower to suppress the context-inappropriate meaning compared to their controls. Using words of single meaning, my study helps to show that similarities between L2 learners and some special L1 populations do not only exist in the processing of homonyms. Moreover, my study shows that these similarities do not only exist in the visual domain.

If the same mechanisms are involved in the processing of meaning in L2 learners and some special L1 populations, what are these mechanisms? I proposed, based on Gernsbacher's

Structure Building Framework and previous research, that L2 learners may have a less efficient suppression mechanism than native speakers. In a strong context, as in Experiments 1 to 5, L2 learners are less able to suppress the strong potential candidate provided by the context. This strong candidate thus competes with the real target in the neutral and incongruent contexts. We thus could not observe an inhibitive effect when comparing the neutral condition and incongruent condition.

Results from Experiments 1 to 5 are consistent with my predictions. However, an activation account can also explain the results from these five experiments. To clarify whether the facilitation-without-inhibition phenomenon was mainly a result of suppression or activation, testing materials with less constraining contexts were used in Experiment 6. In Experiment 6, the inhibitive effect was observed when a competitive target was removed by using a less constraining context, and disappeared when the competitive target came back in a more constraining context. It thus clearly demonstrated that suppression was the more probable explanation for the facilitation-without-inhibition phenomenon. This finding is again comparable to that of Federmeier, McLennan, De Ochoa, & Kutas (2002). Their older adults showed a larger difference in N400 amplitude between within-category violation (i.e., the neutral baseline) and cross-category violation (i.e., the incongruent condition) in the low constraint sentences. In other words, their older adults showed an inhibitive effect in less constraining contexts.

In summary, this series of six experiments has demonstrated that the facilitation-without-inhibition effect is a result of insufficient suppression of unwanted information. It is worth noting, however, that previous research with L1 comprehenders has found that the problem of insufficient suppression does not exist merely in linguistic tasks. It can also be found from nonlinguistic tasks such as object recognition in Gernsbacher & Faust (1991). These findings

suggest that insufficient suppression is a problem in the general cognitive mechanism that causes less skilled comprehenders' language difficulty. Studies from slower readers, older adults, and aphasic patients provide further support for the connection between some neuropsychological deficits and insufficient suppression.

Does such a connection also exist in L2 listening comprehension? Is it possible that my L2 learners have some neuropsychological deficits? In order to answer these questions, L2 learners' ability to activate and suppress non-linguistic information was tested in Experiments 7 and 8.

CHAPTER 5

SUPPRESSION AND ACTIVATION IN A NON-LINGUISTIC TASK: EXPERIMENTS 7 AND 8

In this chapter, I examined nonnative speakers' ability to activate or suppress information in a non-linguistic environment by using an object recognition task (Biederman, Blickle, Teitelbaum, & Klatsky, 1988; Gernsbacher & Faust, 1991). In this task, participants first view scenery created by the presence of a set of pictures. For example, the following pictures create the scenery of "kitchen". After viewing the scenery, participants see an object name and decide whether the object has appeared in the scenery.

Figure 5 Object Arrangement in Experiments 7 and 8

If the object does not appear in the scenery, participants tend to make more errors and their reaction time is slower when the object is related to the scenery. For example, participants' reaction time is slower if the object name is "spoon", a typical object in a kitchen than when the object appears in atypical scenery, e.g., hospital. An explanation offered is that the typical scenery activates the concept of "spoon" and participants need time to suppress it to get the correct answer "no". I thus chose this method to investigate the issue of suppression.

On the other hand, if the object appears in the scenery, participants tend to make fewer errors and their reaction time is faster when the object is related to the scenery. For example, their response to "spoon" is faster in the kitchen scenery than in the hospital scenery. This is because the previous scenery has already activated the concept of kitchen and its typical objects, such as "spoon". Participants do not need to re-activate the concept of "spoon". This task thus investigates the issue of activation.

Experiment 7: Object Absent

Experiment 7 was designed to investigate the ability to suppress unwanted nonlinguistic information in nonnative speakers. The critical object that the participants need to respond to does not appear as one of the objected in the scenery that they see.

Method

Participants

Twenty native speakers of American English and sixteen Chinese learners of English from the same participant population as those in Experiments 1 to 6 participated in Experiment 7 (see Table 22 for details).

Table 22 Participant Information for Chinese Learners of English in Experiment 7

	Mean	Range
Age	26	21-36
TOEFL	607.10	550-665
Age at beginning of English instruction	12	9-14
Years of formal instruction	13	12-22
Years of residence in the US	3yrs 4 m	8months-7yrs
Self-evaluation of English proficiency (1-10)		
Speaking	6.0	6-9
Listening	6.2	7-10
Reading	7.1	8-10
Writing	6.2	6-9

Materials and Design

I constructed the materials by first selecting ten sceneries from Gernsbacher & Faust (1991). I then constructed two additional sceneries and twelve category sets. A scenery set includes objects that appear in a place, and a category set includes objects that belong to the same category, e.g., vegetable (see Figure 6). I used category sets because many of the scenery sets are culture-specific (e.g., baseball, camp ground, or nursery). It is very difficult to find enough number of scenery sets for the experiment (See Appendix J for details of each critical set).

Figure 6 Example of a Category Set

Each of the 24 critical experimental sets served as both a typical set and an atypical set. When serving as typical set, its test object was typical of the objects in the set. For example, when the set comprising a pot, a coffee maker, a stove, a microwave, and a kettle, served as typical set, its test object was “spoon”. When the same set served as atypical set, its test object was “stamp”. These test objects did not appear in the sets, and the participants need to respond *no*.

I also constructed 24 fillers that contained twelve scenery sets and twelve category sets. Half of the filler sets serve as typical sets and half have one atypical object. These filler sets

differed from the experimental sets in that the test objects were present in their respective set; participants thus should respond *yes*.

All the pictures of objects were arranged in a clock face fashion. Each picture was the same size regardless of the object's real size.

Procedure

Each trial began with a warning signal, which was a plus sign that appeared for one second (or 1000 ms) in the center of the screen. Then the set was displayed for two seconds (or 2000 ms). The use of 2000 ms was determined by a set of small pilot studies. In these pilot studies, I used display time of 250 ms, 350 ms, 500 ms, 1000 ms, 1500 ms, and 2000 ms. 2000 ms was chosen because it allowed participants to view every picture in each set comfortably and reduced the error rate to an acceptable level (i.e., less than 20%). Previous studies have used display time of 100 ms (Biederman, et al., 1988) and 250 ms (Gernsbacher & Faust, 1991). My participants' error rate was extremely high (around 50%) when the 250 ms display time was used.

After the set disappeared, the name of the test object appeared 1,000 ms later. The name of the test object remained on the screen until the participant responded. Participants responded by pressing either the Left shift key (to answer *no)* or the Right Shift key (to answer *yes).* After each trial, the participants received feedback: They were told whether they were correct, and if correct, they were shown their reaction times. Subjects completed 10 practice trials before performing the actual experiment.

Results and Discussion

Participants' error rates in this task were relatively high (NS = 14.6%, NNS = 17.4%) compared to other reaction time tasks. This error rate, however, is normally found in the object recognition task (e.g., Biederman, et al., 1988), and acceptable for reaction time analysis. For

each participant, outliers were identified as RTs more than 2 standard deviations from the relevant cell mean of the relevant participant (NS= 4%; NNS= 3.9%) and RTs less than 200 ms (NS= 0.01%, NNS= 0%) or more than 4000 ms (NS=NNS= 0%).

Because the main purpose of the study was to find out whether there was a difference between NS and NNS in using different types of contexts, NSs' and NNSs' data were analyzed separately. To assess the effect of context, I calculated an ANOVA (see Table 23). Analyses were conducted by participants (F1) and by items (F2); *scenery* was a repeated measure variable in both analyses. Effect size, Partial Eta squared (η_p^2) is also reported.

Table 23 Analysis of Variance for Experiment 7

	Subject RT (SD)	
	NS (N=18) F1 (1, 17) = 66.01 ($p < .001$, $\eta_p^2 = .80$)	NNS (N=16) F1 (1, 15) = 16.57 ($p =. 001$, $\eta_p^2 = .525$)
Typical	1380.07 (363.99)	1242.21 (284.33)
Atypical	1135.48 (269.90)	1075.19 (270.58)
	Item RT (SD)	
	F2 (1, 23) = 33.16 ($p < .001$, $\eta_p^2 = .59$)	F2 (1, 23) = 10.39 ($p = .004$, $\eta_p^2 = .311$)
Typical	1422.24 (197.62)	1240.71 (230.07)
Atypical	1139.15 (113.91)	1058.37 (128.38)

It is clear from Table 23 that native speakers and nonnative speakers did not differ in performing this task. Similar to their native-speaking counterparts, the time that the nonnative speakers used for identifying an absent typical object was significantly longer than that for an absent atypical object. This suggests that L2 learners performed as efficiently as native speakers at suppressing unwanted information (i.e., the scenery created by an array of five typical objects) in a non-linguistic task.

Experiment 8: Object Present

Experiment 8 was designed to investigate the ability to activate relevant nonlinguistic information in nonnative speakers. The critical object that the participants need to respond to appears as one of the objected in the scenery that they see.

Method

Participants

Twenty native speakers of American English and sixteen Chinese learners of English from the same participant population as those in Experiments 1 to 7 participated in Experiment 8 (see Table 24 for details).

Table 24 Participant Information for Chinese Learners of English in Experiment 8

	Mean	Range
Age	26	23-40
TOEFL	615.34	570-640
Age at beginning of English instruction	12	10-15
Years of formal instruction	15	10-24
Years of residence in the US	4yrs 1 m	1yr-6yrs
Self-evaluation of English proficiency (1-10)		
Speaking	6.5	5-9
Listening	6.9	5-9
Reading	7.3	8-10
Writing	6.3	4-8

Materials and Design

The 24 critical experiment sets used in Experiment 7 were used in Experiment 8 except that the test object appeared as one of the objects in the scenery. Each of the 24 experimental sets served as both a typical set and an atypical set. When serving as a typical set, its test object was typical of the objects in the set. For example, when the set comprising a pot, a coffee maker, a stove, a microwave, and a spoon (or stamp in an atypical scenery), served as the typical set, its

test object was “spoon”. When the same set served as an atypical set, its test object was “stamp”. Since these test objects appeared in the set, the participants need to respond *yes*.

I also constructed 24 filler sets. These fillers contain twelve scenery sets and twelve category sets. Half of the filler sets have typical objects and half have one atypical object. These filler sets differed from the experimental sets in that the test objects were absent in their respective set; participants thus should respond *no.*

All the pictures of objects were arranged in a clock face fashion. Each object was pictured as the same size regardless of its real size.

Procedure

The procedure for administering Experiment 8 was exactly the same as that for Experiment 7.

Results and Discussion

Participants’ error rate for Experiment 8 was still relatively high (NS = 7.8%; NNS = 10.3%). For each participant, outliers were identified as RTs more than 2 standard deviations from the relevant cell mean of the relevant participant (NS= 6.1%; NNS= 3.9%) and RTs less than 200 ms (NS= 0%, NNS= 0%) or more than 4000 ms (NS=NNS= 0%). ANOVA was conducted with data from Experiment 8 and are presented in Table 25.

Both native speakers and L2 learners showed a similar pattern when responding to a present object in two types of set. Their reaction time to the object in the typical set is significantly shorter that that in the atypical set. This result suggests that L2 learners performed as efficiently as native speakers at activating relevant information (i.e., the present typical object) in a nonlinguistic task.

Table 25 Analysis of Variance for Experiment 8

	Subject RT (SD)	
	NS (N=20) F2 (1, 19) = 7.47 (p = .013, η_p^2 = .59)	NNS (N=16) F1 (1, 15) = 5.12 (p = .039, η_p^2 = .254)
Typical	1080.73 (334.67)	1071.25 (234.19)
Atypical	1141.60 (332.47)	1140.56 (262.48)
	Item RT (SD)	
	F2 (1, 23) = 4.48 (p = .045, η_p^2 = .163)	F2 (1, 23) = 2.87 (p = .104, η_p^2 = .111)
Typical	1083.07 (106.27)	1102.8 (138.47)
Atypical	1150.54 (100.52)	1162.54 (136.47)

Experiments 7 and 8 clearly demonstrated that L2 learners' ability to suppress or activate information do not differ from native speakers in nonlinguistic tasks. Nonnative speakers' disadvantage at suppression in the listening tasks is most likely a result of their relatively limited L2 knowledge.

CHAPTER 6

GENERAL DISCUSSION AND CONCLUSION

Nearly all previous psycholinguistic studies of second language listening comprehension examined the processes of decoding or word recognition. The current dissertation study was aimed at understanding the mechanisms involved in the process of meaning integration within the psycholinguistic models of language comprehension. Understanding meaning integration in L2 listening comprehension is of paramount importance. Meaning integration is an inseparable component in L2 listening comprehension; and L2 listening difficulty can and often does happen at the process of meaning integration.

In this dissertation project, meaning integration is defined as a component in language comprehension in which incoming meaning inputs from lower processes such as word recognition and parsing are selected and integrated into a coherent meaning representation in the mind of the comprehender. Based on Gernsbacher's Structure Building Framework, meaning integration is considered to include three steps and two mechanisms. The three steps are laying a foundation, mapping, and shifting; and the two mechanisms are activation and suppression. Activation increases the strength of information that is relevant to the representation being built and suppression decreases the activation of irrelevant information. The mechanism of activation mainly functions at the stage of laying a foundation. If there is no incongruity, incoming information will be integrated to the already constructed meaning representation. If an incongruity appears, the incongruent information and the processed information are in competition. The mechanism of suppression comes into play and meaning shifting is initiated.

Based on this framework, comprehension difficulty may come from two sources. Less skilled comprehenders may be unable to suppress irrelevant information. As a result, too many

mental representations are constructed and maintained in the brain. Alternatively, less skilled comprehenders may fail to activate enough memory nodes for building a mental representation.

Researchers in L1 comprehension have identified the role that suppression plays in successful L1 meaning integration. Less skilled comprehenders were found to be less efficient at suppressing irrelevant information in both linguistic and nonlinguistic tasks when compared with skilled comprehenders. Studies in L2 processing have not provided a clear and consistent pattern on the role that suppression plays in L2 meaning integration. Results from L2 reading seem to suggest a slower suppression mechanism (e.g., Elston-Guttler & Friederici, 2005; Frey, 2005), and the only L2 study involving listening tried to suggest an inefficient suppression mechanism but the results did not completely support the claim (Love, et al., 2003). More discussions of previous studies in comparison with the present project will be provided below.

The current dissertation project uses the context effect to investigate L2 meaning integration in the audio modality. Compared to previous studies on L2 comprehension, the present project has three unique contributions. First, the current project looks at the activation and suppression of meaning generated by a sentential context. Previous studies only investigated the use of context to suppress the irrelevant meaning of a homonym. The present project thus expands our understanding of the role that activation and suppression plays in L2 comprehension. Second, the current study looks at listening comprehension, an area that is often ignored in the psycholinguistic study of L2 comprehension. The present project is the first to examine the cognitive processes involved in L2 listening comprehension. Third, the discovery of the facilitation-without-inhibition effect and the follow-up experiments raise many questions for future projects that will deepen our understanding of L2 comprehension and language comprehension in general.

Three connected patterns of results were obtained across a series of eight experiments.

1. A facilitation-without-inhibition effect was found for L2 learners but not for native speakers of English. The facilitation-without-inhibition effect refers to a phenomenon when L2 participants are processing three types of sentential contexts: congruent, neutral, and incongruent. Their processing time in the congruent context is faster than that in the neutral context, but no difference exists between the neutral context and the incongruent context. The facilitation-without-inhibition effect is observed in different conditions and listening tasks. Native speakers' performance was consistent with previous L1 studies; both facilitation and inhibition were observed.
2. An inhibitive effect was found for L2 learners when the sentential context provided no strong candidate. This finding suggests that the facilitation-without-inhibition effect is a result of L2 learners' inability to suppress unwanted information. By using less constrained sentential contexts in Experiment 6, I was able to address the question of whether the facilitation-without-inhibition effect was a result of insufficient suppression of unwanted meanings or insufficient activation of related meanings. The purpose of using a less constrained sentential context is to remove the strong potential target that may compete with the real target. Since there is not a strong target to suppress, we should observe a difference between the neutral and the incongruent sentences if the facilitation-without-inhibition effect is caused by an insufficient suppression mechanism. On the other hand, if no difference is observed between the neutral and the incongruent sentences, the facilitation-without-inhibition effect is most likely caused by an insufficient activation mechanism. An inhibitive effect was observed from both native and nonnative speakers in this experiment. A reanalysis of the data further showed that

when the contexts were more constrained, the inhibitive effect disappeared in the nonnative group.

3. L2 learners were found to perform as well as native speakers in tasks requiring activating and suppressing concepts represented by pictures. This suggests that insufficient meaning suppression is a linguistic issue for L2 learners.

Comparison with Previous Studies

Findings of this dissertation project are highly consistent with L1 studies that use similar sentential contexts. In a study comparing older and younger adults (Federmeier, et al., 2002), a similar facilitation-without-inhibition effect was observed in older adults when the sentential contexts were highly constrained. Similar to the present project, this effect disappeared when the sentences were less constrained. These patterns of results revealed that older adults had difficulty at suppressing unwanted information. It seems that L2 learners are like the older adults in that both of them are less efficient at suppressing unwanted information.

L2 learners' disadvantage at suppression was also revealed in previous studies looking at L2 learners' use of homonyms in reading tasks (Elston-Guttler & Friederici, 2005; Frey, 2005). The researchers found that L2 learners had no difficulty at activating the multiple meanings of a homonym but were slower than native speakers at suppressing context-inappropriate meaning. Although the only listening study by Love and Swinney (2003) did not provide consistent results, there was still the pattern that L2 learners were less efficient at suppressing the unwanted meaning of a homonym. My findings were consistent with these studies using homonyms although the materials I used were sentential contexts. We all found that L2 learners performed as well as native speakers in activation, but not in suppression.

There is a difference between the target of suppression in the previous studies and the present study. In previous studies, participants needed to suppress the irrelevant meaning of a homonym, while in the present project participants needed to suppress a highly plausible candidate. Although language users are unlikely to encounter the incongruent sentences used in the present project in actual language use, employing such materials is a way to investigate the cognitive processes involved in L2 listening comprehension. Many psycholinguistic studies have employed special sentences (e.g., garden path sentences such as "the man whistling tunes pianos") to investigate language processing (e.g., Juffs & Harrington, 1996; Trueswell, Tanenhaus, & Kello, 1993; Williams, Mobius, & Kim, 2001).

L2 learners' inability to suppress the unwanted meaning of a homonym in these previous studies was similar to some special L1 populations such as less skilled readers, older adults, and aphasic patients. Such a similarity in performance between L2 learners and some special L1 population is also observed from this dissertation project. The L2 learners as well as these special populations are less efficient at suppressing unwanted information than their control groups in linguistic tasks. However, the present project also showed that the L2 learners differed from the special L1 populations in that their suppressing disadvantage does not exist in nonlinguistic tasks. L2 learners' inability to suppress unwanted information in linguistic tasks, therefore, must be related to some special characteristics of L2 processing.

Possible Explanations for the Less Efficient Suppression Mechanism

It will be of great value to study why L2 learners are less efficient at suppression. Answers to this question can not only deepen our understanding of the processes involved in L2 comprehension, but provide useful information to L2 learning.

Previous studies have suggested several possibilities. A study by Rosen and Engle (1998) revealed a relationship between working memory and an individual's ability to suppress unwanted information. Working memory was measured by the number of words that a participant could remember from a set of 66 words while the participant was solving some mathematic problems. The participants in their study needed to name the second word (response word) in a word pair for three pairs (e.g., eye-glass, eye-tear, eye-glass). Participants first studied each pair for 2 seconds and then recalled the response words. Since the first and second pairs shared the same first word (i.e., eye), the participants would need to suppress the first response word in order to repeat the second response word. When the participants' accuracy was measured, the low memory span participants were more likely to say the first response word (i.e., glass) when they were asked to name the second response word (i.e., tear) than the high memory span participants. This result revealed that the low span participants were less efficient at suppressing the first response word. When speed was measured, high memory span participants were slower than their low memory span counterparts in naming the third response word (e.g., glass). Since the first and third pair contained the same words, a faster response time revealed a still active first response word for the low span participants. Findings from this study thus suggested a relationship between working memory span and suppression. It has been found that L2 learners have a larger working memory span in their L1 than L2 (Walter, 2000, cited in Frey 2005). L2 learners' inability to suppress unwanted information in language comprehension may be a result of not having enough cognitive resources to support L2 processing.

However, it is also possible that a smaller working memory span is the result rather than the cause of an individual's inability to suppress unwanted information. Because L2 learners

need much more cognitive resources to perform suppression, their ability to hold more information in their working memory suffers.

Another source may come from L2 learners' lack of general knowledge in the L2, especially knowledge of the L2 culture. Employing a design similar to that of Gernsbacher, et al.(1990) (i.e., *He dug with the spade*), McNamara & McDaniel (2004) found that native speaking participants with greater general knowledge, as revealed by a General Knowledge Test, were more efficient in suppressing unwanted information than participants with less general knowledge. The General Knowledge Test used by McNamara and McDaniel consisted of 20 multiple choice questions taken from published tests (e.g., Graduate Management Admission Test [GMAT]). Five possible answers were given for each question. Questions covered a variety of areas such as literature (e.g., "A 20th century novel which made the public aware of the plight of migrant workers is"), history (e.g., "At the end of the Civil War, the vast majority of freed slaves found work as"), and biology (e.g., "A process which can only take place in living cells containing chlorophyll is").

L2 learners' smaller vocabulary size may play a role as well. In the second part of Federmeier, Mclennan, De Ochoa, & Kutas (2002), the researchers conducted a battery of seven neuropsychological tests (verbal fluency, vocabulary size, semantic relations, reading comprehension, digit span, reading span, and Wisconsin card sorting test) to look at the relationship between different cognitive abilities and older adults' ability to process unexpected words in a sentence. They found that vocabulary size and verbal fluency (i.e., generating as many words from a particular category or starting with a particular letter within one minute) were the best predictors of the performance of the older adults (Federmeier, 2007; Federmeier, et

al., 2002). Older adults with a larger vocabulary size and higher verbal fluency were more able to suppress unwanted meanings.

Another possible source may be the influence of the L2 learners' first language. A central question for second language research has been whether observed differences between L2 learners' and native speakers' processing can be explained by certain linguistic differences between the L1 and the L2. Although it is hard to see the linguistic properties of Chinese that could influence the processing of English at this level, the facilitation-without-inhibition phenomenon may reflect a processing preference of Chinese native speakers. Testing learners whose native language is not Chinese, or testing Chinese learners of English using Chinese sentences are two possible ways of examining this possibility.

Inability to suppress unwanted information might also be a general effect of knowing more than one language. It has been proposed that both the L1 and L2 subsystems of a bilingual always remain activated to some extent and that a bilingual must expend resources to suppress one language while speaking the other (e.g., Green, 1986). In a series of production experiments, for example, Mackay and Flege (2004) asked early (people who immigrated to Canada between 2 to13) and late (people who immigrated to Canada between15 to 28) Italian-English bilinguals to repeat sentences in both Italian and English. They found that late bilinguals spoke more slowly in English than in Italian, and thus took longer to produce English sentences than Italian sentences. The opposite pattern was found for the early bilinguals. They also found that the more Italian used by bilinguals, the slower their English sentences were. This difference between early and late bilinguals cannot be explained by the lack of practice because the difference was found when the participants have the opportunity to repeat a sentence. Similarly, the possibility of slowing down for intelligibility cannot solve the problem either because late bilinguals'

intelligibility increased as they increased their speaking rate but the same manipulation reduced the early bilinguals' intelligibility. Flege and his colleagues (Guion, Flege, Liu, & Yeni-Komshian, 2000; Mackay & Flege, 2004) proposed that the late bilinguals produced slower English sentences than the early bilinguals because they needed to expend more resources to suppress their Italian subsystem than did the early bilinguals. The authors believed that the more established the L1 is at the time of first exposure to the L2, the more it will interfere with L2 production, thus requiring greater processing resources to suppress it. It is also possible that an activated L1 slows down the suppression of unwanted information in the L2.

Future Studies

The discovery of the facilitation-without-inhibition phenomenon opens doors for many future projects that could help deepen our understanding of the processes involved in second language listening comprehension. In the above discussion, I offered several possible explanations for L2 learners' inability to suppress unwanted information, such as working memory, general knowledge, and vocabulary size. Since these factors are identified through correlation analyses, we do not know the real cause of insufficient suppression. For example, a smaller working memory might be the effect rather than the cause of insufficient suppression because the unsuppressed irrelevant information could take much of the L2 learners' mental resources. One way to address this question is to add an additional working memory task to the original listening tasks. The working memory task could be to ask the participants to remember the last word of each sentence and to report them back after they finish all the listening tasks (Daneman & Carpenter, 1980). The context in half of the listening materials is highly constraining, i.e., there is a highly predictable target, while the context in the other half is less constraining, i.e., there is no highly predictable target. The targets for these contexts are either

neutral or incongruent. In the highly constraining context, participants need to suppress the highly predictable target. On the contrary, little suppression is needed in the less constraining context. If the participants remember fewer words in the highly constraining context than in the less constraining context, we can conclude that a smaller working memory span is a result of insufficient suppression.

The other two possible factors, general knowledge and vocabulary size, are related to the L2 learners' proficiency in the second language. To investigate whether insufficient suppression is a result of lower proficiency, we can use L2 learners of different proficiency levels. The more proficient the learners are, the more likely we can observe an inhibitive effect.

One way to test whether inability to suppress unwanted information is a general effect of knowing more than one language is to use bilinguals who are exposed to the L2 at different ages. Researchers have suggested that bilinguals who acquire the L2 at a later age are more likely to have a more established L1 system and have more difficulty in suppressing this system when using the L2 (Guion, et al., 2000; Mackay & Flege, 2004). If this claim is true, earlier bilinguals are more likely to show inhibition than later bilinguals. Since age of L2 acquisition is usually positively correlated to L2 learners' proficiency, the bilinguals' L2 proficiency should be controlled for. In other words, we need to test high-proficiency early bilinguals and comparable high-proficiency late bilinguals.

As to whether the facilitation-without-inhibition effect is specific to Chinese learners of English, using learners whose first language is not Chinese can answer this question.

Another important area for future research is to investigate whether this facilitation-without-inhibition effect also exists in second language reading. Answers to this question will contribute greatly to our understanding of L2 comprehension in general and to the development

of models of language comprehension. If the same effect is found in L2 reading, it suggests that L2 listening and L2 reading are regulated by similar cognitive processes. It further suggests that L2 comprehension may involve processes similar to those of L1 comprehension. We thus would be more confident when borrowing L1 comprehension models to explain findings in L2 comprehension.

If the facilitation-without-inhibition effect is not observed from L2 reading, it suggests that L2 listening comprehension and reading comprehension might involve different cognitive mechanisms. We will then need to answer two important questions concerning L2 comprehension. This first one is what cognitive mechanisms are involved in L2 reading comprehension, and the second one is how are these mechanisms different from those involved in L2 listening.

Further, comparing L2 listening and reading comprehension will raise many interesting questions for models of language comprehension. Models of language comprehension assume that listening and reading employ the same cognitive processes. If L2 reading and listening show different effects, should we still hold the same assumption when explaining phenomena found in L2 comprehension? If we continue to assume that listening and reading employ the same cognitive processes, how will the differences between L2 listening and reading be explained? If we do not, should we treat L1 comprehension and L2 comprehension as two separate components? It seems highly unlikely for two linguistic systems to be separated. In that case, we need to know how these two systems are connected.

Contributions

The present dissertation project is the first to examine systematically the mechanisms in semantic integration in L2 listening comprehension. It established the facilitation-without-

inhibition effect in L2 listening comprehension and discovered the underlying mechanism that produces this effect. Findings from this project contribute to our understanding of L2 semantic processing and language comprehension in general.

This dissertation project can help explain the difference in semantic processing between native speakers and L2 learners. Numerous ERP studies (e.g., Ardal, et al., 1990; Hahne & Friederici, 2001; Mueller, 2006; Mueller, et al., 2005; Ojima, et al., 2005; Peroverbio, et al., 2002; Weber-Fox, et al., 2003) have consistently found that N400 responses are delayed for second language learners in comprehending semantically unacceptable sentences, indicating certain difficulty in L2 semantic integration. The results of the present project reveal that an insufficient suppression mechanism may be the cause of this difficulty.

Findings from this project and relevant future projects will also contribute to our understanding of semantic integration and language comprehension in general. According to Gernsbacher's Structure Building Framework, linguistic activities and general cognitive activities are regulated by the same cognitive mechanisms. In previous L1 studies (e.g., Gernsbacher & Faust, 1991), less skilled comprehenders are less efficient at suppressing irrelevant information in both linguistic and nonlinguistic tasks. In the current project, L2 learners do not differ from native speakers in suppression or activation when performing nonlinguistic tasks. Findings from the current project thus pose a challenge for the Structure Building Framework. If the same cognitive mechanisms are involved in both linguistic and nonlinguistic activities, why is there a disconnection between suppression in L2 linguistic tasks and suppression in nonlinguistic tasks? If L2 processing involves mechanisms different from those of L1 processing, we are undermining the underlying assumption of the Structure Building Framework.

One way to resolve this conflict is to introduce the concepts of input and practice to the framework. We keep the assumptions that linguistic and nonlinguistic activities use the same cognitive mechanisms, and that L2 processing is regulated by the same cognitive mechanisms underlying L1 processing. Because of the lack of input and practice in L2, these cognitive mechanisms are less efficient in processing L2 than L1. This explanation has two advantages. First, the Structure Building Framework is still parsimonious. Second, it is consistent with what we experience when learning a new language or a new nonlinguistic skill: less input and practice result in poorer performance.

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APPENDIX A: SENTENCE COMPLETION NORM (NS)

Number of respondents: 21

target % (count)

Realizing the office was locked, the professor went back to his car to get the *key 100% (21)*
When Beth left the house, she again forgot to lock the *door 100% (21)*
It was getting cold, but they could hardly afford to buy more clothes to keep the children *warm 100% (21)*
For millions of Chinese, bikes remain to be an affordable and reliable means of *transportation 100% (21)*
When the plane flew over Alaska, they saw the mountains were covered with *snow 100% (21)*
Before I left the room, I couldn't help looking again at the picture hung on the *wall 100% (21)*
The story was so sad and touching that all children had tears in their *eyes 100% (21)*
They started looking for a restaurant because they felt a bit *hungry 100% (21)*
The agreement was signed by both parties that afternoon in the lawyer's *office 100% (21)*
Captain Smith told the crew that he wanted to stay with the sinking *ship 100% (21)*
He was invited to the White House to have dinner with the *president 100% (21)*
Though he had introduced himself, I could not remember his *name 100% (21)*
The boy threw a rock at the house and broke a *window 100% (21)*
At first the woman refused, but she soon changed her *mind 100% (21)*
Once she got to campus, Kate first stopped at the library to return a few *books 100% (21)*
Mrs. Jones hoped to use the afternoon to go to the salon to color her *hair 100% (21)*
When the applicant was introduced to the manager, they shook *hands 100% (21)*
The customer was asked to pay by cash or credit card, or write a *check 100% (21)*
Though it was raining, the children still wanted to go outside to

play 100% (21)
The police searched the burned house in order to find the cause of the *fire 100% (21)*
Whenever he saw a new word, he would look it up in his *dictionary 100% (21)*
The gardener told Mary that water and sunshine help plants *grow 100% (21)*
While he enjoys Jazz the most, David likes any type of *music 100% (21)*
As it was getting dark, they decided to find a roadside hotel to spend the *night 100% (21)*
To get more sunshine in their backyard, they decided to cut down some *trees 100% (21)*
It was raining hard, so the boy went back to get an *umbrella 100% (21)*
They soon discovered that the ship was too big to pass under the *bridge 100% (21)*
Hoping to take better photos, Steve decided to buy an expensive *camera 95% (20); tuxedo 5% (1)*
Not feeling well in the morning, Matthew made an appointment to see his *doctor 95% (20); physician 5% (1)*
The couple sat together without speaking a single *word 95% (20); time 5% (1)*
Joe enjoys living in a big city, but Teresa wants to live in a small *town 95% (20); city 5% (1)*
After they returned to the hotel, they found they had lost the key to their *room 95% (20); house 5% (1)*
As the room was getting dark, John stood up and turned on the *light 95% (20); lamp 5% (1)*
At this time, we don't know whether the storm has done much *damage 95% (20); good 5% (1)*
Tom could not sign on the form because he didn't have a *pen 95% (20); password 5% (1)*
After the dinner, Sharon washed the bowls and dishes, and dried them with a *towel 95% (20); rug 5% (1)*
The little girl dropped a letter in the mailbox without a *stamp 90% (19); thought 10% (2)*
Children were more affected by the disease than *adults 90% (19); parents 5% (1); anyone 5% (1)*
When I returned home, I saw the little boy still sleeping in his *bed 90% (19); window 5% (1); clothes 5% (1)*
Tom enjoyed the movie so much that he went to see it *again 90% (19); twice 10% (2)*
I am the only person in our office who drinks tea rather than

coffee 90% (19); water 5% (1); coke 5% (1)
The waiter was careless and rude, so the couple didn't leave him any *tip 90% (19); gratuity 5% (1); money 5% (1)*
Since Jane did not bring her camera with her, she could not take any *pictures 90% (19); photos 10% (2)*
More people came to the talk than expected, so they had to go and find more *chairs 85% (18); seats 10% (2); people 5% (1)*
Many soldiers and civilians lost their lives during the four-year-long *war 85% (18); battle 10% (2); civil war 5% (1)*
The theatre was so jammed they could not find a single *seat 85% (18); chair 15% (3)*
This is a five-mile trail leading to the top of the *mountain 85% (18); hill 10% (2); trail 5% (1)*
By the time he got to the station, the train had already *left 85% (18); departed 15% (3)*
John felt very sorry, even though it was not his *fault 80% (17); problem 15% (3); parent 5% (1)*
When the two finally met again 30 years later, the old teacher could hardly recognize his *student 80% (17); face 15% (3); pupil 5% (1)*
After the visit from the dentist, Abby brushed her teeth after every *meal 75% (16); day 20% (4); night 5% (1)*
After hearing several robbery incidents in the downtown area, he decided to purchase a *gun 75% (16); alarm 10% (2); lock 10% (2); car 5% (1)*
Three people were seriously injured in a major highway *accident 70% (15); crash 20% (4); collision 10% (2)*
The next day, the postman came again and handed him a few more *letters 70% (15); bills 10% (2); stamps 5% (1); parcels 5% (1); envelopes 5% (1); packages 5% (1)*
Before going to the airport, she stopped at the bank to get some *money 65% (14); cash 35% (7)*
While her husband wants to have a son, Kate has always wanted to have a beautiful *daughter 65% (14); girl 25% (5); baby girl 5% (1); little girl 5% (1)*
More power stations have been built in this part of China to meet the increasing demand for *electricity 60% (13); energy 35% (7); power 5% (1)*
This was the place where, during the draught, the villagers would come and pray for *rain 60% (13); water 40% (8)*
Phil tried to kick-open the door, but it remained *shut 55% (12); closed 20% (4); locked 10% (2); jammed 10% (2); stuck 5% (1)*
Shortly after the divorce, Mary returned to her hometown to live with her

parents 47% (10); mother 38% (8); aunt 5% (1); family 5% (1); mom 5% (1)
When we reached the bank, we saw several children swimming in the *river 41% (9); pool 29% (6); pond 10% (2); water 10% (2); fountain 10% (2)*
What he did represented a break from the past and a strong desire for a new *future 32% (7); life 23% (5); beginning 15% (3); challenge 5% (1); change 5% (1); start 5% (1); innovation 5% (1); horizon 5% (1); destiny 5% (1)*
After a dam was built for the reservoir and the water rose, this area had become a huge *lake 32% (7); flood 23% (5); swamp 20% (4); attraction 10% (2); disaster 5% (1); city 5% (1); resort 5% (1)*

APPENDIX B: SENTENCE COMPLETION NORM (NNS)

Number of respondents: 38

target % (count)

Realizing the office was locked, the professor went back to his car to get the *key 100% (38)*
When Beth left the house, she again forgot to lock the *door 100% (38)*
Hoping to take better photos, Steve decided to buy an expensive *camera 100% (38)*
It was getting cold, but they could hardly afford to buy more clothes to keep the children *warm 100% (38)*
Not feeling well in the morning, Matthew made an appointment to see his *doctor 100% (38)*
Before I left the room, I couldn't help looking again at the picture hung on the *wall 100% (38)*
The story was so sad and touching that all children had tears in their *eyes 100% (38)*
They started looking for a restaurant because they felt a bit *hungry 100% (38)*
The couple sat together without speaking a single *word 100% (38)*
He was invited to the White House to have dinner with the *president 100% (38)*
Many soldiers and civilians lost their lives during the four-year-long *war 100% (38)*
Though he had introduced himself, I could not remember his *name 100% (38)*
The boy threw a rock at the house and broke a *window 100% (38)*
As the room was getting dark, John stood up and turned on the *light 100% (38)*
Once she got to campus, Kate first stopped at the library to return a few *books 100% (38)*
When the applicant was introduced to the manager, they shook *hands 100% (38)*
Though it was raining, the children still wanted to go outside to *play 100% (38)*
The gardener told Mary that water and sunshine help plants *grow 100% (38)*
While he enjoys Jazz the most, David likes any type of

music 100% (38)
After the visit from the dentist, Abby brushed her teeth after every *meal 97.5% (37); dinner 2.5% (1)*
For millions of Chinese, bikes remain to be an affordable and reliable means of *transportation 97.5% (37); traffic 2.5% (1)*
The theatre was so jammed they could not find a single *seat 97.5% (37); space 2.5% (1)*
Whenever he saw a new word, he would look it up in his *dictionary 97.5% (37); ? 2.5% (1)**
I am the only person in our office who drinks tea rather than *coffee 97.5% (37); wine 2.5% (1)*
It was raining hard, so the boy went back to get an *umbrella 97.5% (37); raincoat 2.5% (1)*
John felt very sorry, even though it was not his *fault 95% (36); mistake 5% (2)*
Tom could not sign on the form because he didn't have a *pen 95% (36); membership 2.5% (1); look 2.5% (1)*
As it was getting dark, they decided to find a roadside hotel to spend the *night 95% (36); weekend 2.5% (1); evening 2.5% (1)*
To get more sunshine in their backyard, they decided to cut down some *trees 95% (36); branches 2.5% (1); grass 2.5% (1)*
Three people were seriously injured in a major highway *accident 92.5% (35); this morning 2.5% (1); crash 2.5% (1); ? 2.5% (1)*
Mrs. Jones hoped to use the afternoon to go to the salon to color her *hair 92.5% (35); life 5% (2); picture 2.5% (1)*
The waiter was careless and rude, so the couple didn't leave him any *tip 92.5% (35); fee 7.5% (3)*
They soon discovered that the ship was too big to pass under the *bridge 92.5% (35); tunnel 2.5% (1); deck 2.5% (1); ? 2.5% (1)*
The police searched the burned house in order to find the cause of the *fire 90% (34); accident 2.5% (1); disaster 2.5% (1); murder 2.5% (1); incident 2.5% (1)*
Captain Smith told the crew that he wanted to stay with the sinking *ship 90% (34); boat 7.5% (3); people 2.5% (1)*
The agreement was signed by both parties that afternoon in the lawyer's *office 87.5% (33); presence 2.5% (1); firm 2.5% (1); supervision 2.5% (1); company 2.5% (1); room 2.5% (1)*
When I returned home, I saw the little boy still sleeping in his *bed 87.5% (33); room 5% (2); chair 5% (2); bedroom 2.5% (1)*
Tom enjoyed the movie so much that he went to see it *again 87.5% (33); twice 10% (4); immediately 2.5% (1)*
The customer was asked to pay by cash or credit card, or write a *check 87.5% (33); sign 2.5% (1); bank draft 2.5% (1); note2.5% (1); ? 5% (2)*
When the plane flew over Alaska, they saw the mountains were covered with

snow 85% (32); clouds 7.5% (3); trees 5% (2); ice 2.5% (1)
By the time he got to the station, the train had already *left 85% (32); gone 7.5% (3); stopped 5% (2); moved 2.5% (1)*
When we reached the bank, we saw several children swimming in the *river 82.5% (31); pool 10% (4); sea 5% (2); lake 2.5% (1)*
When the two finally met again 30 years later, the old teacher could hardly recognize his *student 82.5% (31); friend 7.5% (3); pupil 2.5% (1); name2.5% (1); face 2.5% (1); identity 2.5% (1)*
At first the woman refused, but she soon changed her *mind 80% (30); idea 10% (4); attitude 7.5% (3); situation 2.5% (1)*
Children were more affected by the disease than *adults 77.5% (29); weather 10% (4); anything else 5% (2); environment 2.5% (1); cold 2.5% (1); starvation 2.5% (1)*
After they returned to the hotel, they found they had lost the key to their *room 77.5% (29); door 22.5% (9)*
At this time, we don't know whether the storm has done much *damage 77.5% (29); harm 20% (8); destruction 2.5% (1)*
This is a five-mile trail leading to the top of the *mountain 75% (28); hill 25% (10)*
Before going to the airport, she stopped at the bank to get some *money 72.5% (27); cash 22.5% (9); food 5% (2)*
Joe enjoys living in a big city, but Teresa wants to live in a small *town 72.5% (27); village; 22.5% (9); country 2.5% (1); city 2.5% (1)*
This was the place where, during the draught, the villagers would come and pray for *rain 72.5% (27); safety 10% (4); harvest 5% (2); God 5% (2); rainfall 2.5% (1); themselves 2.5% (1); security 2.5% (1)*
The next day, the postman came again and handed him a few more *letters 72.5% (27); mails 20% (8); cards 7.5% (3)*
More people came to the talk than expected, so they had to go and find more *chairs 69% (26); seats 16% (6); space 7.5% (3); rooms 5% (2); help 2.5% (1)*
More power stations have been built in this part of China to meet the increasing demand for *electricity 63% (24); energy 27% (10); industry 2.5% (1); travel 2.5% (1); power 2.5% (1); gas 2.5% (1)*
Shortly after the divorce, Mary returned to her hometown to live with her *parents 58% (22); mother 37% (14); daughter 2.5% (1); family2.5% (1)*
After the dinner, Sharon washed the bowls and dishes, and dried them with a *towel 58% (22); cloth 22% (8); drier 5% (2); machine 5% (2); device 2.5% (1); dish cloth 2.5% (1); fan 2.5% (1); handkerchief 2.5% (1)*
Phil tried to kick-open the door, but it remained *closed 55% (21); locked 25% (9); shut 17.5% (7); stuck 2.5% (1)*
Since Jane did not bring her camera with her, she could not take any *picture 55% (21); photo 45% (17)*

What he did represented a break from the past and a strong desire for a new *life 53% (20); start 29.5% (11); future 10% (4); beginning 7.5% (3)*
After hearing several robbery incidents in the downtown area, he decided to purchase a *gun 53% (20); lock 13.5% (5); car 8% (3); alarm 8% (3); pistol 5% (2); house 5% (2); safe 5% (2); rifle 2.5% (1)*
While her husband wants to have a son, Kate has always wanted to have a beautiful *girl 53% (20); daughter 47% (18)*
The little girl dropped a letter in the mailbox without a *stamp 50% (19); word 20% (7); thought 7.5% (3); stop 7.5% (3); signature 2.5% (1); lock 2.5% (1); glance 2.5% (1); seal 2.5% (1); sound 2.5% (1); second 2.5% (1)*
After a dam was built for the reservoir and the water rose, this area had become a huge *lake 34% (13); pond 10% (4); pool 2.5% (2); sea 2.5% (2); ? 7.5% (3); and many different answers*

* "?" means no answer was given.

APPENDIX C: ACCEPTANCE RATE FOR NEUTRAL TARGET 1

Number of respondents: 20

1 represents acceptable, 7 represents unacceptable

1. More power stations have been built in this part of China to meet the increasing demand for power.	2.3
2. This was the place where, during the draught, the villagers would come and pray for water.	2.9
3. Before going to the airport, she stopped at the bank to get some cash.	1.8
4. While her husband wants to have a son, Kate has always wanted to have a beautiful girl.	2.6
5. The next day, the postman came again and handed him a few more stamps.	2.8
6. Three people were seriously injured in a major highway crash.	1.6
7. After the visit from the dentist, Abby brushed her teeth after every day.	4.8
8. John felt very sorry, even though it was not his parent.	4.4
9. When the two finally met again 30 years later, the old teacher could hardly recognize his face.	3.5
10. By the time he got to the station, the train had already departed.	1.8
11. Many soldiers and civilians lost their lives during the four-year-long battle.	2.4
12. More people came to the talk than expected, so they had to go and find more seats.	2.6
13. The theatre was so jammed they could not find a single chair.	2.3
14. This is a five-mile trail leading to the top of the hill.	2.3
15. Children were more affected by the disease than parents.	3.4
16. I am the only person in our office who drinks tea rather than water.	2.3
17. Since Jane did not bring her camera with her, she could not take any photos.	1.8
18. The little girl dropped a letter in the mailbox without a thought.	2.2
19. The waiter was careless and rude, so the couple didn't leave him any gratuity.	2.4
20. Tom enjoyed the movie so much that he went to see it twice.	2.1
21. When I returned home, I saw the little boy still sleeping in his clothes.	2
22. After the dinner, Sharon washed the bowls and dishes, and dried them with a rug.	5.8

23. After they returned to the hotel, they found they had lost the key to their house.	3.8
24. As the room was getting dark, John stood up and turned on the lamp.	2.8
25. At this time, we don't know whether the storm has done much good.	3.8
26. Hoping to take better photos, Steve decided to buy an expensive lens.	2.1
27. Joe enjoys living in a big city, but Teresa wants to live in a small village.	2.7
28. Not feeling well in the morning, Matthew made an appointment to see his physician.	2
29. The couple sat together without speaking a single time.	3.9
30. Tom could not sign on the form because he didn't have a password.	4.3
31. As it was getting dark, they decided to find a roadside hotel to spend the weekend.	4.4
32. At first the woman refused, but she soon changed her position.	2.8
33. Before I left the room, I couldn't help looking again at the picture hung on the nail.	3.9
34. Captain Smith told the crew that he wanted to stay with the sinking plane.	3.8
35. For millions of Chinese, bikes remain to be an affordable and reliable means of exercise.	3.8
36. He was invited to the White House to have dinner with the ambassador.	2.5
37. It was getting cold, but they could hardly afford to buy more clothes to keep the children comfortable.	3
38. It was raining hard, so the boy went back to get his raincoat.	2.3
39. Mrs. Jones hoped to use the afternoon to go to the salon to color her nails.	4.3
40. Once she got to campus, Kate first stopped at the library to return a few tapes.	2.6
41. Realizing the office was locked, the professor went back to his car to get the code.	3.3
42. The agreement was signed by both parties that afternoon in the lawyer's presence.	1.7
43. The boy threw a rock at the house and broke a television.	2.5
44. The customer was asked to pay by cash or credit card, or paypal.	3.3
45. The gardener told Mary that water and sunshine help plants live.	2.1
46. The police searched the burned house in order to find the cause of the disaster.	2

47. The story was so sad and touching that all children had tears in their faces.	4
48. They soon discovered that the ship was too big to pass under the cliff.	3.4
49. They started looking for a restaurant because they felt a bit tired.	4.4
50. Though he had introduced himself, I could not remember his face.	2.8
51. Though it was raining, the children still wanted to go outside to swim.	2.3
52. To get more sunshine in their backyard, they decided to cut down some branches.	2.6
53. When Beth left the house, she again forgot to lock the windows.	3.9
54. When the applicant was introduced to the manager, they shook heads.	6
55. When the plane flew over Alaska, they saw the mountains were covered with clouds.	2.6
56. Whenever he saw a new word, he would look it up in his computer.	2.9
57. While he enjoys Jazz the most, David likes any type of band.	3.3

APPENDIX D: ACCEPTANCE RATE FOR NEUTRAL TARGET 2

Number of respondents: 20

58. More power stations have been built in this part of China to meet the increasing demand for energy.	1.8
59. This was the place where, during the draught, the villagers would come and pray for snow.	2.6
60. Before going to the airport, she stopped at the bank to get some checks.	1.8
61. While her husband wants to have a son, Kate has always wanted to have a beautiful babygirl.	1.9
62. The next day, the postman came again and handed him a few more parcels.	2.3
63. Three people were seriously injured in a major highway collision.	1.3
64. After the visit from the dentist, Abby brushed her teeth after every night.	3.1
65. John felt very sorry, even though it was not his problem.	2.4
66. When the two finally met again 30 years later, the old teacher could hardly recognize his pupil.	2.1
67. By the time he got to the station, the train had already arrived.	1.7
68. Many soldiers and civilians lost their lives during the four-year-long civilwar.	2
69. More people came to the talk than expected, so they had to go and find more paper.	2.7
70. The theatre was so jammed they could not find a single friend.	2.9
71. This is a five-mile trail leading to the top of the park.	2.2
72. Children were more affected by the disease than nurses.	2
73. I am the only person in our office who drinks tea rather than coke.	1.9
74. Since Jane did not bring her camera with her, she could not take any shot.	3.8
75. The little girl dropped a letter in the mailbox without a sound.	2.7
76. The waiter was careless and rude, so the couple didn't leave him any money.	2.7
77. Tom enjoyed the movie so much that he went to see it alone.	2.3
78. When I returned home, I saw the little boy still sleeping in his room.	1.9
79. After the dinner, Sharon washed the bowls and dishes, and dried them with a dryer.	3.8
80. After they returned to the hotel, they found they had lost the key to their car.	1.9
81. As the room was getting dark, John stood up and turned on the television.	2.4
82. At this time, we don't know whether the storm has done much harm.	2.7
83. Hoping to take better photos, Steve decided to buy an expensive tripod.	1.8

84. Joe enjoys living in a big city, but Teresa wants to live in a small place.	2.5
85. Not feeling well in the morning, Matthew made an appointment to see his therapist.	2.6
86. The couple sat together without speaking a single sentence.	2.2
87. Tom could not sign on the form because he didn't have a code.	2.9
88. As it was getting dark, they decided to find a roadside hotel to spend the time.	4.3
89. At first the woman refused, but she soon changed her opinion.	2.9
90. Before I left the room, I couldn't help looking again at the picture hung on the door.	2
91. Captain Smith told the crew that he wanted to stay with the sinking boat.	1.8
92. For millions of Chinese, bikes remain to be an affordable and reliable means of travel.	1.8
93. He was invited to the White House to have dinner with the officials.	1.3
94. It was getting cold, but they could hardly afford to buy more clothes to keep the children happy.	3.1
95. It was raining hard, so the boy went back to get his boots.	1.7
96. Mrs. Jones hoped to use the afternoon to go to the salon to color her fingers.	4.7
97. Once she got to campus, Kate first stopped at the library to return a few magazines.	2.9
98. Realizing the office was locked, the professor went back to his car to get the access card.	1.8
99. The agreement was signed by both parties that afternoon in the lawyer's firm.	2.2
100. The boy threw a rock at the house and broke a mirror.	3
101. The customer was asked to pay by cash or credit card, or money order/bankdraft.	2.8
102. The gardener told Mary that water and sunshine help plants survive.	2.3
103. The police searched the burned house in order to find the cause of the accident.	1.8
104. The story was so sad and touching that all children had tears in their voices.	4.9
105. They soon discovered that the ship was too big to pass under the construction.	3.3
106. They started looking for a restaurant because they felt a bit cold.	3.4
107. Though he had introduced himself, I could not remember his position.	2.6
108. Though it was raining, the children still wanted to go outside to dig.	2.2
109. To get more sunshine in their backyard, they decided to cut down some shrubs.	2.4
110. When Beth left the house, she again forgot to lock the computer.	3.8
111. When the applicant was introduced to the manager, they shook fists.	4.9

112. When the plane flew over Alaska, they saw the mountains were covered with trees.	2.8
113. Whenever he saw a new word, he would look it up in his notes.	2.9
114. While he enjoys Jazz the most, David likes any type of concert.	2.2

APPENDIX E: MATERIALS USED IN EXPERIMENTS 1-4

Lead-in sentence	congruent	neutral	incongruent
More power stations have been built in this part of China to meet the increasing demand for	electricity	energy	accident
This was the place where, during the drought, the villagers would come and pray for	rain	water	coffee
Before going to the airport, she stopped at the bank to get some	money	cash	seats
While her husband wants to have a son, Kate has always wanted to have a beautiful	daughter	girl	war
The next day, the postman came again and handed him a few more	letters	stamps	chairs
Three people were seriously injured in a major highway	accident	collision	meal
After the visit from the dentist, Abby brushed her teeth after every	meal	night	fault
John felt very sorry, even though it was not his	fault	problem	electricity
By the time he got to the station, the train had already	left	departed	leaped
Many soldiers and civilians lost their lives during the four-year-long	war	battle	money
More people came to the talk than expected, so they had to go and find more	chairs	seats	adults
The theatre was so jammed they could not find a single	seat	chair	daughter
This is a five-mile trail leading to the top of the	mountain	hill	stamp
Children were more affected by the disease than	adults	nurses	letters
I am the only person in our office who drinks tea rather than	coffee	coke	rain
The little girl dropped a letter in the mailbox without a	stamp	sound	mountain
The waiter was careless and rude, so the couple didn't leave him any	tip	money	town
Tom enjoyed the movie so much that he went to see it	again	twice	easily
When I returned home, I saw the little boy still sleeping in his	bed	room	camera
After they returned to the hotel, they found they had lost the key to their	room	car	damage
As the room was getting dark, John stood up and turned on the	light	lamp	transportation
At this time, we don't know whether the storm has done much	damage	harm	room

Hoping to take better photos, Steve decided to buy an expensive	camera	lens	president
Joe enjoys living in a big city, but Teresa wants to live in a small	town	place	tip
Not feeling well in the morning, Matthew made an appointment to see his	doctor	physician	word
The couple sat together without speaking a single	word	sentence	doctor
Tom could not sign on the form because he didn't have a	pen	code	wall
At first the woman refused, but she soon changed her	mind	opinion	ship
Before I left the room, I couldn't help looking again at the picture hung on the	wall	nail	mind
Captain Smith told the crew that he wanted to stay with the sinking	ship	boat	pen
For millions of Chinese, bikes remain to be an affordable and reliable means of	transportation	travel	light
He was invited to the White House to have dinner with the	president	ambassador	bed
It was getting cold, but they could hardly afford to buy more clothes to keep the children	warm	happy	tall
It was raining hard, so the boy went back to get the	umbrella	boots	fire
Once she got to campus, Kate first stopped at the library to return a few	books	magazines	trees
Realizing the office was locked, the professor went back to his car to get the	key	code	office
The agreement was signed by both parties that afternoon in the lawyer's	office	presence	key
The boy threw a rock at the house and broke the	window	mirror	umbrella
The gardener told Mary that water and sunshine help plants	grow	live	play
The police searched the burned house in order to find the cause of the	fire	disaster	window
They soon discovered that the ship was too big to pass under the	bridge	cliff	name
Though he had introduced himself, I could not remember his	name	position	bridge
Though it was raining, the children still wanted to go outside to	play	swim	grow
To get more sunshine in their backyard, they decided to cut down	trees	branches	music

some			
When Beth left the house, she again forgot to lock the	door	car	dictionary
When the plane flew over Alaska, they saw the mountains were covered with	snow	clouds	books
Whenever he saw a new word, he would look it up in his	dictionary	notes	door
While he enjoys Jazz the most, David likes any type of	music	concert	snow

APPENDIX F: ACCEPTANCE RATE IN THE WORD MONITORING TASK

Number of respondents: 15

(7 represents highly acceptable; 1 represents highly unacceptable)

More power stations have been built in this part of China to meet the increasing demand for electricity. 6.53
More big stations have been built in this part of China to meet the increasing demand for electricity. 5.13
More grocery stores have been built in this part of China to meet the increasing demand for electricity. 1.43

By the time they got to the station, the train had already left. 6.6
By the time they got to the park, the players had already left. 6.27
By the time they got to the park, the fireworks had already left. 2.33

More people came to the talk than expected, so they had to go and find more chairs. 5.13
More people came to the gym than expected, so they had to go and find more chairs. 3.33
More bees came to the garden than expected, so they had to go and find more chairs. 1

To get more sunshine in their backyard, they decided to cut down some trees. 5
To get a beautiful vegetable garden, the couple decided to cut down some trees. 4.6
To increase the gas mileage, the couple decided to cut down some trees. 1.33

Tom could not sign on the form because he didn't have a pen. 6.6
Tom could not finish the work because he didn't have a pen. 5.27
Tom could not finish the meal because he didn't have a pen. 1

The little girl dropped a letter in the mailbox without a stamp. 6.2
The little girl dropped a card in the bag without a stamp. 3.8
The little girl burnt a card in the room without a stamp. 1.4

It was raining hard, so the boy went back to get the umbrella. 6.93
Next morning, the boy and his sister went back to get the umbrella. 2.4
It was so beautiful, so the boy went back to get the umbrella. 1.93

The waiter was careless and rude, so the couple didn't leave him any tip. 6.07
Joe was careless and rude, so his friends didn't leave him any tip. 3.93
Joe was shy and quiet, so his friends didn't leave him any tip. 2.73

Once she got to campus, Kate first stopped at the library to return a few books. 6.53
Once she got to Atlanta, Kate first stopped at the office to return a few books. 4.33
Once she got to the house, Kate first stopped at the kitchen to return a few books. 1.27

Three people were seriously injured in a major highway accident. 6.13
Three young children were seriously scared in an unexpected accident. 5.2
Three people were happily entertained in an unexpected accident. 1.6

After the visit from the dentist, Abby brushed her teeth after every meal. 6.6
After the visit from her parents, Abby took her medicine after every meal. 4.13
After the visit from the doctor, Abby typed an essay after every meal. 1.4

For millions of Chinese, bikes remain to be an affordable and reliable means of transportation. 6.4
For millions of Chinese, it is hard to find an affordable and reliable means of transportation. 5.07
For millions of Chinese, carrots remain to be an affordable and reliable means of transportation. 1

The agreement was signed by both parties that afternoon in the lawyer's office. 6.4
The agreement was prepared by the secretaries that afternoon in the main office. 6.07
The food was prepared by the mothers that afternoon in the main office. 2.73

The police searched the burned house in order to find the cause of the fire. 6
The police searched the new house in order to find the cause of the fire. 5.67
The police broke the old mirror in order to find the cause of the fire. 33

At this time, we don't know whether the storm has done much damage. 6.07
At this time, we don't' know whether the students have done much damage. 4.14
At this time, we don't' know whether the trees have done much damage. 3.33

They soon discovered that the ship was too big to pass under the bridge. 6.86
They soon discovered that the box was too big to pass under the bridge. 4
They soon discovered that the kitten was too big to pass under the bridge. 1.53

Hoping to take better photos, Steve decided to buy an expensive camera. 6.4
Hoping to have better effects, Steve decided to buy an expensive camera. 4.73
Hoping to have better food, Steve decided to buy an expensive camera. 1.4

Though it was raining, the children still wanted to go outside to play. 6.4
Though it was Monday, the family still wanted to go to the beach to play. 5.73
Though it was Sunday, the workers still wanted to go to the factory to play. 1.73

Not feeling well in the morning, Matthew made an appointment to see his doctor. 6
Not feeling well in the morning, Matthew went to the countryside to see his doctor. 3.47
Not feeling well in the morning, Matthew went to the bedroom to see his doctor. 1.27

The couple sat together without speaking a single word. 6.467
The couple sat together without using a single word. 4.47

The dogs sat together without using a single word. 2.53

When the plane flew over Alaska, they saw the mountains were covered with snow. 6.6
When the plane flew over Seattle, they saw the mountains were covered with snow. 5.8
When the plane flew over Florida, they saw the fields were covered with snow. 1.6

This was the place where, during the draught, the villagers would come and pray for rain. 6.6
This was the place where, during the night, the villagers would come and pray for rain. 4.33
This was the place where, during the war, the soldiers would come and pray for rain. 3.47

Whenever he saw a new word, he would look it up in his dictionary. 6.73
Whenever he saw a new animal, he would look it up in his dictionary. 4.2
Whenever he watered the plant, he would look it up in his dictionary. 2.47

At first the woman refused, but she soon changed her mind. 5.87
At first the woman smiled, but she soon changed her mind. 2.93
At first the woman lost, but she soon changed her mind. 1.53

Before going to the airport, she stopped at the bank to get some money. 6.67
Before going to the airport, she stopped at the store to get some money. 5.13
Before going to the kitchen, she stopped at the dentist's to get some money. 1.33

It was getting cold, but they could hardly afford to buy more clothes to keep the children warm. 5.33
Christmas was coming, but they could hardly afford to buy things that could keep the children warm. 4.87
It was getting cloudy, but they could hardly afford to buy more umbrellas to keep the children warm. 1.27

As the room was getting dark, John stood up and turned on the light. 6.53
As the room was getting cold, John stood up and turned on the light. 2.2
As the room was getting small, John stood up and turned on the light. 1.27

APPENDIX G: NON-CONSTRAINING SENTENCE COMPLETION NORM (NS)

Number of respondents: 14 *target % (count)*

My mother says that no one in my family likes *peas 7% (1) snitches 7% (1) dogs 7% (1) avocado 7% (1) cats 7% (1) pie 7% (1) cheese 7% (1) broccoli 7% (1) dirt 7% (1) ketchup 7% (1) orange juice 7% (1) grits 7% (1) bananas 7% (1) pumpkin*
Mrs. Black hoped that Sam and Dave could help her remove the *bugs 7% (1) odor 7% (1) door 7% (1) stains 7% (1) chest 7% (1) couch 7% (1) piano 7% (1) TV 7% (1) pipe 7% (1) dust 7% (1) weeds 7% (1) mice 7% (1) stump 7% (1) stove 7% (1)*
These beautiful photographs were found to belong to the *royalty 7% (1) artist 7% (1) family 7% (1) collection 7% (1) library 7% (1) president 7% (1) model 7% (1) museum 7% (1) grandparent 7% (1) state 7% (1) queen 7% (1) woman 7% (1) grandmother 7% (1) city 7% (1)*
This is the only store in town where you can buy *pets 7% (1) clothes 7% (1) comics 7% (1) beer 7% (1) cookies 7% (1) videogames 7% (1) Prada 7% (1) pastries 7% (1) artwork 7% (1) fertilizer 7% (1) chips 7% (1) diamonds 7% (1) earrings 7% (1) organic milk 7% (1)*
The next day, his brother came again and brought him a *CD 7% (1) bouquet 7% (1) video 7% (1) letter 7% (1) drink 7% (1) football 7% (1) mirror 7% (1) present 7% (1) ball 7% (1) present 7% (1) hotdog 7% (1) wrench 7% (1) jacket 7% (1) toy 7% (1)*
One of the highlights of the trip was to see the *mountains 14% (2) Eiffel Tower 14% (2) tower 7% (1) canyon 7% (1) statue 7% (1) play 7% (1) waterfall 7% (1) attractions 7% (1) museum 7% (1) Louvre 7% (1) grand canyon 7% (1) animals 7% (1)*
The only thing I didn't like about the house was the *door 14% (2) kitchen 14% (2) looks 7% (1) floor 7% (1) lighting 7% (1) windows 7% (1) balcony 7% (1) paint 7% (1) odor 7% (1) paint 7% (1) color 7% (1) room 7% (1)*
On her way to campus this morning, Mary saw a *bird 14% (2) bus 14% (2) cat 7% (1) train 7% (1) kitten 7% (1) rabbit 7% (1) mushroom 7% (1) deer 7% (1) fight 7% (1) snake 7% (1) dog 7% (1) semi-truck 7% (1)*
While cleaning the car, Liza found her mother's *ring 14% (2) earrings 14% (2) purse 14% (2) pearls 7% (1) calendar 7% (1) wallet 7% (1) pom-poms 7% (1) necklace 7% (1) keys 7% (1) watch 7% (1) diamond 7% (1) bracelet 7% (1)*
Dr. Smith is a professor at Oxford University and he teaches *English 21% (3) science 21% (3) psychology 14% (2) biology 7% (1) linguistics 7% (1) history 7% (1) math 7% (1) Biology 7% (1) statistics 7% (1)*

The little girl decided that her father must have really enjoyed the *movie 21% (3) show 14% (2) play 14% (2) food 7% (1) game 7% (1) present 7% (1) amusement park 7% (1) book 7% (1) party 7% (1) hug7% (1)*
Chris cried all morning when he discovered there was no *milk 21% (3) water 7% (1) food 7% (1) cure 7% (1) cereal 7% (1) Santa Clause s 7% (1) school 7% (1) lights 7% (1) pizza 7% (1) food 7% (1) snow 7% (1) candy 7% (1)*
When Albert woke up the next morning, his father handed him a *letter 21% (3) aspirin7% (1) toothbrush7% (1) book7% (1) $10 bill 7% (1) note7% (1) backpack 7% (1) lunch7% (1) hammer7% (1) baseball7% (1) bill7% (1) broom7% (1)*
Once every four days, Sam and Dave go to the grocery store to buy some *milk 21% (3) eggs7% (1) sodas7% (1) icecream7% (1) fireworks7% (1) juice 7% (1) popcorn7% (1) bread7% (1) cigarettes 7% (1)beer 7% (1) yogurt7% (1) drinks 7% (1)*
A few days ago, Jim attended a big dinner party with his *girlfriend 21% (3) wife 21% (3) friends14% (2) colleagues7% (1) mother7% (1) fiance7% (1) family7% (1) brother7% (1) associates 7% (1)*
Next Wednesday evening, Mr. and Mrs. Eastwood will dance in front of the *church 21% (3) audience14% (2) crowd7% (1) community7% (1) Rialto7% (1) class7% (1) congregation7% (1) crowd7% (1) building7% (1) president7% (1) yard7% (1)*
To prepare for today's dinner, mother bought some beef, fish, potato and *beans 21% (3) corn 21% (3) carrots 14% (2) salad 7% (1) asparagus 7% (1) tomatoes 7% (1) broccoli 7% (1) yams 7% (1) macaroni 7% (1)*
On the right side of the highway, they saw a big *Sign 21% (3) billboard 21% (3) deer 14% (2) truck 14% (2) accident 14% (2) 18-wheeler 7% (1) cross 7% (1)*
In the upcoming new movie, Joan played the role of a *teacher 21% (3) superhero14% (2) mother 14% (2) agent 7% (1) vixen 7% (1) man 7% (1) housewife 7% (1) snob 7% (1) singer 7% (1) villain 7% (1)*
The hotel is situated in the heart of the old town, only a few minutes away from the *city courthouse14% (2) capital7% (1) highway7% (1) diner7% (1) empire state building 7% (1) court 7% (1) park 7% (1) store 7% (1) beach 7% (1) desert 7% (1)*
Justin and his sister both shared a lifelong interest in *sports 28% (4) baseball 7% (1) singing 7% (1) football 7% (1) reading 7% (1) swimming 7% (1) teaching 7% (1) psychology 7% (1) science 7% (1) cars 7% (1) pictures 7% (1)*
Tim asked his neighbor if he could borrow her *Lawnmower 28% (4) flour14% (2) telephone 14% (2) bike 7% (1) iron*

7% (1) sugar 7% (1) tools 7% (1) car 7% (1) bowl 7% (1)
A tall man wearing a dark suit is standing next to an old *man 28% (4) lady 21% (3) woman 21% (3) building 14% (2) house 7% (1) lamp 7% (1)*
Sue warned her sister not to play near the *fire 28% (4) street 21% (3) pool 14% (2) ants 7% (1) pond 7% (1) fireplace 7% (1) oven 7% (1) lake 7% (1)*
My parents taught the children in the family how to make *cookies 28%(4) pizza 14% (2) money 14%(2) quilts 7% (1) cakes 7% (1) clothes 7% (1) cornbread 7% (1) breakfast 7% (1) dinner 7% (1)*
Mr. Jones is afraid of counting money in front of the *customers 28%(4) strangers 14% (2) employees 7% (1) homeless 7% (1) workers 7% (1) window 7% (1) people 7% (1) bank 7% (1) TV 7% (1) store 7% (1)*
At the end of this corridor, there is a *door 28%(4) light 14% (2) hall 7% (1) room7% (1) classroom 7% (1light 7% (1) bathroom7% (1) sign 7% (1) restroom7% (1)) ally 7% (1) ? 7% (1)*
Before going to the movie theatre, the young people waited for each other at the *entrance 28%(4) restaurant 14%(2) busstop 7% (1) diner 7% (1) lobby 7% (1) frontdoor 7% (1) mall 7% (1) courtyard 7% (1) door 7% (1) park 7% (1)*
At the beginning of March, Luke and Beth took their children to the *zoo 28%(4) park 21%(3) movies 14%(2) playground 14%(2) museum 14%(2) play7%(1)*
The boy had to stand in front of the building in order to keep an eye on the *birds 28%(4) bike 14%(2) cops 7% (1)teacher 7% (1) crowd 7% (1) cars 7% (1) child 7% (1)customers 7% (1) dog 7% (1) card7% (1)*
The video camera showed that the store manager did not leave the building until *midnight 28%(4) 10pm 14%(2) night 7% (1)12 7% (1)closing 7% (1)11pm 7% (1)late 7% (1)10:30 7% (1) 9 7% (1) close7% (1)*
His father got very angry when John came home carrying that *dog 35%(5) cat 21%(3) gun 7% (1)sweater 7% (1)skateboard 7% (1)basketball 7% (1)detentionslip 7% (1)report 7% (1)*
Stephanie seems really happy that Lucy gave her that *bracelet ring 14%(2) necklace 14%(2) CD 7% (1)hat 7% (1) car 7% (1) present 7% (1) card7% (1)*
George decided it was the last time he would ever buy a cheap *watch 35%(5) car 21%(3) tire 7% (1) hat 7% (1) computer 7% (1) cologne 7% (1) laptop 7% (1) card 7%(1)*
His mother wondered why Billy was pretending to be a *girl 35%(5) superhero 14%(2) rabbit 7% (1) allien 7% (1) cowboy 7% (1)*

monster 7% (1) rockstar 7% (1) duck7% (1) astronaut 7% (1)
The woman followed him into the room and then stabbed him with a knife hidden in the *drawer 35%(5) desk 14%(2) pantry 7%(1) closet 7%(1) purse 7%(1) back 7%(1) pillow 7%(1) cupboard 7%(1) sofa 7%(1)*
Jim's girlfriend enjoys watching TV quietly in the *livingroom den 21% (3) bedroom 21%(3) room 7%(1) dark 7%(1)*
The boy complained that he couldn't eat his cake without *icing 42%(6) icecream 28%(4) milk 14%(2) sprinkles 7%(1) a fork 7%(1)*
After work, John always go to the same *restaurant 42%(6) bar 14%(2) diner 14%(2) park 7%(1) store 7%(1) spot 7%(1) place 7%(1)*
Alice had been studying Spanish for two years before she moved to *Spain 42%(6) Mexico 28%(4) Santigo 7%(1) Columbia 7%(1) New York 7%(1) Atlanta 7%(1)*
To cook this type of vegetable, you need to prepare some *water 42%(6) sauce 14%(2) butter 7%(1) soup 7%(1) spices 7%(1) oil 7%(1) rice 7%(1) ? 7%(1)*
Every Saturday afternoon, Scott and Bob help Frank's grandma to clean the *house 42%(6) garage 21%(3) kitchen 14%(2) attic 14%(2) car 7%(1)*
By the later afternoon, the sky had darkened and thunder rolled in the *sky 42%(6) clouds 14%(2) town 7%(1) air 7%(1) proximity 7%(1) city 7%(1) rain7%(1) ? 7%(1)*
When I was little, my parents would not allow me to eat any *candy 47%(7) sweets 21%(3) sugar 7%(1)desert 7%(1)cheese 7%(1) lollipops 7%(1)*
After some thought, Eric decided to paint a *picture 47%(7) wall 7%(1) door 7%(1) portrait 7%(1) duck 7%(1) mural 7%(1) woman 7%(1) house7%(1)*
Charlie is such a brave child that he is not afraid of the *dark 56%(8) water 7%(1) lion 7%(1) fire 7%(1) ride 7%(1) spiders 7%(1) mouse 7%(1)*
Susan and her friends decided to work on their project in the *library 63%(9) den 7%(1) meantime 7%(1) rain 7%(1) morning 7%(1) kitchen 7%(1)*
I headed north out of town. Twenty minutes later, we could look down towards the *city 63%(9) valley 14%(2) ocean 7%(1) river 7%(1) stateline 7%(1)*
When the man bumped into her, Alice dropped the *book(s) 70%(10) pen 7%(1) notebook 7%(1) papers 7%(1) bag7%(1)*

APPENDIX H: NON-CONSTRAINING COMPLETION NORM (NNS)

Number of respondents: 13 *target % (count)*

Chris cried all morning when he discovered there was no *game 8% (1) breakfast 8% (1) milk 8% (1) mom 8% (1) food 8% (1) toy 8% (1) trip 8% (1) chance 8% (1) candy 8% (1) covers 8% (1) electricity 8% (1) icecream 8% (1) gift 8% (1)*
My mother says that no one in my family likes *skating 8% (1) her 8% (1) durian 8% (1) golf 8% (1) sports 8% (1) cooking 8% (1) jelly beans 8% (1) rock 8% (1) Tony 8% (1) John 8% (1) smoking 8% (1) spicy food 8% (1) movie 8% (1)*
One of the highlights of the trip was to see the *canyon 8% (1) sea 8% (1) museum 8% (1) shark 8% (1) panda 8% (1) Great Wall 8% (1) wax museum 8% (1) church 8% (1) Cathedral 8% (1) bridge 8% (1) scenery 8% (1) sunrise 8% (1) coral 8% (1)*
These beautiful photographs were found to belong to the *bookstore 8% (1) man 8% (1) grandparents 8% (1) elder 8% (1) city 8% (1) artist 8% (1) priest 8% (1) museum 8% (1) boy 8% (1) government 8% (1) princess 8% (1) school 8% (1) women 8% (1)*
On the right side of the highway, they saw a big *store 8% (1) tree 8% (1) truck 8% (1) cow 8% (1) dog 8% (1) statue 8% (1) bear 8% (1) billboard 8% (1) rat 8% (1) museum 8% (1) truck 8% (1) cat 8% (1) guide board 8% (1)*
Susan and her friends decided to work on their project in the *evening 15% (2) garage 8% (1) classroom 8% (1) living room 8% (1) morning 8% (1) library 8% (1) warehouse 8% (1) sun 8% (1) hotel 8% (1) fall 8% (1) protection 8% (1) room 8% (1)*
Tim asked his neighbor if he could borrow her *bike 15% (2) mower 15% (2) chair/s 15% (2) hammer 8% (1) ladder 8% (1) shovel 8% (1) table 8% (1) hair drier 8% (1) car 8% (1) kit 8% (1)*
When Albert woke up the next morning, his father handed him a *newspaper 15% (2) present 8% (1) cake 8% (1) watch 8% (1) Bible 8% (1) water 8% (1) bottle 8% (1) book 8% (1) present 8% (1) tissue 8% (1) key 8% (1) school bag 8% (1)*
His mother wondered why Billy was pretending to be a *liar 15% (2) student 8% (1) grownup 8% (1) guy 8% (1) coward 8% (1) superman 8% (1) cop 8% (1) goodboy 8% (1) policeman 8% (1) gay 8% (1) adult 8% (1) silly boy 8% (1)*
Sue warned her sister not to play near the *river 15% (2) sea 15% (2) fire 8% (1) lake 8% (1) railroad 8% (1) well 8% (1) fireplace 8% (1) TV 8% (1) street 8% (1) house 8% (1) dog 8% (1)*
Mrs. Black hoped that Sam and Dave could help her remove the *furniture 15% (2) trash 8% (1) sofa 8% (1) box 8% (1) bed 8% (1)*

bookcase 8% (1) picture 8% (1) stone 8% (1) dots 8% (1) garbage 8% (1) tree 8% (1) table 8% (1)
Charlie is such a brave child that he is not afraid of the *dog 15% (2) snake 15% (2) enemies 8% (1) tiger 8% (1) dark 8% (1) storms 8% (1) monster 8% (1) ghost 8% (1) lion 8% (1) guy 8% (1) housebreak 8% (1)*
On her way to campus this morning, Mary saw a *professor 15% (2) deer 15% (2) tree 8% (1) tiger 8% (1) monkey 8% (1) police car 8% (1) dog 8% (1) car 8% (1) mouse 8% (1) stranger 8% (1) professor 8% (1) accident 8% (1)*
At the end of this corridor, there is a *room 15% (2) table 15% (2) lamp 8% (1) posting 8% (1) door 8% (1) mirror 8% (1) painting 8% (1) WC 8% (1) desk 8% (1) classroom 8% (1) reading room 8% (1)*
Dr. Smith is a professor at Oxford University and he teaches *English 15% (2) literature 15% (2) physics 15% (2) mathematics 15% (2) science 8% (1) chemistry 8% (1) literature 8% (1) philosophy 8% (1) business 8% (1)*
In the upcoming new movie, Joan played the role of a *housewife 15% (2) girl 8% (1) musician 8% (1) hero 8% (1) princess 8% (1) detective 8% (1) singer 8% (1) policeman 8% (1) writer 8% (1) clown 8% (1) killer 8% (1) officer 8% (1)*
This is the only store in town where you can buy *vegetable 15% (2) food 15% (2) sugar 8% (1) meat 8% (1) sesame 8% (1) alcohol 8% (1) liquor 8% (1) Chinese food 8% (1) bicycles 8% (1) cars 8% (1) anything 8% (1)*
After some thought, Eric decided to paint a *house 15% (2) tree 8% (1) picture 8% (1) statue 8% (1) pottery 8% (1) wall 8% (1) elephant 8% (1) church 8% (1) sunflower 8% (1) desk 8% (1) boat 8% (1) paintings 8% (1)*
The hotel is situated in the heart of the old town, only a few minutes away from the *theater 15% (2) station 15% (2) museum 15% (2) house 8% (1) university 8% (1) cityhall 8% (1) mainstreet 8% (1) beach 8% (1) municipal house 8% (1) restaurant 8% (1)*
To prepare for today's dinner, mother bought some beef, fish, potato and *tomato 23% (3) onion 15% (2) eggs 8% (1) fruits 8% (1) pork 8% (1) lettuce 8% (1) cabbage 8% (1) green pepper 8% (1) cheese 8% (1) shrimp 8% (1)*
The little girl decided that her father must have really enjoyed the *movie 23% (3) game 15% (2) meal 8% (1) gathering 8% (1) party 8% (1) Olympics 8% (1) painting 8% (1) time 8% (1) work 8% (1) music 8% (1)*
The boy complained that he couldn't eat his cake without *fork 23% (3) milk 23% (3) water 15% (2) butter 8% (1) spoon 8% (1)*

icecream 8% (1) pray 8% (1) cheese 8% (1)
His father got very angry when John came home carrying that *cat 23% (3) bag 15% (2) dog 15% (2) skateboard 8% (1) backpack 8% (1) gun 8% (1) woman 8% (1) basin 8% (1) girl 8% (1)*
Stephanie seems really happy that Lucy gave her that *gift 23% (3) book 15% (2) earrings 8% (1) scarf 8% (1) ring 8% (1) necklace 8% (1) watch 8% (1) reward 8% (1) flower 8% (1) toy 8% (1)*
The only thing I didn't like about the house was the *kitchen 23% (3) window 23% (3) wall 8% (1) roof 8% (1) floorplan 8% (1) layout 8% (1) location 8% (1) noise 8% (1) color 8% (1)*
My parents taught the children in the family how to make *cake 23% (3) friends 23% (3) cookies 15% (2) breakfast 8% (1) dumpling 8% (1) order 8% (1) furniture 8% (1) boat 8% (1)*
Next Wednesday evening, Mr. and Mrs. Eastwood will dance in front of the *hall 23% (3) family 15% (2) audience 15% (2) students 8% (1) president 8% (1) crowd 8% (1) livingroom 8% (1) guests 8% (1) classmates 8% (1)*
Before going to the movie theatre, the young people waited for each other at the *station 23% (3) entrance 15% (2) gate 15% (2) lodgingroom 8% (1) door 8% (1) lobby 8% (1) stairs 8% (1) hall 8% (1) corner 8% (1)*
I headed north out of town. Twenty minutes later, we could look down towards the *river 23% (3) lake 15% (2) hill 15% (2) center 8% (1) bridge 8% (1) mountain 8% (1) farm 8% (1) town 8% (1) beach 8% (1)*
The boy had to stand in front of the building in order to keep an eye on the *dog 23% (3) store 8% (1) kids 8% (1) police 8% (1) car 8% (1) clock 8% (1) girl 8% (1) boy 8% (1) helicopter 8% (1) visitor 8% (1) man 8% (1)*
By the later afternoon, the sky had darkened and thunder rolled in the *sky 23% (3) air 15% (2) cloud 15% (2) village 8% (1) community 8% (1) forest 8% (1) castle 8% (1) area 8% (1) city 8% (1)*
When I was little, my parents would not allow me to eat any *candy 31% (4) cheese 8% (1) fat 8% (1) chocolate 8% (1) sweats 8% (1) meat 8% (1) banana 8% (1) sweetfood 8% (1) rice 8% (1) ? 8% (1)*
Mr. Jones is afraid of counting money in front of the *people 31% (4) stranger 23% (3) others 8% (1) public 8% (1) customers 8% (1) boss 8% (1) friends 8% (1) burglar 8% (1)*
To cook this type of vegetable, you need to prepare some *sauce 31% (4) ingredients 15% (2) salt 8% (1) water 8% (1) bakingsoda 8% (1) meat 8% (1) onion 8% (1) juice 8% (1) spices 8% (1)*
While cleaning the car, Liza found her mother's *key 31% (4) ring 23% (3) picture 8% (1) necklace 8% (1) earring 8% (1) watch 8% (1) visa 8% (1) hairpin 8% (1)*

At the beginning of March, Luke and Beth took their children to the *beach 31% (4) mountain 15% (2) lake 8% (1) garden 8% (1) daycare 8% (1) cruise 8% (1) school 8% (1) museum 8% (1) park 8% (1)*
The woman followed him into the room and then stabbed him with a knife hidden in the *bag 31% (4) pocket 15% (2) drawer 8% (1) sleeve 8% (1) coat 8% (1) handbag 8% (1) shoes 8% (1) boot 8% (1) hand 8% (1)*
Justin and his sister both shared a lifelong interest in *music 38% (5) reading 23% (3) hobbies 8% (1) biking 8% (1) literature 8% (1) swimming 8% (1) stamps 8% (1)*
George decided it was the last time he would ever buy a cheap *car 38% (5) shirt 15% (2) gift 8% (1) wine 8% (1) shoes 8% (1) pencil 8% (1) alarm 8% (1) ? 8% (1)*
A tall man wearing a dark suit is standing next to an old *lady 38% (5) man 31% (4) woman 15% (2) dog 8% (1)*
When the man bumped into her, Alice dropped the *book 38% (5) purse 15% (2) bag 8% (1) handbag 8% (1) dishes 8% (1) pen 8% (1) key 8% (1) box 8% (1)*
Once every four days, Sam and Dave go to the grocery store to buy some *food 38% (5) fruit 15% (2) groceries 8% (1) milk 8% (1) snacks 8% (1) chocolate 8% (1) cigarettes 8% (1) meat 8% (1)*
A few days ago, Jim attended a big dinner party with his *wife 38% (5) girlfriend 23% (3) friend 15% (2) classmates 8% (1) boyfriend 8% (1) sister 8% (1)*
Jim's girlfriend enjoys watching TV quietly in the *livingroom 38% (5) room 31% (4) bedroom 23% (3) couch 8% (1)*
The next day, his brother came again and brought him a *book 38% (5) pajamas 8% (1) jacket 8% (1) wallet 8% (1) car 8% (1) Wii 8% (1) wine 8% (1) bag 8% (1) gift 8% (1)*
Alice had been studying Spanish for two years before she moved to *Spain 46% (6) Mexico 15% (2) US 15% (2) Germany 8% (1) this country 8% (1) New York 8% (1)*
The video camera showed that the store manager did not leave the building until *midnight 46% (6) 5pm 15% (2) 8 8% (1) 9 8% (1) 10 8% (1) 11 8% (1) shooting 8% (1)*
Every Saturday afternoon, Scott and Bob help Frank's grandma to clean the *house 54% (7) kitchen 15% (2) yard 8% (1) backyard 8% (1) floor 8% (1) apartment 8% (1)*
After work, John always go to the same *bar 62% (8) restaurant 15% (2) place 15% (2) park 8% (1)*

APPENDIX I: CRITICAL MATERIALS FOR NON-CONSTRAINING CONTEXT

(Instance information from the Brown Corpus)

Lead-in sentences	Neutral	Instances	Incongruent	Instances
The little girl decided that her father must have really enjoyed the	party	216	level	213
Chris cried all morning when he discovered there was no	candy	16	orbit	16
Tim asked his neighbor if he could borrow her	bicycle	6	coffin	6
When Albert woke up the next morning, his father handed him a	book	193	road	197
My mother says that no one in my family likes	smoke(ing)	41	shift(ing)	41
One of the highlights of the trip was to see the	museum	32	gesture	32
The only thing I didn't like about the house was the	floor	158	paper	157
Sue warned her sister not to play near the	lake	54	item	54
My parents taught the children in the family how to make	breakfast	53	practices	53
Next Wednesday evening, Mr. and Mrs. Eastwood will dance in front of the	president	382	second	373
Mrs. Black hoped that Sam and Dave could help her remove the	sofa	6	goat	6
Mr. Jones is afraid of counting money in front of the	store	74	frame	74
These beautiful photographs were found to belong to the	woman	224	voice	226
To prepare for today's dinner, mother bought some beef, fish, potato and	shrimp	2	slang	2
On her way to campus this morning, Mary saw a	rabbit	11	sleeve	11
At the end of this corridor, there is a	lamp	18	tray	18
Before going to the movie theatre, the young people waited for each other at the	lobby	20	mercy	20
While cleaning the car, Liza found her mother's	necklace	3	boatman	3
On the right side of the highway, they saw a big	truck	57	uncle	57
Dr. Smith is a professor at Oxford University and he teaches	biology	7	breadth	7
In the upcoming new movie, Joan played the role of a	singer	10	thesis	10
At the beginning of March, Luke and Beth took their children to the	play	200	type	200
This is the only store in town where you can buy	alcohol	13	antenna	13
The hotel is situated in the heart of the old town, only a few minutes away from the	beach	61	ideal	61
The boy had to stand in front of the building in order to keep an eye on the	police	155	growth	155
His father got very angry when John came home carrying that	gun	118	eye	122

Stephanie seems really happy that Lucy gave her that	present	377	order	376
His mother wondered why Billy was pretending to be a	monster	6	cherry	6

APPENDIX J: CRITICAL MATERIALS USED IN PICTURE RECOGNITION

Scenery			
	DINNER	POSTOFFICE	BATHROOM
TARGETS TYPICAL ATYPICAL	SPOON STAMP	STAMP SPOON	TOOTHBRUSH BOOKCASE
DISTRACTORS	GLASS WINEBOTTLE PLATE FORK CHOPSTICK	ENVELOPES MAILBOX MAIL TRUCK SCALE BOXES	BATHTUB RAZOR HAIR DRYER TOILET TOOTHPASTE
	GYM	CONCERT	STREET
TARGETS TYPICAL ATYPICAL	SWIMMING SNOWMAN	PIANO TRUCK	TRUCK PIANO
DISTRACTORS	DUMBBELLS AEROBICS YOGA WEIGHTLIFTING STATIONARY BICYCLE	CONDUCTOR MUSIC STAND HARP VIOLIN HORN	STREET LIGHT FIRE HYDRANT STOP SIGN TRAFFIC LIGHTS SEDAN CAR
	CLASSROOM	ELECTRONICS	OFFICE
TARGETS TYPICAL ATYPICAL	CHALK LAMP	LAMP CHALK	BOOKCASE TOOTHBRUSH
DISTRACTORS	PROJECTOR DESK/CHAIR BLACKBOARD MICROPHONE WHITEBOARD	SOCKET SWITCH CORD BULB ELCTRONIC OUTLET	CLOCK FILE CABINET CHAIR DESK FILE TRAY
	WINTER	KITCHEN	HOSPITAL
TARGETS TYPICAL ATYPICAL	SNOWMAN SWIMMING	POT WHEELCHAIR	WHEELCHAIR POT
DISTRACTORS	SKIING SNOWING SLEIGHING ICE PLAYING IN SNOW	MICROWAVE STOVE COFFEEMAKER KETTLE REFRIGIRATOR	SLING CRUTCHES BLOOD- PRESSURE- METER STETHOSCOPE TABLETS

Categories			
	TOOL	FLOWER	VEGETABLE
TARGETS			
TYPICAL	HAMMER	SUNFLOWER	CARROT
ATYPICAL	SUNFLOWER	HAMMER	PLANE
DISTRACTORS	SAW	TULIP	CUCUMBER
	PLIERS	LILY	LETTUCE
	SCREWDRIVER	DAISY	EGGPLANT
	WRENCH	ROSE	OINION
	TAPE MEASURE	POINSETTIA	GREEN PEPPER
	WEAPON	SPORTS	CLOTHES
TARGETS			
TYPICAL	TANKER	BASKETBALL	SKIRT
ATYPICAL	APPLE	SKIRT	BASKETBALL
DISTRACTORS	CANNON	VOLLEYBALL	T-SHIRT
	GRENADE	BADMINGTON	SUIT
	DAGGER	SOCCER	PANTS
	RIFLE	TENNIS	BLOUSE
	FIGHTER PLANE	PINGPONG	SWEATER
	SEA ANIMAL	INSECT	BIRD
TARGETS			
TYPICAL	SHARK	BEE	PIGEON
ATYPICAL	BEE	SHARK	PEN
DISTRACTORS	LOBSTER	DRAGONFLY	PARROT
	FISH	LADYBUG	OWL
	OCTOPUS	ANT	PEACOCK
	DOLPHIN	BEETLE	HUMMINGBIRD
	STARFISH	GRASS HOPPER	SPARROW
	OFFICE TOOL	TRANSPORTATION	FRUIT
TARGETS			
TYPICAL	PEN	PLANE	APPLE
ATYPICAL	PIGEON	CARROT	TANKER
DISTRACTORS	STAPLER	BUS	WATERMELON
	PEN HOLDER	TRAIN	STRAWBERRY
	FAX MACHINE	MOTOCYCLE	ORANGE
	TAPE	BICYCLE	PEAR
	DISPENSER	CAR	CHERRY
	PAPER CLIP		