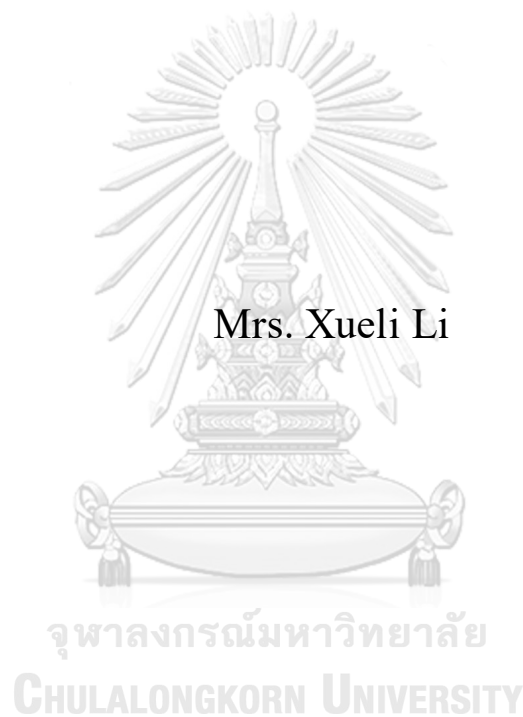


EFFECTS OF STRUCTURAL PRIMING AND LEXICAL  
RESIDUAL ACTIVATION ON THE ACQUISITION OF THE  
ENGLISH “NOUN + RELATIVE CLAUSE” BY L1 CHINESE  
LEARNERS



A Dissertation Submitted in Partial Fulfillment of the Requirements  
for the Degree of Doctor of Philosophy in English as an International  
Language

Inter-Department of English as an International Language

GRADUATE SCHOOL

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ผลจากการเตรียมการรับรู้ทางโครงสร้างและจากการกระตุ้นที่เหลือทางคำศัพท์ต่อการรับ  
โครงสร้าง "นาม + คุณานุประโยค" ในภาษาอังกฤษของผู้เรียนที่มีภาษาจีนเป็นภาษาที่หนึ่ง



วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาศิลปศาสตรดุษฎีบัณฑิต  
สาขาวิชาภาษาอังกฤษเป็นภาษานานาชาติ สหสาขาวิชาภาษาอังกฤษเป็นภาษานานาชาติ

บัณฑิตวิทยาลัย จุฬาลงกรณ์มหาวิทยาลัย

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By	Mrs. Xueli Li
Field of Study	English as an International Language
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ชื่อหัวข้อ : ผลจากการเตรียมการรับรู้ทางโครงสร้างและจากการกระตุ้นที่เหลือทางคำศัพท์ต่อการรับ โครงสร้าง "นาม +  
 คุณานุประโยค" ในภาษาอังกฤษของผู้เรียนที่มีภาษาจีนเป็นภาษาที่หนึ่ง. ( EFFECTS OF STRUCTURAL  
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 OF THE ENGLISH “NOUN + RELATIVE CLAUSE” BY L1 CHINESE  
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งานวิจัยนี้ศึกษาการรับโครงสร้างประโยค “คำนาม + คุณานุประโยค” ในภาษาอังกฤษของผู้เรียนที่มีภาษาจีนเป็นภาษาที่  
 หนึ่ง โดยใช้แนวคิดการเตรียมการรับรู้ทางโครงสร้าง (Structural Priming (SP)) (Bock, 1986; Bock, 1989;  
 Bock & Griffin, 2000) และการกระตุ้นที่เหลือทางคำศัพท์ (Lexical Residual Activation (LRA))  
 (Cleland, 2003; Levelt et al., 1999) ตามสมมติฐานของ SP ในกรณีที่โครงสร้างสำหรับการเตรียมการรับรู้ทางโครงสร้าง  
 และโครงสร้างประโยคเป้าหมายมีคำนาม หลักที่ต่างกัน เมื่อผู้เรียนที่มีภาษาจีนเป็นภาษาที่หนึ่งได้รับการเตรียมการรับรู้ทางโครงสร้าง  
 “คำนาม + คุณานุประโยค” ผู้เรียนจะผลิต โครงสร้างประโยค “คำนาม + คุณานุประโยค” มากกว่าตอนที่ได้รับการเตรียมการรับรู้ทาง  
 โครงสร้างภาษาอังกฤษในโครงสร้าง “คำคุณศัพท์ + คำนาม” และผลจากการเตรียมการรับรู้ทางโครงสร้างที่พบจะแตกต่างอย่างมี  
 นัยสำคัญ โดยตามแนวคิดของ SP และ LRA เมื่อโครงสร้าง สำหรับการเตรียมการรับรู้และประโยคเป้าหมายมีคำนามหลักเดียวกัน ผล  
 ที่ได้จากการเตรียมการรับรู้ทางโครงสร้างจะเพิ่มมากขึ้น

ผู้เข้าร่วมวิจัยประกอบด้วยนักศึกษาระดับปีที่ 1 ชาวจีนซึ่งเป็นผู้ที่ไม่ได้เรียนภาษาอังกฤษเป็นสาขาวิชาเอกจำนวน 90 คน จาก  
 มหาวิทยาลัยการเงินและเศรษฐศาสตร์กุ้ยโจว และผู้ที่มีภาษาอังกฤษเป็นภาษาแม่จำนวน 10 คน โดยใช้แบบทดสอบการบรรยายภาพใน  
 การ เก็บข้อมูลวิจัย ผลการวิจัยพบว่า หลังจากผู้เรียนได้รับการเตรียมการรับรู้ทางโครงสร้างภาษาอังกฤษ “คำนาม + คุณานุประโยค”  
 ผู้เรียนผลิตโครงสร้างประโยค “คำนาม + คุณานุประโยค” มากกว่าโครงสร้างประโยค “คำคุณศัพท์ + คำนาม” เมื่อโครงสร้างสำหรับ  
 การเตรียมการ รับรู้และโครงสร้างประโยคเป้าหมายมีคำนามหลักแตกต่างกัน ผลการวิจัยนี้แสดงให้เห็นว่าการเตรียมการรับรู้ทางโครงสร้าง  
 ส่งผลต่อการผลิตคุณานุประโยคอย่างมีนัยสำคัญ ( $p < 0.05$ ) ในกรณีที่โครงสร้างสำหรับการเตรียมการรับรู้และโครงสร้างประโยค  
 เป้าหมายมีคำนามหลักเดียวกัน ผลที่ได้จากการเตรียมการรับรู้ทางโครงสร้างเพิ่มขึ้นอย่างมีนัยสำคัญ โดยผลการวิจัยนี้มีความสอดคล้องกับ  
 สมมติฐาน

งานวิจัยนี้ช่วยเพิ่มความเข้าใจในการรับภาษาที่สอง โดยพบว่าการเตรียมการรับรู้ทางโครงสร้างและการกระตุ้นที่เหลือทาง  
 คำศัพท์ ช่วยเพิ่มประสิทธิภาพการรับภาษาอังกฤษในโครงสร้างประโยค “คำนาม + คุณานุประโยค” ในผู้เรียนภาษาอังกฤษที่มีภาษาจีน  
 เป็นภาษาที่หนึ่งได้ ถึงแม้ว่าโครงสร้างนี้จะไม่ปรากฏในภาษาที่หนึ่งของผู้เรียนก็ตาม นัยยะ ในด้านการเรียนการสอนของงานวิจัยนี้คือการใช้  
 วิธีการเตรียมการรับรู้ทางโครงสร้างและการกระตุ้นที่เหลือทางคำศัพท์ที่จะช่วยให้การรับโครงสร้างของภาษาที่สองมีประสิทธิภาพเพิ่มขึ้น

สาขาวิชา ภาษาอังกฤษเป็นภาษานานาชาติ  
 ปีการศึกษา 2565

ลายมือชื่อนิติ .....  
 ลายมือชื่อ อ.ที่ปรึกษาหลัก .....

# # 6087807220 : MAJOR ENGLISH AS AN INTERNATIONAL LANGUAGE

KEYWORD: Structural Priming, Lexical Residual Activation, English Noun + Relative Clause, L1 Chinese Learners

Xueli Li : EFFECTS OF STRUCTURAL PRIMING AND LEXICAL RESIDUAL ACTIVATION ON THE ACQUISITION OF THE ENGLISH “NOUN + RELATIVE CLAUSE” BY L1 CHINESE LEARNERS. Advisor: Assoc. Prof. NATTAMA PONGPAIROJ, Ph.D.

This study investigated L1 Chinese learners’ acquisition of the English “Noun + Relative Clause” based on Structural Priming (SP) (Bock, 1986; Bock, 1989; Bock & Griffin, 2000) and Lexical Residual Activation (LRA) (Cleland, 2003; Levelt et al., 1999). It was hypothesized that, based on SP, when L1 Chinese learners were primed by the English “Noun + Relative Clause”, when the priming and the target structures shared different head nouns, they would produce more “Noun + Relative Clause” than when they were primed by the English “Adj + Noun”, and the priming effect was significant. Also, based on SP and LRA, when the priming and the target structures shared the same head noun, the increasing priming effect would be enhanced.

The participants were 90 first year non-English major Chinese students attending Guizhou University of Finance and Economics, and 10 native English speakers. A picture description task was used to elicit data. The results showed, that after having been primed by the English “Noun + Relative Clause” when the priming and target structure shared different head nouns, the L1 Chinese learners produced more “Noun + Relative Clause” than “Adj + Noun”, and the priming effect was significant ( $p < 0.05$ ). When the priming and the target structures shared the same head noun, the increasing priming effect was enhanced, and the enhancement was significant ( $p < 0.05$ ). The hypotheses were therefore confirmed.

The study contributed to Second Language Acquisition in that SP and LRA would facilitate L1 Chinese learners’ acquisition of English “Noun + Relative Clause”, although this structure is non-existent in the learners’ L1. The study also gave pedagogical implications in that application of SP and LRA would facilitate as well as enhance the acquisition of L2 structures.

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Field of Study: English as an International Language      Student's Signature .....

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Xueli Li

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# CHAPTER 1

## INTRODUCTION

### 1.1 Background of the study

There is a ubiquitous phenomenon that people prefer to reuse sentence structures that they have heard or used previously, and we call this structural priming (Bock, 1986; Bock, 1989). The sentence appearing previously is called the priming sentence, and the latter sentence is called the target sentence. For instance, after hearing “The car’s windshield was struck by a brick”, the listener would likely produce “The boy was awakened by a noisy alarm” in a picture description task.(Bock & Griffin, 2000). The former sentence is the priming sentence, and the latter sentence is the target sentence.

In the past decades, structural priming has been widely scrutinized. Such studies concerning structural priming mainly focused on four directions: structural priming and mental representation of syntactic knowledge (Bock, 1986; Bock, 1989; Saffran & Martin, 1997), structural priming and language comprehension (Branigan et al., 2005; Traxler, 2008a, 2008b), structural priming and language production (Bock et al., 1992; Chang et al., 2003; Griffin & Weinstein-Tull, 2003), and structural priming and different populations (Brooks & Tomasello, 1999; Huttenlocher et al., 2004; Meijer & Fox Tree, 2003; Schoonbaert et al., 2007). The results of the previous studies showed that structural priming is independent of the event roles (Bock, 1986; Bock et al., 1992), function words (Levelt & Kelter, 1982), closed class morphology(Pickering & Branigan, 1998; Saffran & Martin, 1997), metrical factors(Bock & Loebell, 1990), and modality (writing or speaking) (Cleland &

Pickering, 2006). Thus, structural priming, as its name suggests, relies on sentence structure. To the best of my knowledge, most of these studies employed dative structures (Prepositional Dative and Double-Object Dative) and transitive structures (Passive and Active), only a few studies focused on noun phrases (“Adj + Noun” and “Noun + Relative Clause”)(Sarah Bernolet et al., 2007; Cleland & Pickering, 2003; Liesbeth M van Beijsterveldt & Janet G van Hell, 2009). The participants of the previous studies that focused on “Adj + Noun” and “Noun + Relative Clause” structures were either native English speakers or native Dutch speakers, and both languages included “Adj + Noun” and “Noun + Relative Clause” structures. However, since Chinese is a left branch language, there are only “Adj + Noun” and “Relative Clause + Noun” structures.

The previous studies also found that if the priming sentence and the target sentence shared the same verb, the priming effect was enhanced (Branigan et al., 2000; Cleland & Pickering, 2006; Corley & Scheepers, 2002; Pickering & Branigan, 1998). This kind of effect was called lexical boost, and it is because of lexical residual activation (Pickering & Ferreira, 2008). To the best of my knowledge, there has been only few studies focused on repetition of noun between the priming structure and the target (Cleland & Pickering, 2003; Liesbeth M van Beijsterveldt & Janet G van Hell, 2009), and both studies were conducted in the native English speakers and native Dutch speakers context, there has been no study focused on the context of L1 Chinese speakers’ acquisition of “Noun + Relative Clause” .

To sum up so far, previous studies concerning structural priming just focused on the dative structures (Double-Object-Dative and Prepositional Dative) and transitive

structures (Active and Passive). Only few studies concerned structural priming and noun phrases (“Adj + Noun” and “Noun + Relative Clause”), and there has been no study conducted in the context of L1 Chinese speakers’ acquisition of “Noun + Relative Clause” structure. Considering lexical boost effect, previous studies merely concentrated on the verbs, only few studies focused on the nouns in noun phrases (Cleland & Pickering, 2003). To the best of my knowledge, there has been no such kind of research conducted in the L1 Chinese learners’ context. Thus, the present study investigated the effect of structural priming on the acquisition of English “Noun + Relative Clause” by L1 Chinese learners, and the effect of structural priming when the priming and target shared the same noun based on lexical residual activation.

### **1.2 Research questions**

- (1) What is the effect of structural priming on the acquisition of the English “Noun + Relative Clause” structure by L1 Chinese learners?
- (2) What is the effect of structural priming on the acquisition of the English “Noun + Relative Clause” structure by L1 Chinese learners when the priming structure and the target share the same noun based on lexical residual activation?

### **1.3 Objectives of the study**

- (1) To investigate the effect of structural priming on the acquisition of the English “Noun + Relative Clause” structure by L1 Chinese learners.
- (2) To investigate the effect of structural priming on the acquisition of the English “Noun + Relative Clause” by L1 Chinese learners when the priming structure and the target share the same noun based on lexical residual activation.

#### **1.4 Statement of hypotheses**

Hypothesis 1:

L1 Chinese learners produce more “Noun + Relative Clause” phrases when they are primed by the “Noun + Relative Clause” structure, and the priming effect is significant.

Hypothesis 2:

Based on lexical residual activation, when the priming “Noun + Relative Clause” and the target share the same noun, L1 Chinese learners produce more “Noun + Relative Clause” phrases, and the priming effect is enhanced.

#### **1.5 Scope of the study**

- (1) The present study focuses mainly on the English defining “Noun + Relative Clause” structure, and the relative clause is introduced by “who”, “that”, and “which”.
- (2) The participants of the present study were 90 first-year non-English major students attending Guizhou University of Finance and Economics, China, and 10 native English speakers.
- (3) The theories that applied in the study were structural priming and lexical residual activation, which were defined in section 1.6 (definition of terms) and elaborated in detail in Chapter 2 (Literature Review).
- (4) The task applied in the present study to elicit data was the picture description task, which was described in detail in Chapter 3 (Methodology).

#### **1.6 Definition of terms**

- (1) Structural priming ----Structural priming refers to the tendency by speakers to reuse the same structural pattern previously encountered, even if an alternate structure

is available (Bock, 1986; Bock, 1989). In other words, speakers tend to use the structure in a sentence they have heard recently, although another sentence structure that can express the same meaning may be available. For instance, if the prime sentence is “The car’s windshield was struck by a brick”, the listener would like to produce “The boy was awakened by a noisy alarm” in a picture description task after the priming sentence (Bock & Griffin, 2000).

(2) Lexical residual activation---- Lexical residual activation means that once a word is used, then the properties and structures linked to the word are activated. In the following language production process, if the same word occurs again, then the residual of the activated word would activate the same properties and structures linked to the word. Speakers would probably reuse the same structure that linked to the word as the previous sentence. It can enhance structural priming effect, but it is not necessary for structural priming, since if there is no repeated word, structural priming still occurs.(Pickering & Ferreira, 2008)

(3) Noun + Relative Clause---- It refers to the noun phrase which is defined by a relative clause. The relative clause begins with relative pronouns, like “who”, “which”, and “that”, etc.

(4) L1 Chinese Learners----It refers to L1 Mandarin Chinese speaking students who are learning English as a foreign language. At the moment of the experiment, they were studying in the Guizhou University of Finance and Economics, Guiyang, Guizhou, China. The English proficiency level for all the students is intermediate.

(5) Place holder sentence---- In the field of psycholinguistics, this refers to a sentence that appears between two experimental trials, and its function is to segment the two

experimental trials, so that the impacts between the experimental trials could be eliminated or diminished. It is also called a filler sentence.

(6) Place holder picture----In the field of psycholinguistics, this refers to a picture that appears between two experimental trials, and its function is to segment the two experimental trials, so that the impacts between the experimental trials could be eliminated or diminished. It is also called a filler picture.

### **1.7 Research procedure**

Ninety first year non-English major intermediate English proficiency level students were selected according to the Oxford Quick Placement Test from Guizhou University of Finance and Economics, China. They were divided into three parallel groups, i.e., Group One, Group Two, and Group Three. Ten Native English speakers who were working in Bangkok Thailand at the time of the experiment, were recruited. They formed Group Four.

The experiment investigated the effect of structural priming on the acquisition of English “Noun + Relative Clause” structure by L1 Chinese learners, and the effect of structural priming on the acquisition of English “Noun + Relative Clause” structure by L1 Chinese learners when the priming and the target sentence share the same head noun based on lexical residual activation. A Latin Square Design was used, and a picture description task was employed to elicit data. The participants’ production was collected and counted, and the results were analyzed with ANOVA.

### **1.8 Significance of the study**

The present study sheds light to the effect of structural priming on the acquisition of the English “Noun + Relative Clause” structure by L1 Chinese learners, whose native



language does not possess this structure. It can also benefit Chinese people's acquisition of English relative clauses. Moreover, this study also has some pedagogical implications. That is, utilizing SP and LRA in teaching can enhance the acquisition of sentence and phrase structures in the target language. These findings may apply to other English constructions, such as "Passive Construction", "Dative Construction", and "Accusative Verb Construction". Inclusion of SP and LRA in teaching materials can facilitate learners' acquisition of the targeted linguistic features. For example, teachers could design practice materials for reading or writing that provide example sentences of a structure and then give students a picture or some words to use in creating a new sentence. Additionally, they could design example sentences and target sentences including the same content words. Application of SP and LRA could facilitate the students' acquisition of the targeted constructions.

## **CHAPTER 2**

### **LITERATURE REVIEW**

The present study explores the effect of structural priming and lexical residual activation on the acquisition of English “Noun + Relative Clause” by L1 Chinese learners. It is very important to review the literature concerning the theories adopted in the present study, English “Noun + Relative Clause” and Chinese “Relative Clause + Noun”, as well as previous studies concerning structural priming and L1 Chinese learners’ acquisition of English “Noun + Relative Clause”. Therefore, this chapter includes the following sections: 2.1 explains related theories adopted in the present study; 2.2 gives information about English “Noun + Relative Clause” and Chinese “Relative Clause + N”, so as to compare these two different structures in the two different languages; 2.3 displays previous studies concerning structural priming and L1 Chinese learners’ acquisition of English “Noun + Relative Clause” to exhibit the body of knowledge in the related area, and to show that L1 Chinese learners have problems with the English “Noun + Relative Clause”.

#### **2.1 Related theories**

Two theories are included in this section: 2.1.1 structural priming, and 2.1.2 Lexical residual activation.

##### **2.1.1 Structural priming**

Two parts were included: 2.1.1.1 Structural priming and the abstract structure; 2.1.1.2 short-term memory effect.

###### **2.1.1.1 Structural priming and the abstract structure**

Structural priming is dependent with abstract structure, and independent of event roles, function words, metrical factors, closed morphology and modality (Bock, 1986;

Bock, 1989; Bock & Loebell, 1990; Cleland & Pickering, 2006; Pickering & Branigan, 1998),

Bock (1986) conducted experiments to explore syntactic persistence using a picture description task. Experiment one indicated that when the priming sentences were prepositional dative sentences, the participants were more likely to produce prepositional dative sentences rather than double-object dative sentences. When the priming sentences were double-object dative sentences, the production of double-object dative sentences would be greater. However, in active and passive sentences, the participants seemed to prefer to use active sentences when the agent was human, and passive sentences when the agent was non-human, irrespective of whether the priming sentence was in the active or passive voice. To know whether the feature of the agent played an important role in syntactic repetition, a second experiment was conducted. Experiment two showed that the participants preferred to produce passive sentences after passive priming, and active sentences after active priming. However, the effect of the agent persisted but was weaker than that for syntactic structure persistence. Since the effect of the agent still existed in experiment two, although weaker than in experiment one, experiment three was conducted with the purpose of making sure whether the agent played a role in syntactic persistence. The results indicated that the production of passive sentences increased for both non-human and human agent events. These three experiments indicated that the effects of priming were specific to the features of the sentence form, but independent of the event role (Bock, 1986).

Bock (1989) conducted two experiments with a syntactic priming procedure. The results showed that the participants were inclined to use the same structure as in the priming sentences and changing the function words had no impact on the participants' production. These results indicate that the function words are not the inherent constituents of English sentence structure, and in priming, what is repeated is the structure of the sentence, not the function words, which means that structural priming is structurally based, and it is independent of the function words. (Bock, 1989).

Bock & Loebell (1990) conducted research to explore whether sentence frames were purely structural configurations or if they were affected by conceptual and metrical factors (*e.g., rhyme, number of syllables, and lexically stress patterns*). A picture depiction paradigm was employed but disguised as a memory test. Three sentence structures were used, a prepositional object dative, a locative structure, and a double object dative. In each set, all the three sentence structures were included, and they described the same event. The results showed that changing of the event had no impact on repetition of the prime sentence structure within the target sentences. Moreover, the structural frames were independent of the metrical and conceptual factors, and they were independent syntactic representations (Bock & Loebell, 1990).

Pickering & Branigan (1998) conducted research to investigate structural priming. A written sentence completion task was employed in the experiments, and the sentences were prepositional object dative (PO) and double object dative (DO) structures. The results indicate that structural priming could occur if the priming and the target sentence did not share the same verb, but, if the verb was repeated the effect

of structural priming was enhanced. They also found that structural priming is independent of tense, aspect or number of the verbs (Pickering & Branigan, 1998).

Cleland and Pickering (2006) explored whether writing and speaking employed the same syntactic representations via a sentence completion task. The subjects were students attending the University of Glasgow, the materials were sets of prepositional-object-inducing prime sentences, double-object-inducing prime sentences, and target fragments. The effect of structural priming within modality and between modality was assessed. Considering priming between modality, written priming and the spoken target, and spoken priming and the written target were included. Regarding priming within modality, spoken priming and the spoken target, and written priming and the written target were included. The results revealed that there was structural priming both within and between modality, but there was no significant difference between the priming effects. These results indicate that structural priming is independent of modality (Cleland & Pickering, 2006).

To sum up, structural priming is independent of event roles, function words, metrical factors, closed morphology, and modality, and it is dependent with abstract structures.

#### **2.1.1.2 Short-term memory effect**

Memory is important for language acquisition and language production. Theoretically, we can articulate an endless sentence. But, in practice, we just produce limited length sentences. That is because in spontaneous speech, short-term memory limits the sentences we produce. If we speak a very long sentence, we may forget what we have said at the very beginning. Our interlocutor may also not remember

what we have said. Because of short-term memory effect, we can search what we or our interlocutor have said.

Priming involves the same tracing process as for memory search (Collins & Loftus, 1975). According to De Smedt (1990), structural priming is due to the short-term memory effect. During the process of structural priming, the short-term memory increases activation of syntactic categories (nouns, verbs, etc.) and sentence fragments (De Smedt, 1990), similar to lexical priming (Collins & Loftus, 1975). This short-term activation occurs in a memory point or representation. For the subsequently information to be processed, the short-term activation moves quickly from the current point to the next (Dell et al., 1997). For example, for the serial order of a sentence, the activation must activate the present, de-activate the past, and prepare to activate the future (Dell et al., 1997). So, this activation process lasts for a very short timescale. See Figure 1 for an example.

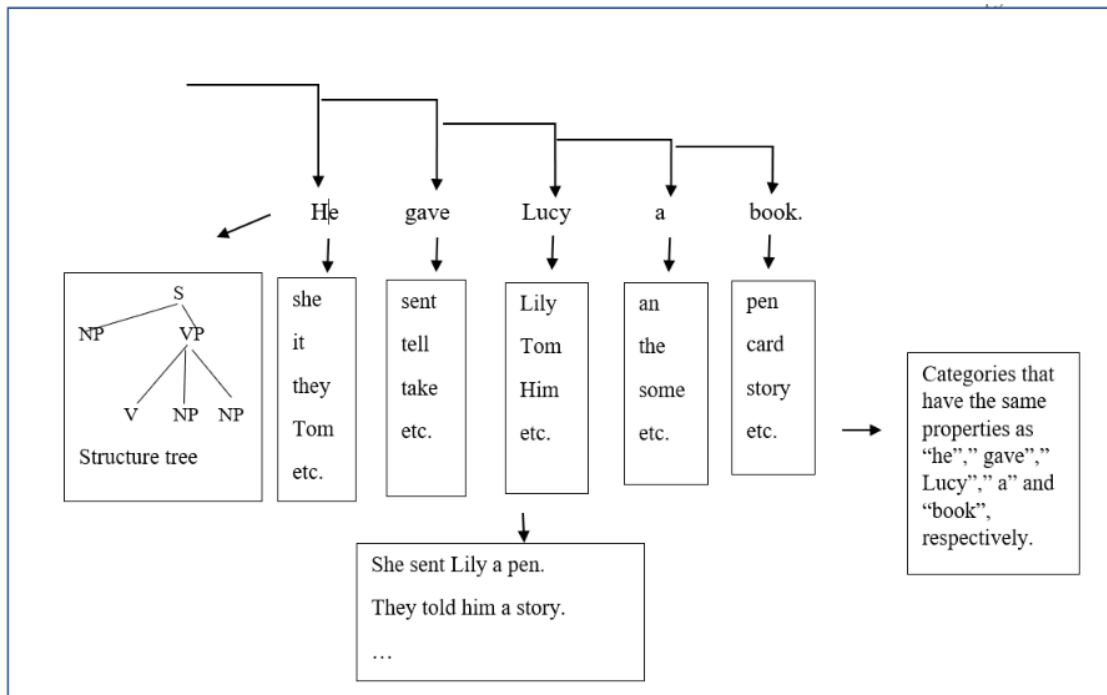


Figure 1 Example of the process of structural priming based on the short-term memory effect

Figure 1 shows an example of the process of structural priming based on the short-term memory effect. We see that, when people hear or articulate the sentence “he gave Lucy a book”, each word and the structure tree of the sentence were increased activation. This means that, for each word, the category that has the same properties as it, is activated. And for the whole sentence, the abstract structure tree or the fragment of the structure tree is activated. During this process, after “he” is activated, the activation moves quickly to “gave”, and “he” is deactivated, “Lucy” is preparing to be activated, and so on. Then, because of the short-term memory effect, people are more likely to produce sentences such as “she sent Lily a pen” or “They told him a story”, etc.

Levelt and Kelter (1982) supported the above viewpoint. They investigated the match between questions and answers and found that after the question “At what time

do you close?”, the shopkeeper was much more likely to answer, “at seven”. When the question was “What time do you close?”, the answer was more likely to be “seven”. But this matching declined very quickly after even a short interval. Levelt and Kelter also assessed the relationship between the participants’ explicit memory<sup>1</sup> of the preposition and the sentence, and the match between the question and the answer. They found that there was a strong relationship between them. The results suggest that memorization of the words and sentence structure determined the match between the questions and answers (Levelt & Kelter, 1982).

Branigan et al. (1999) conducted research to investigate the time course of structural priming. Fifty-four students attending the University of Glasgow participated in the experiment. The participants were required to do a written sentence completion task by completing sentence fragments that allowed two completions, either Double-Object-Dative or Prepositional-Dative. The results showed that the participants were more likely to complete the sentence with a Double-Object-Dative and Prepositional-Dative if the prior priming sentence is a Double-Object-Dative and Prepositional-Dative, respectively. However, this tendency declined rapidly after even one interval (Branigan et al., 1999). In line with Levelt and Kelter (1982), the results indicate that structural priming is due to the short-term memory effect.

### **2.1.2 Lexical residual activation**

Levelt et al. (1999) reported the theory of lexical access in speech production, and the process is illustrated in Figure 2:

---

<sup>1</sup> Explicit memory refers to the conscious, intentional recollection of factual information, previous experiences, and concepts. (Ullman, 2004)



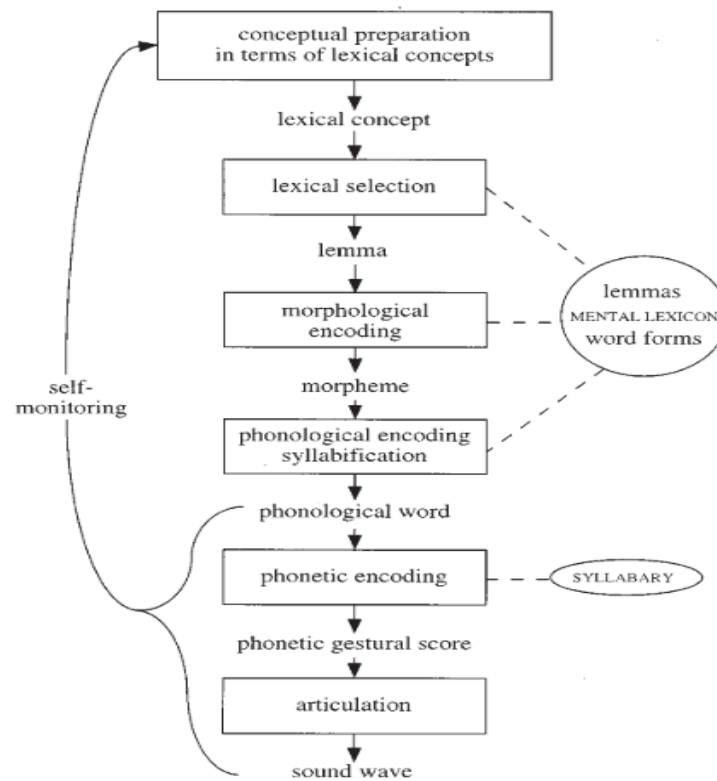


Figure 2 Lexical access in production (Levelt et al., 1999, p. 3)

The process involves several stages, from lexical concept to articulation. The general procedure is that speaker prepares a lexical concept, then selects an appropriate lexicon, followed by morphological encoding, phonological encoding, and phonetic encoding, and finally, articulation. The last three stages are accompanied by self-monitoring. If there are some errors, the same process recycles (Levelt et al., 1999). What should be mentioned is the lexical selection stage. According to Levelt et al. (1999), after a lexical concept is formed, a retrieval of lemma is concerned to express the lexical concept. As shown in the network in Figure 3.

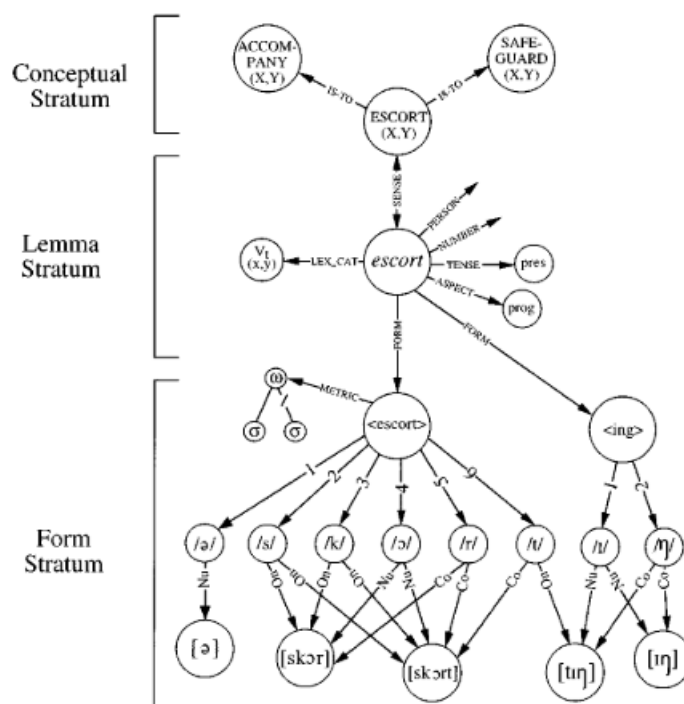


Figure 3 Example of the lexical network during lexical access (Levelt et al., 1999, p. 4)

Figure 3 is an example of the lexical network during lexical access, showing a feed-forward process. Nodes in the conceptual stratum represent lexical concepts. Nodes in the lemma stratum represent syntactic words or lemmas and their syntactic properties. Nodes in the form stratum represent morphemes and their phonemic segments. Also at this level there are syllable nodes (Levelt et al., 1999). The Conceptual Stratum activates the Lemma Stratum, and then activates the Form Stratum. The example here is “escort”, there are two lexical concepts----- “safeguard” and “accompany”, and two syntactic properties “X” and “Y”. These concepts combine as a node; then activates the selection of an appropriate lemma in the Lemma Stratum. In the Lemma Stratum stage, “escort” is linked to different properties, such as tense, number, person, aspects, and so forth. When it is activated, all these properties are also activated. This means that syntactic encoding occurs at the Lemma

Stratum stage. Then the Form Stratum is activated by the Lemma Stratum (Levelt et al., 1999).

Pickering and Branigan (1998) extended Levelt et al. (1999)'s theory by claiming that lemma is linked to the combinatorial nodes, which could be activated when the articulator uses syntactic structures (Pickering & Branigan, 1998; Pickering & Ferreira, 2008). It means that syntactic encoding happens at the combinatorial node level. See details in Figure 4:

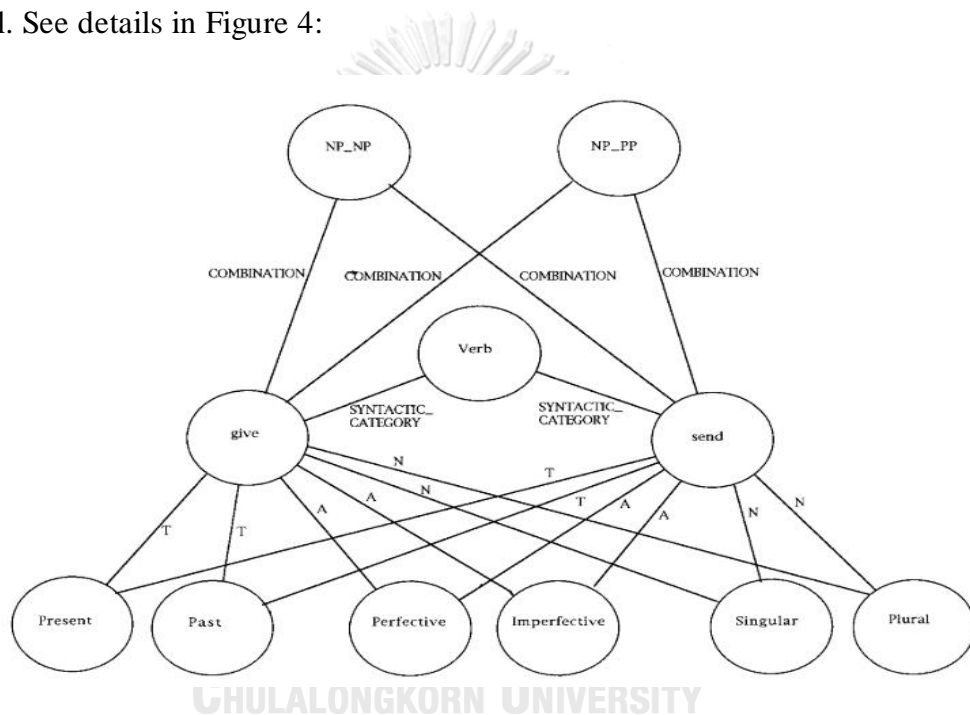


Figure 4 Example of verb syntactic information and combinatorial nodes (Pickering & Branigan, 1998, p. 635) T,A,N means tense, aspect, and number.

As Figure 4 shows, when speakers use the Double-Object-Dative structure, the combinational node NP-NP is activated, and NP-PP is activated when the Prepositional-Dative construction is used. “Give” and “send” are lemmas in the Lemma Stratum, and both link to NP-NP and NP-PP nodes. For example, when the articulator speaks “she took some fruits to her boss”, the NP-PP node is activated, and

then both “give” and “send” are activated, as well as the tense, number, and aspects linked to them.

According to Pickering and Branigan (1998), the repetition of content words can facilitate structural priming due to the residual activation of combinatorial and lemma nodes, as well as the links between them (Pickering & Ferreira, 2008). More specifically, when the priming sentence and the target sentence do not share the same verb, the enhanced priming effect derives from the residual activation of the combinatorial nodes, as in the NP-PP NP-NP structure. When the priming sentence and the target sentence have the same verb, the enhanced priming effect results from residual activation of the lemma node, and the links between the lemma node and combinatorial node, which is lexical residual activation, as example shown in Figure 5:

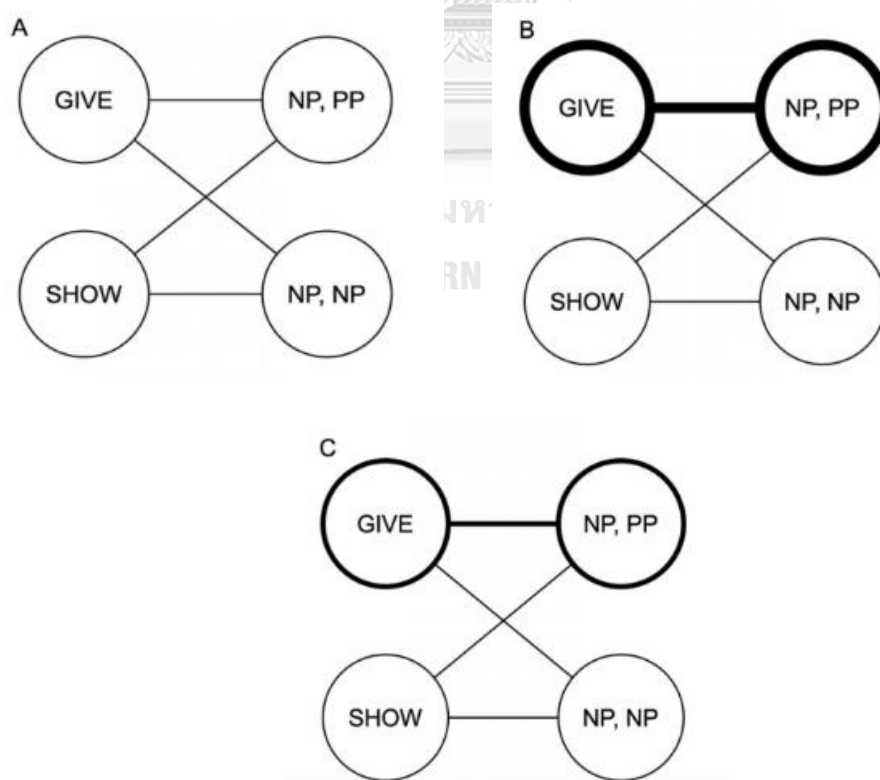


Figure 5 Example of lexical residual activation (Pickering & Ferreira, 2008, p. 438)

Figure 5 is an example of lexical residual activation. A shows the status before activation, B is the status when “give” and NP-PP are activated, and C is the status after the activation. We can see that before the activation (A), the links between them are the same. During the activation (B), both “give” and NP-PP, as well as the link between them are strengthened. After the activation (C), the nodes and links weaker, but still exist, which is residual activation. With respect to “show”, since it has never been activated, the links between it and NP-NP and NP-PP are not activated. Then, in the following process, if the language producers encounter the word “give”, the residual activation of “give + NP-PP” would make them prone to reuse the same structure.

To sum up, there are several steps for language production, among which lexical selection is closely related to the function of enhancing structural priming effect. According to Levelt et al. (1999), after a lexical concept is formed, a retrieval of lemma is concerned to express the lexical concept, since the lexical lemma stratum is linked to the grammatical properties, such as tense, person number, etc. Then the form stratum is activated by the lemma stratum. Pickering and Branigan (1998) extended the view-point proposed by Levelt et al. (1999), claimed that lemma is linked to the combinatorial nodes, which could be activated when the articulator uses syntactic structure. The repetition of content words can facilitate structural priming due to the residual activation of combinatorial and lemma nodes, and the links between them. More specifically, when the priming sentence and target sentence share the same content word, the enhanced priming effect results from residual activation of the lemma node, and the links between the lemma node and the combinatorial node, which is lexical residual activation.

## 2.2 Relative Clauses (RC) in Chinese and English

There are many types of definitions of Relative Clause (RC), the definition by Lyda (1976:73) is adopted here as the working definition. According to Lyda, a relative clause (RC) is a subordinate or dependent clause which modifies a noun, a noun phrases (NP), or a pronoun. In Chinese, relative clauses precede the head noun or NP they modified and introduced by the relativizer *de*. However, in English, relative clauses follow the head noun or NP they modified, and introduced by the relative pronoun, such as “who, that, which, where”, etc. In this section, 2.2.1 is about English relative clauses, 2.2.2 is focused on Chinese relative clauses.

### 2.2.1 English relative clauses

According to Murcia-Celce and Diane (1999), English is a right-branch orientation language (RBOL), the relative clause is located after the head noun or noun phrases (Murcia-Celce & Diane, 1999). Examples are as follows:

Table 1 Example of English relative clauses

Items	Relative pronouns	Examples
1	that	The book <b>that we are looking at</b> is written by a famous writer.
2	which	My grandchildren stayed with me for one month during <b>which time they ate all the nuts I had</b> .
3	whom	I have many friends to <b>whom I am going to send gifts</b> .
4	whose	He is the person <b>whose suggestions she would listen to</b> .

5	who	The young lady <b>who is a music teacher</b> is now dancing with my elder brother.
6	when	I shall never forget the days <b>when I studied in Thailand.</b>
7	why	Could you tell me the reason <b>why she laughed at the kids?</b>
8	where	They have gone to the districts <b>where the Chinese people live.</b>

In the following sections, 2.2.1.1 mainly focuses on the relative markers and their functions in English relative clauses; 2.2.1.2 is about the grammatical functions of English relative clauses; 2.2.1.3 pays more attention to defining and non-defining English relative clauses.

### 2.2.1.1 The relative markers and their functions in English relative clauses

Relative marker, which is also called relativizer, is a grammatical element that indicate a relative clause. There are totally eight relative markers in English: who, whom, whose, that, which, when, where and why. And they could be divided into two groups ---- the relative pronouns and the relative adverbs.

#### (1) Relative pronouns: who, whom, whose, that and which

Table 2 Relative pronouns in English

Items	Relative pronouns	Examples
1	who	She is a good teacher <b>who</b> would like to help any student.
2	whom	He is the manager <b>whom</b> I met last Friday.

3	whose	The girl <b>whose</b> mother is a model is very pretty.
4	that	Where is the pen <b>that</b> I bought yesterday?
5	which	Basketball is a game <b>which</b> is liked by most boys.

*Who* is relative pronoun for person, and it functions as subject, while *whom* which is also relative pronoun for person, is functioned as object. With respect to *that*, it could be used to refer to both person and impersonal things and worked as both subject and object. Considering *which*, it is usually used to indicate things and animals. *Whose* is a possessive relative pronoun *which* could be used to refer to both person and things as well as animals. (Swan, 2005)

## (2) Relative adverbs: when, where and why

Table 3 Relative adverbs in English

Items	Relative pronouns	Examples
1	when	I will brand my stay in Bangkok on my heart <b>when</b> I led a busy and fruitful life.
2	where	My neighbors went to the same island <b>where</b> we went to last year for vocation.
3	why	I cannot imagine the reason <b>why</b> they rejected my application.

Relative adverbs *when*, *where* and *why* are used to refer to time, place, and reason, respectively. As mentioned in Chapter one, relative adverbs are excluded from the present study.



### 2.2.1.2 The grammatical functions of English relative clauses

The grammatical functions of ERCs are the same as the normal NPs, so when they are combined with head noun or noun phrases, their grammatical functions are as follows.

Table 4 Examples of the grammatical functions of English relative clauses

Items	Functions	Examples
1	Subject	[s The guy <u>who dressed formally</u> s] is the cover boy in our university.
2	Direct object	The boss scolded [do his secretary <u>whom no one dare to scold.</u> do]
3	Indirect object	The secretary gave [io her boss <u>whom she was scolded by</u> io] a cake.
4	Object of prepositions	The failure of her application should be attributed to [OPREP the second interview <u>which she did not prepare</u> OPREP].
5	Subject compliment	Her advisor is [sc a man <u>who is professional in psychology</u> sc].
6	Object compliment	You can call him [oc <u>what you like</u> oc].

### 2.2.1.3 Defining and non-defining English relative clause

There are two kinds of English relative clauses----identifying ERC and non-identifying ERC(Swan, 2005). Considering identifying ERC, it is also called defining ERC or restrictive ERC. It refers to relative clauses that identify or classify noun

phrases (NP), and they tell us which person or thing, or which kind of person or thing, is meant (Swan, 2005).

Table 5 Examples of defining English relative clauses

Items	Examples
1	What is the name of the student <b>who answered the question just now</b> ?
2	The teachers <b>who are very kindhearted</b> are welcomed by all the students.
3	The bag <b>that contains a lot of English books</b> is mine.
4	The bikes <b>that are painted in pink in our campus</b> are shared bikes.

In example 1, the relative clause *who answered the question just now* defines the student and differentiates the student from other students. Considering example 2, the relative clause *who are very kindhearted* restricts the teachers and serves to differentiate the teachers from other kinds of teachers. With respect to example 3, the bag is identified by the relative clause *that contains a lot of English books*. With regard to example 4, the bikes are defined by the relative clause *that are painted in pink in our campus*, and the relative clause can identify which kinds of bikes they are. The obviously indicator of the defining relative clause is that there is no comma in the sentence. What is more, *that* can be used in defining ERC, but can never be used in non-defining ERC. (Swan, 2005) Another perspective to define defining relative clause is that the omission of a relative pronoun used as an object in a relative clause is permitted, such as the following example.

Table 6 Example of defining English relative clauses with the omission of a relative pronoun used as an object in a relative clause

Item	Example
1	The bike painted pink is Lucy's.

With respect to non-defining ERC, it is also called non-defining ERC or non-restrictive ERC. Different from defining ERC, it does not identify or classify NP, it simply tells us more information about a person or thing that is already identified (Swan, 2005).

Table 7 Examples of Non-defining English relative clauses

Items	Examples
1	The girl, whose mother is a teacher, studies very hard.
2	They went back to Bangkok, where they have been lived for four years.
3	My mother, who is more than 60 years old, is beautiful and elegant.

In example 1, relative clause *whose mother is a teacher* just supply extra information about the girl and does not defining it. Situations in examples 2 and 3 are the same.

Moreover, non-defining ERC can be introduced by *who*, *whom*, *whose*, *which*, *when* and *where*, but *that* is not permitted (Azar, 2017).

Table 8 Examples of incorrect English non-defining relative clause with "that" as the pronoun (Azar, 2017)

Items	Examples
1	Mr Lee, whom I met yesterday, teaches chemistry.
2	* Mr Lee, that I met yesterday, teaches chemistry.

Different from defining ERC, there is always a comma in non-defining ERC (Eastwood, 1994), as we can see all the examples above. Moreover, the pronouns in the non-defining ERC cannot be leaved out (Eastwood, 1994).

Table 9 Examples of incorrect English non-defining relative clause with the pronouns leaved out

Items	Examples
1	The first bus, which came after five minutes, is a seven.
2	*The first bus, came after five minutes, is a seven.

### 2.2.2 Chinese relative clauses

As reported by Murcia-Celce and Diane (1999), Chinese is a left-branch orientation language (LBOL), the relative clause is located before the head noun or noun phrases (Murcia-Celce & Diane, 1999). For example,

1. 喜欢旅游的人都很有趣。

Xi huan lv you ReL<sup>2</sup> ren dou hen you qu.<sup>3</sup>

Like traveling ReL people all very funny.

People who like traveling are funny.

2. 这是我导师送我的书。

Zhe shi wo dao shi song wo ReL shu.

This is my adviser give me ReL book.

This is the book that my adviser gave me.

Different from English relative clause which is complete sentence, Chinese relative clause could be a verb /verb phrase, or ‘Subject+ Verb’, or ‘Subject + Verb + Object’, or a complete sentence (Teng, 2016). Examples are as follows.

<sup>2</sup> ReL refers to relative marker in Chinese.

<sup>3</sup> This line is Chinese pin yin for each word.

### *Verbs and verb phrases*

3. . A: 他昨天有一个书展。

Ta zuo tian you yi ge shu zhan.

He yesterday had one classifier book fair.

He had a book fair yesterday.

B: 去的人多吗?

qu ReL ren duo ma?

Go ReL people many particle?

Were there many people went to (the book fair)?

4. 喜欢运动的人身材都挺好的。

xi huan yun dong ReL ren shen cai dou ting hao de

Like doing sports ReL people shape all very good.

People who like doing sports are good in shape.

In the dialogue between A and B, A said ‘he had a book fair yesterday’, and B asked ‘qu de ren duo ma?’ The relative clause in this sentence is just a verb which is ‘qu (go)’. Considering the second example ‘xi huan yun dong de ren shen cai dou ting hao de’, the relative clause in this sentence is ‘xi huan yun dong’ which is a verb phrase.

### *Subject + verb*

5. A: 我上周看的那本书特别好。

Wo shang zhou kan ReL na ben shu te bie hao.

I last week read ReL that classifier book very nice.

The book which I read last week is very nice.

B: 是不是导师推荐的那本书?

Shi bus hi dao shi tui jian ReL na ben shu?

Yes or not adviser recommend ReL that classifier book?

Is it the book that our advisor recommended?

In this dialogue, A said that ‘wo shang zhou kan de na ben shu te bie hao’ in which the relative clause is ‘wo shang zhou kan’ which means ‘last week I read’, is composed with a subject ‘wo’ and a verb ‘kan’ and the adverb of time. Considering B’s answer, the relative clause is ‘dao shi tui jian’, which means ‘advisor recommended’, consists of a subject which is ‘dao shi (advisor)’ and a verb which is ‘tui jian (recommended)’.

***Subject + verb + object***

6. 那是爸爸送给妈妈的生日礼物。

na shi ba ba song gei ma ma ReL sheng ri li wu

That is father sent to mother ReL birthday gift.

That is a birthday gift that my father sent to my mother.

7. 我把弟弟告诉我的事情告诉了妈妈。

wo ba di di gao su wo ReL shi qing gao su le ma ma.

I ba younger brother told me ReL things told le mum.

I told mum the things that my younger brother told me.

With respect to the first example, the relative clause is ‘ba ba song gei ma ma’, which consists of a subject which is ‘ba ba (father)’, a verb which is ‘song gei (sent to)’, and an object which is ‘ma ma (mother)’. Regarding the second sentence, the

relative clause is ‘di di gao su wo’, which includes a subject ‘di di (younger brother)’, a verb ‘gao su (told)’ and an object ‘wo (me)’.

### *Complete sentences*

8. 我喜欢他做的菜的那个厨师辞职了。

wo xi huan ta zuo ReL cai ReL na ge chu shi ci zhi le

I like he cook ReL dish ReL that classifier chef resigned tense marker.

The chef who I like his cooking resigned.

In this example, the relative clause is ‘wo xi huan ta zuo de cai’, which means ‘I like his cooking’. It is a complete sentence. Actually this kind of relative clause is very rare, and sometimes sounds awkward but it is still acceptable in Chinese (Teng, 2016).

In the remaining sections, 2.2.2.1 is about the relative marker and its function in Chinese relative clause; 2.2.2.2 mainly focus on the grammatical function of Chinese relative clauses; 2.2.2.3 concerns defining Chinese relative clauses.

#### **2.2.2.1 The relative marker and its function in Chinese relative clauses**

Relative marker is also called relativizer, its function is to introduce a relative clause. Unlike English, there is only one relative marker in Chinese, which is *de*.

9. 我喜欢吃他做的饭的那个厨师是个胖子。

Wo xi huan chi ta zuo **ReL** fan ReL na ge chu shi shi ge pang zi.

I like eat he cook ReL food ReL that classifier chef is classifier fat man.

The chef who I like to eat his food is a fat man.

10. 不 喜 欢 吃 饭 的 小 孩 都 比 较 瘦。

Bu xi huan chi fan **ReL** xiao hai dou bi jiao shou

Do not like have food ReL children all comparatively thin.

Children who do not like have food are comparatively thinner.

As mentioned above, there are kinds of grammatical functions of English relative markers. Such as, who could be functioned as subject or object while whom can only be used as object; that could be both subject and object, etc. In Chinese, the relative marker is just a marker, it does not function as either subject or object or other components in a clause.

#### 2.2.2.2 The grammatical functions of Chinese relative clauses

The Chinese relative clauses are similar as English relative clauses in that both have a head noun or noun phrase and a subordinate clause. What is different is that in English the relativized NP is *who, whom, that, which, that* and etc., while in Chinese it is zero in form (Pu, 2007). The following are some examples in which the head NPs are underlined, while the relativized NPs are represented by zero ( $\emptyset$ ).

11. 喜 欢 打 篮 球 的 男 生 个 子 都 很 高。

[ $\emptyset$  Xi huan da lan qiu ReL] nan sheng ge zi dou hen gao.

Like play basketball ReL boys height all very tall.

The boys who like playing basketball are tall.

12. 妈 妈 给 正 在 写 作 业 的 小 明 倒 了 一 杯 水。

Ma ma gei [ $\emptyset$  zheng zai xie zuo ye ReL] xiao ming dao le yi bei shui.

Mum gave doing writing home work ReL xiao ming pour le one cup

water.

Mum gave a cup of water to Xiao Ming who is doing homework.



Theoretically, on the above examples, the constituent in the square brackets is treated as the relative clause (Pu, 2007). The functions of Chinese relative clauses are similar as English relative clauses. It could be functioned as subject, direct object, indirect object, object of prepositions and subject compliment. But it cannot function as object compliment, since there is no object compliment in Chinese. (黄伯荣 et al., 2007)

### *Subject*

13. 喜欢打篮球的那个男孩是我弟弟。  
 [Ø Xi huan da lan qiu ReL] na ge nan hai shi wo di di.  
 Like play basketball ReL that classifier boy is my younger brother.  
 The boy who likes playing basketball is my younger brother.

### *Indirect object*

14. 我给了穿粉色裙子的小女孩一瓶酸奶。  
 Wo gei le [Ø chuan fen se qun zi ReL] xiao nu hai yi ping suan nai.  
 I gave le dress pink skirt ReL little girl one bottle yogurt.  
 I gave the girl who dressed pink skirt a bottle of yogurt.

### *Direct object*

15. 老师批评了那个上课捣乱的男生。  
 Lao shi pi ping le na ge [Ø shang ke dao luan ReL] nan sheng.  
 Teacher scold le that classifier have class make trouble ReL boy.  
 The teacher scolded the boy who made trouble in the class.

### *Object of prepositions*

16. 她把辞职的原因归结于那个爱挑剔的老板。  
 Ta ba ta ci zhi de yuan yin gui jie yu na ge [Ø ai tiao ti ReL] lao ban.

She ba she resignation de reason attribute to that classifier very strict ReL boss.

She attributed her resignation to her boss who is very strict.

***Subject compliment***

17. 她的妈妈是一个很喜欢小孩子的妇女。

Ta de ma ma shi yi ge [Ø hen xi huan xiao hai zi ReL] fu nu.

Her mother is one classifier very like little children ReL woman.

Her mother is a women who likes little children very much.

**2.2.2.3 Defining Chinese relative clauses**

Different from ERC, CRCs are all defining relative clause (Del Gobbo, 2001, 2004, 2005). Although Huang (1982) have been used the term non-restrictive Chinese relative clause, he explicated that the use of *non-restrictive* in his dissertation is different from the use of the same term to describe English. The term non-restrictive in his dissertation refers to that the relative does not specify the reference of a preceding demonstrative. (Huang, 1982).

Chao (1965) and Hashimoto, A. Y. (1971) stated that if a Chinese relative clause follows a demonstrative, it is ‘descriptive’, but if it precedes it, it is defining relative clause (Chao, 1965; Hashimoto, 1971). Chao (1965) gave some examples.

18.

(i) **Na-wei** dai yanjing de xiansheng shi shei?

that-CL wear glasses DE gentleman is who

‘Who is that gentleman (who incidentally is) wearing glasses?’

(ii) Dai yanjing de **na-wei** xiansheng shi shei?

Wear glasses DE that-CL gentleman is who?

Who is the gentleman who is wearing glasses (not the one who is not wearing glasses)? (Chao, 1965)

According to Chao (1965), the relative clause in the first example is descriptive relative clause, while the relative clause in the second example is defining relative clause.

Del Gobbo (2003,2005) analyzed the so called ‘descriptive’ Chinese relative clauses, and distinguished it from appositive relative clauses in languages like English and Italian, since many researchers tried to identify that Chinese ‘descriptive’ relative clauses share properties with appositive relative clauses in these two language(Del Gobbo, 2003). Moreover, Del Gobbo (2005) claimed that it is impossible for Chinese relative clauses to be truly appositive, because of the nature of appositive relative clauses, which are independent sentences and instances of E-type anaphora(Del Gobbo, 2005), according to the statement in Del Gobbo (2003). Examples of the Chinese relative clauses above can show that all of them are restrictive relative clauses.

### 2.3 Previous studies

There are two sections included in this section: 2.3.1 previous studies concerning L1 Chinese learners’ acquisition of English relative clauses; and 2.3.2 previous studies related to structural priming.

### **2.3.1 Previous studies concerning L1 Chinese learners' acquisition of English relative clauses**

Two subsections were consisted in this section: 2.3.1.1 previous studies concerning types of errors that L1 Chinese learners' make in the acquisition of English relative clauses; and 2.3.1.2 previous research concerning factors effecting Chinese learners' acquisition of English relative clauses.

#### **2.3.1.1 Previous studies concerning types of errors that L1 Chinese learners make in the acquisition of English relative clauses**

Most of the previous studies concerning the types of errors that Chinese learners make in the acquisition of English relative clauses were based on error analysis and contrast analysis, as well as interlanguage theories (Chen, 2011; Liu, 2012; Liu, 2015; Wang, 2018; Xie, 2013; Zhang, 2011). Misuse of relative pronouns, omission of relative pronouns, the usage of resumptive pronouns, pre-positing relative clauses were the main types of errors found.

Zhang (2011) explored Chinese high school students' acquisition of English relative clauses based on error analysis. The participants were eighty-two intermediate level English proficiency high school students, and thirty high school English teachers in Nanjing, China. A grammar test concerning English relative clauses was conducted. A questionnaire concerning the students' attitude to learning English relative clauses and their learning strategies was given to the students. Another questionnaire concerning the teachers' teaching methods was given to the teachers. The results showed that the main errors that the participants made were the misuse of relative pronouns, omission of relative pronouns,

agreement errors between the main clause and subordinate clause, and redundancy of the resumptive pronouns. Some examples as follows:

19. They talked for one hour of things and persons whom they remembered in the school. (Misuse of relative pronoun)

20. Is this the reason why he explained at the meeting for his carelessness in his work? (Omission of relative pronouns)

21. This is the magazine which were sent to me by post. (Agreement errors between the main clause and subordinate clause)

22. This is the book I borrowed it yesterday. (Redundancy of the resumptive pronouns)

(Zhang, 2011, pp. 20-30)

Zhang assumed the following causes of the errors: Firstly, some students paid too much attention to the format of English relative clauses and applied the rule mechanically rather than by considering the context and meaning of the clauses. Secondly, some students lacked enough knowledge of English relative clauses. Thirdly, most of the students were not used to English relative clauses because of the affection of Chinese relative clauses (Zhang, 2011).

Similarly, based on the interlanguage and error analysis theory, Chen (2011) undertook empirical research to investigate Chinese high school students' acquisition of English relative clauses. The participants were one hundred and three high school students attending Number One High School in Jinjiang, China. A grammatical test concerning English relative clauses, and a questionnaire with respect to their learning

attitude and learning strategies, were used as the instruments. The data showed that there were eight types of errors: pronoun retention, inappropriate omission of relative pronouns, misuse of relative pronouns, non-adjacency, omission of the head-noun, incomplete prepositional phrase, redundant of predict and lack of predict. Examples are as follows:

23. The man who he had parked his car was fined. (Pronoun retention)

24. Those \_\_didn't finish homework cannot go home. (Inappropriate omission of relative pronouns)

25. The woman which my dad sold a car to is an engineer. (Misuse of relative pronoun)

26. John's boss didn't show up who was invited to the party. (Non-adjacency)

27. She got married to \_\_\_ whom I introduced her to. (Omission of head-noun)

28. This is the room which I lived. (Incomplete prepositional phrase)

29. The manager whom they talked about is got fired. (Redundant of predict)

30. The tallest man that I have just interviews in the bank. (Lack of predict)

(Chen, 2011, pp. 23-25)

According to the interlanguage hypothesis and error analysis theory, these errors can be attributed to inter-lingual transfer, intra-lingual interference, the learning context, and communication strategies (Chen, 2011).

H. Liu (2012) conducted research to investigate English relative clause errors committed by Chinese senior middle school students. The participants were two

hundred and thirty-two senior middle school students attending the Second Senior Middle School in Lankao County, Henan Province, China. A grammatical test concerning English relative clauses was conducted. The results showed that there were six kinds of errors made by the participants: (1) Misuse of relative pronouns and adverbs; (2) Misuse of “as”; (3) Errors in agreement; (4) Errors in the “preposition + relative pronoun” structure; (5) errors in the omission of relative words; (6) problems of pronoun retention. Examples as follows:

31. I will never forget the day when I spent in Beijing with my friends. (Misuse of relative pronoun or adverb)

32. I have the same pen that you have. (Misuse of “as”)

33. She is the only one of the students in her class who have won three years’ scholarship. (Errors in agreement)

34. Oxygen is a kind of air without it human being cannot live. (Error in the “preposition+ relative pronoun” structure)

35. The most interesting book I have read is Gone with wind. (Error in the omission of relative word)

A. which B. where C. / D. what

36. This is the bike that I bought it last year. (Problem of pronoun retention)

(Liu, 2012, pp. 25-47)

The causes of the errors included: (1) Emphasizing the language format too much; (2) Lack of systematic grammar; (3) Shortage of the necessary vocabulary; (4) Language transfer; and (5) Over-generalization (Liu, 2012).

J. Liu (2015) conducted research to investigate the errors in English relative clauses by Chinese high school students. The participants were one hundred and ten students attending the No.1 Senior Middle School in Heishan, Liaoning Province, China. A grammatical test concerning English relative clauses was conducted. The results showed that there were five types of errors that the participants committed: wrong use of relative pronouns, wrong use of relative adverbs, omission errors, coherence errors, and redundant component errors. Examples as follows:

37. They looked over the old things and people whom they remembered in the early days. (Wrong use of relative pronoun)

38. Shanghai is no longer the city where it used to be. (Wrong use of relative adverb)

39. This is the school where I study every day. (Omission error)

40. He is one of the boys who plays the piano well. (Coherence error)

41. It is a pretty toy that I bought it yesterday. (Redundant component error)

(Liu, 2015, pp. 34-46)

Based on error analysis, contrast analysis, and interlanguage theories, Wang (2018) undertook research to investigate Chinese high school students' acquisition of English relative clauses. One hundred high school students and four English teachers at the No. Three High School, Yantai, China, participated in the research. A grammatical test concerning English relative clauses was conducted. A questionnaire with respect to the students' attitude toward learning English relative clauses and the learning strategies was given to the students. All the English teachers participated in



an interview concerning their teaching method of English relative clauses. The results showed that there are five types of errors made by the participants: misuse of relative pronouns, misuse of relative adverbs, omission of relative words, disagreement of predict and antecedent, and redundant in relative clauses. Examples as follows:

42. Those that would like to study from books and through practice will be successful. (Misuse of relative pronoun)

43. I will never forget the days when we played together. (Misuse of relative adverbs)

44. This is the biggest laboratory \_\_\_ we have ever built in our school. (Omission of relative words)

A. which B. what C. where D. /

45. He is one of the boys who plays the piano well. (Disagreement of predict of antecedent)

46. Finally she told her mother everything that it made her unhappy. (Redundant in relative clause) (Wang, 2018, pp. 31-40)

The factors that contribute to the errors were L1 transfer, lack of lexical and grammatical knowledge of English relative clauses, paying too much attention to the format, lack of effective practice, and treating errors incorrectly. Advices for the students' learning and the teachers' teaching method was given at the end of the research (Wang, 2018).

Unlike the previous studies, Xie (2013) conducted a study to explore Chinese EFL learners' errors in English relative clauses by written data. The participants were

one hundred and six non-English major students attending J. College, China. A corpus of the participants' final project, which was written in English, was collected, and analyzed. The results showed that there were six types of errors made by the participants: wrong use of relative pronouns or adverbs, resumptive pronouns, absence of the head noun, ellipsis of the relative pronouns or adverbs, non-adjacency, and ellipsis of the preposition relative clauses. Examples are as follows:

47. It is no longer the place where it is used to be. (Wrong use of relative adverb)

48. This is an interesting thing that I heard it from an old friend. (Resumptive pronoun)

49. I missed \_\_\_ which he sent to yesterday. (Absence of the head noun)

50. This depends on the purpose (which) the exhaust steam is used for. (Ellipsis of the relative pronoun)

51. Jack opens his eyes who fell asleep. (Non-adjacency)

52. There is lots of things which I am blessed. (Ellipsis of the preposition in relative clauses)

(Xie, 2013, pp. 67-81)

To sum up, previous studies concerning the English relative clause errors committed by L1 Chinese learners found that the main types of error included misuse of relative pronouns, omission of relative pronouns, usage of resumptive pronouns, and pre-positing relative clauses.

Table 10 is a summary of the previous studies reviewed in this subsection.

Table 10 Previous studies concerning error types L1 Chinese learners committed on the acquisition of English relative clauses

Study	Participants	Data collection instruments	Main results
Zhang (2011)	82 intermediate level English proficiency high school students, and 30 high school English teachers in Nanjing, China	Grammatical test Questionnaire	The main errors that that the participants made were the misuse of relative pronouns, omission of relative pronouns, agreement errors between the main clause and subordinate clause, and redundancy of the resumptive pronouns.
Chen (2011)	103 high school students attending Number One High School in Jinjiang, China	Grammatical test Questionnaire	There were eight types of errors that the participants made: pronoun retention, inappropriate omission of relative pronouns, misuse of relative pronouns, non-adjacency, omission of the head-noun, incomplete prepositional phrase, redundant of predict and lack of predict.
H. Liu (2012)	232 senior middle school students attending the Second Senior Middle School in Lankao County, Henan Province, China	Grammatical test	There were six kinds of errors made by the participants: misuse of relative pronouns and verbs, misuse of “as”, errors in agreement, Errors in the “preposition + relative pronoun” structure, errors in the omission of relative words, problems of pronoun retention.
J. Liu (2015)	110 students attending the Number One Middle School in Heishan, Liaoning Province, China	Grammatical test	There were five types of errors that the participants committed: wrong use of relative pronouns, wrong use of relative adverbs, omission errors, coherence errors, and redundant component errors.
Wang (2018)	100 high school students and 4 English teachers at the Number Three High School, Yantai, China	Grammatical test Questionnaire Interview	There were five types of errors made by the participants: misuse of relative pronouns, misuse of relative adverbs, omission of relative words, disagreement of predict and antecedent, and redundant in relative clauses.

Xie (2013)	106 non-English major students attending J. College, China.	Corpus	There were six types of errors made by the participants: wrong use of relative pronouns or adverbs, resumptive pronouns, absence of the head noun, ellipsis of the relative pronouns or adverbs, non-adjacency, and ellipsis of the preposition relative clauses.
Chang (2004)	237 Chinese native speakers majoring in English	Written composition Multiple-choice test	There were several reasons for the participants' incorrect production of English relative clauses: Chinese relative clause order, pronoun usage, pronoun retention, and agreement between number and tense. Not only the order of L1 transferred by L1 Chinese learners in the acquisition of English relative clauses, but also other properties of Chinese transferred, such as "pronoun retention" and the Chinese relative marker "de".

### **2.3.1.2 Previous research concerning factors effecting Chinese learners' acquisition of English relative clauses**

Previous research concerning the factors effecting Chinese learners' acquisition of English relative clauses concentrated mainly on two aspects: L1 transfer ((Chang, 2004; Chiang, 1981; Liu, 1998; Yip & Matthews, 2000) and avoidance of using English relative clauses (Bley-Vroman & Houn, 1988; Chiang, 1980; Collier-Sanuki, 1993; Kamimoto et al., 1992; Schachter, 1974). In the following sections, 2.3.1.2.1 focuses mainly on previous studies concerning L1 transfer and L1 Chinese learners' acquisition of English relative clauses; 2.3.1.2.2 concentrates on previous studies concerning avoidance of using English relative clauses by L1 Chinese learners.

#### **2.3.1.2.1 Previous studies concerning L1 transfer and Chinese learners' acquisition of English relative clauses**

There are two opposite claims concerning L1 transfer and L1 Chinese learners'

acquisition of English relative clauses: some studies assumed that L1 transfer is an important factor that obstacle Chinese learners' acquisition of English relative clauses(Chang, 2004; Yip & Matthews, 2000) ; whereas some research showed there was little evidence of L1 transfer during the process of L1 Chinese learners' acquisition of English relative clauses(Chiang, 1981; Liu, 1998).

Chang (2004) investigated whether or not the word order of the relative clause in Chinese is transferred to the learners' English relative clause acquisition, because the relative clause is located before the head noun in Chinese, whereas the relative clause appears after the head noun in English. A total of 237 Chinese native speakers majoring in English participated in the research. One written composition by each participant was collected, and a multiple-choice test about relative clauses was conducted. The errors in the participants' composition were analyzed. The results showed there were several reasons for the participants' incorrect production of English relative clauses: Chinese relative clause order, pronoun usage, pronoun retention, and agreement between number and tense. Examples as below:

53. I can read many books I like or buy **I love books**. (L1 order transfer)

54. I think I will buy many new books or borrow **some books of I would like to read** from library. (Transfer L1 Chinese relative marker “de” to English as the pronoun)

55. I have more leisure to do something I want to make **it**. (Pronoun retention)

56. I am **a person who love reading**. (Agreement of number and tense)

(Chang, 2004, pp. 10-12)

The results indicated that not only the order of L1 transferred by L1 Chinese learners in the acquisition of English relative clauses, but also other properties of Chinese transferred, such as “pronoun retention” and the Chinese relative marker “de”(Chang, 2004).

Yip and Matthews (2000) also found L1 transfer for L1 Chinese learner’s acquisition of English relative clauses. Yip and Matthews (2000) conducted a case study to investigate syntactic transfer by a Cantonese-English bilingual child. The participant was a Cantonese- English bilingual child named Timmy, living in Hong Kong, with language exposure of 2/3 Cantonese and 1/3 English. Because he lives in a Cantonese community, both his mother and relatives, as well as the community members speak Cantonese, while only his father and the Filipino domestic helper speak English. Longitudinal recording transcript data and diary data were collected and analyzed. The data collection process lasted for two years (From Timmy’s age of one year and six days to three years and five days). The results showed that almost all the English relative clauses produced during this period were prenominal relative clauses, which are not permitted in English but allowed in Cantonese. The data also showed that the participant began to produce post-nominal English relative clauses with pronoun retention, which is permitted in Cantonese rather than English, when he was three years and four days old. See the examples below:

57. Where is **you buy that one**, where is **you buy that one motorbike**?  
(Prenominal relative clause)

58. I want **Pet-Pet but that one videotape**. (Prenominal relative clause)

59. It's like **the one you bought it**. (Pronoun retention)

(Yip & Matthews, 2000, pp. 203-205)

The results indicated that this Cantonese-English bilingual child transferred the syntactic knowledge of Cantonese relative clauses to English, since Cantonese was the dominant language in his living environment (Yip & Matthews, 2000).

Following-up previous research, Yip (2007) reported another study concerning the process of Cantonese-English bilingual children's acquisition of English relative clauses based on diary data. The participants were three Cantonese-English bilingual siblings living in Hong Kong. The diary recorded their acquisition of English relative clauses at an early age (before six years old). The data showed that the three siblings processed two stages in the acquisition of English relative clauses: the prenominal relative clause stage and the resumptive pronoun relative clause stage (For examples, see the previous review). The explanation for the prenominal relative clause stage is L1 transfer since the object relative clause in Cantonese is prenominal and Cantonese is the dominant language. The explanation for the resumptive pronoun relative clause stage is that it is a strategy for acquisition of English relative clauses rather than L1 transfer because this stage appeared in the process of all the learners' acquisition, including native English speakers. The results indicates that both L1 transfer and learning strategies contributed to Cantonese-English bilinguals' acquisition of English relative clauses (Yip, 2007).

Unlike Yip and Matthew (2000, 2007) case study, Chan (2004) studied L1 transfer of Chinese EFL learners' acquisition of English relative clauses via group experiments (Chan, 2004). In total, seven hundred and ten L1 Cantonese EFL learners

in Hong Kong participated. Three instruments were self-reporting, translation, and a grammatical judgement test. The participants' data were collected and analyzed. The results showed that the participants were more likely to adopt the Cantonese relative clause structure in their production of English relative clauses. Examples as follows:

60. She was **to my home saw me yesterday**.

(Chan, 2004, p. 64)

According to the self-reporting, on average 60% plus of the participants firstly use L1 Cantonese to present the meaning, and then translate L1 Cantonese to English. The results indicate that the L1 Cantonese participants' failure to produce the correct English relative clauses was affected by L1 transfer (Chan, 2004).

Similarly, Zhu (2014) found more types of L1 transfer from L1 Chinese relative clauses to English relative clauses by Chinese learners (Zhu, 2014). Zhu (2014) conducted a study to investigate syntactic transfer in relative clause learning by Chinese college English majors. A writing Chinese-English translation task was employed. The participants were English major second year students attending DeZhou University. They were divided into a proficient group and a less proficient group according to their performance in the Test for English Majors Band 4. The results displayed that the proficient group used more relative clauses than the less proficient group, and both groups recalled their L1 Chinese to facilitate the English output. The results also showed that there were six types of L1 transfer that affected the participants' production of English relative clauses: pronoun retention, wrong position of the relative clause, be-verb omission, lack of relative pronouns, wrong use of pronouns, and subject omission. Examples as follows:



61. Tom bought a mobile phone **which he lost it** soon. (Pronoun retention)
62. The bank is very reliable **to which I deposit money**. (Wrong position of relative clause)
63. The machine **that bought last year** is working perfect. (Be-verb omission)
64. John **lives in Kansas** is a horseman. (Lack of the relative pronoun)
65. Her brother was a college student **with him you had a conversation just now**. (Wrong use of the pronoun)
66. The first time to be mother gave me a totally different view **which can't learn from psychology course**. (Subject omission)

(Zhu, 2014, pp. 615-616)

The results indicated that no matter whether the students were more proficient or less proficient, their acquisition of English relative clauses was affected by L1 transfer (Zhu, 2014).

Lin and Chuang (2014) also found different types of L1 transfer in the acquisition of English relative clauses by L1 Chinese learners (Lin & Chuang, 2014). Lin & Chuang undertook research to explore Taiwanese EFL learners' acquisition of English relative clauses. The participants were sixty L1 Chinese speaking ninth grade students from Taiwan, China. They were split into two parallel groups according to a pretest concerning English relative clause knowledge. Then, one group was instructed with a comparative analysis teaching method, in which the teacher gave explicit contrast knowledge of English relative clauses and Chinese relative clauses; the other group was taught by a direct method without any comparison of the two languages. After this treatment, a test which included a sentence composition task, and a translation task, as well as a questionnaire concerning the students' attitude toward the

teaching methods, was conducted. The results showed that the comparative analysis method had a positive effect on the L1 Chinese learners' production of English relative clauses, and the students had a positive attitude toward the teaching methods. The results also showed that there were four kinds of L1 transfer in the experiment: redundant use of pronouns, relative pronouns' incorrect omission, relative pronouns' incorrect choice, and relative pronoun and the following verb's inharmonious (Lin & Chuang, 2014).

More types of L1 transfer were found by Xiaoling and Mengduo (2010) in addition to the different types of error affected by L1 Chinese (Xiaoling & Mengduo, 2010). Xiaoling & Mengduo (2010) undertook research to explore inter-lingual factors in Chinese college students' acquisition of English relative clauses. The participants were one hundred and twelve Chinese students, divided into three groups of thirty-five elementary English learners, forty-seven intermediate English learners, and thirty advanced English learners, according to the National College Entrance Examination and College English Test-Band 4. The instruments involved a composition task, a multiple-choice test, and a grammatical judgement test. The production of English relative clauses was collected and compared with the corresponding native English speakers' production extracted from the Louvain Corpus of Native English Essays. The results showed that all the participants produced fewer English relative clauses compared with Native English speakers, and the difference was significant. The participants produced almost equal numbers of restrictive relative clauses and non-restrictive relative clauses, but irrespective of their proficiency level, the students did not have a clear knowledge of the difference between the two types of relative clauses. The results also showed that four types of

incorrect English relative clauses were produced by the participants, relative clause preposing, resumptive pronouns, absence of relative pronouns, and using a personal pronoun instead of a relative pronoun. Examples as follows:

67. **I am reading** the book is very interesting. (Relative clause preposing)

68. The pen **which I wrote with it** was red. (Resumptive pronoun)

69. There are some students **stand at the door**. (Absence of relative pronoun)

70. He gets a friend **he speaks English**. (Using a personal pronoun instead of the relative pronoun)

(Xiaoling & Mengduo, 2010, pp. 120-123)

The results indicate that both the L1 Chinese relative clause properties and the comparatively lower distribution, as well as a lack of non-restrictive relative clauses in Chinese, affected the L1 Chinese learners' acquisition of English relative clauses (Xiaoling & Mengduo, 2010).

Unlike the previous studies, Chiang (1981) and Liu (1998) found little evidence of L1 transfer in the acquisition process of relative clauses by Taiwanese learners.

Chiang (1981) conducted research to investigate writing errors by L1 Chinese English major students attending the National Taiwan Normal University, Tai Bei, China. Considering English relative clauses, the results showed that the main error type in their production was the misuse of English pronouns, such as the inter-replacement of "that" and "where". It also showed that L1 interference was common but not the main source of errors (Chiang, 1981).

Liu (1998) conducted a study to investigate the production of English relative clauses by Taiwanese junior high school students. A picture-identification task, ordering task, and grammatical judgement test were employed. According to the data analysis, there was little evidence of L1 interference in the process of the participants' acquisition of English relative clauses (Liu, 1998).

In short, most of the previous studies concerning L1 transfer, and L1 Chinese learners' acquisition of English relative clauses demonstrated that L1 transfer did affect Chinese learners' acquisition of English relative clauses, while few found little evidence of L1 transfer in the process of Chinese learners' acquisition of English relative clauses. Hence, whether the word order and syntax of a relative clause in Chinese is transferred to the English relative clause acquisition by L1 Chinese learners remains inconclusive.

Table 11 is a summary of the previous studies reviewed in this subsection.

Table 11 Previous research concerning factors effecting L1 Chinese learners' acquisition of English relative clauses

<b>Study</b>	<b>Participants</b>	<b>Data collection instruments</b>	<b>Main results</b>	<b>Implications</b>
Yip & Matthews (2000)	A Cantonese-English bilingual child	Longitudinal recording Diary	Almost all the English relative clauses produced during this period were prenominal relative clauses, which are not permitted in English but allowed in Cantonese. And the participant began to produce post nominal English relative clauses with pronoun retention, which is permitted in Cantonese rather than English.	The results indicate that this Cantonese-English bilingual child transferred the syntactic language of Cantonese relative clauses to English.

Yip & Matthews (2007)	3 Cantonese-English bilingual siblings living in Hong Kong.	Diary	The three siblings processed two stages in the acquisition of English relative clauses: the prenominal relative clause stage and the resumptive pronoun relative clause stage. The reason for the former is L1 transfer, and the reason for the latter is strategy, since this stage appeared in the process of all the learners' acquisition of English relative clauses including the native English speakers.	The results indicate that both L1 transfer and learning strategies contributed to Cantonese-English bilinguals' acquisition of English relative clauses.
Chan (2004)	710 L1 Cantonese EFL learners in Hong Kong.	Self-reporting Translation Grammatical judgement test	The participants were more likely to adopt the Cantonese relative clause structure in their production of English relative clauses.	The results indicated that L1 Cantonese participants' failure to produce the correct English relative clauses was affected by L1 transfer.
Zhu (2014)	English major second year students attending DeZhou University	Writing Chinese-English translation test	The proficient group used more English relatives than the less proficient group, and both groups recalled their L1 Chinese to facilitate the English output.	The results indicate that no matter whether the students were more proficient or less proficient, their acquisition of English relative clauses was affected by L1 transfer.
Lin & Chuang (2014)	60 L1 Chinese speaking ninth grade students	Grammatical test Sentence composition test	There were four kinds of L1 transfer in the experiment: redundant use of pronouns, relative pronouns' incorrect	

	from Taiwan, China	Translation test	omission, relative pronouns' incorrect choice, and relative pronoun and the following verb's inharmonious.	
Xiaoling & Mengduo (2010)	112 Chinese students	Composition task Multiple choice test Grammatical judgement test Louvain Corpus of Native English Essays	All the participants produced fewer English relative clauses compared with Native English speakers. The participants produced almost equal numbers of restrictive relative clauses and non-restrictive relative clauses, but irrespective of their proficiency level, the students did not have clear knowledge of the difference between the two types of relative clauses. Four types of incorrect English relative clauses were produced by the participants: relative clause pre-posing, resumptive pronouns, absence of relative pronouns, and using a personal pronoun instead of a relative pronoun.	The results indicate that both the L1 Chinese relative clause properties and the comparatively lower distribution, as well as a lack of non-restrictive relative clauses in Chinese, affected the L1 Chinese learners' acquisition of English relative clauses.
Chiang (1981)	L1 Chinese English major students attending the National Taiwan Normal University, Tai Bei, China	Corpus	The main errors in the participants' production of English relative clauses was the misuse of English pronouns, such as the inter-replacement of "that" and "where". L1 interference was common but not the main source of errors.	

Liu (1998)	L1 Chinese Taiwan junior high school students	Picture-identification task, Ordering task, Grammatical judgement test	There was little evidence of L1 interference in the process of the participants' acquisition of English relative clauses.	
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### **2.3.1.2.2 Previous studies concerning avoidance of using English relative clauses by L1 Chinese learners**

There were two claims in the previous studies concerning the avoidance of using English relative clauses by L1 Chinese learners. Some research supported the avoidance view (Chiang, 1980; Schachter, 1974), while others denied it (Bley-Vroman & Houn, 1988; Collier-Sanuki, 1993; Kamimoto et al., 1992; Li, 1996).

Schachter (1974) was the first person who claimed that both Chinese and Japanese students avoided using English relative clauses (Schachter, 1974). Schachter (1974) investigated the usage of English relative clauses by L2 participants from four L1 backgrounds: the Chinese native speakers, the Japanese native speakers, the Arabic native speakers, and the Persian native speakers. All the participants were studying English at the American Language Institute, at the University of Southern California. For each group, fifty freestyle (no control of structure) compositions were collected, and the relative clauses extracted. The results demonstrated that both the Chinese and Japanese native speakers made fewer mistakes than the native speakers of Arabic and Persian when using English relative clauses. After statistical analysis, Schachter (1974) found that both the Chinese and Japanese speakers produced fewer English relative clauses than the Arabic and Persian speakers. Schachter (1974) concluded that it was not because the Chinese and Japanese native speakers had a good command of English relative clauses, but it could be due to the avoidance of

using relative clauses (Schachter, 1974). Furthermore, Schachter (1974) claimed that this finding supported the view that contrastive analysis can predict the acquisition of a foreign language.

Following-up on Schachter (1974), Chiang (1980) conducted research to examine three variables as predictors concerning the production of English relative clauses: language background, language proficiency, and the types of input questions. The participants were L1 Chinese, Japanese, Arabic, Persian and Spanish learners of English, and English native speakers. The results showed that among the three predictors, the best one was language proficiency, the second language background, but all the two best predictors only accounted for 10% of the variances. This indicated that none of the predictors can predict avoidance of English relative clauses (Chiang, 1980).

However, Bley-Vroman & Hounig (1988) and Zhao (1989), as well as Liu (1996) challenged Schachter (1974).

Bley-Vroman & Hounig (1988) conducted research to explore why Chinese learners use fewer relative clauses in English. The hypothesis is that the lower proportion of English relative clauses in Chinese learners' production were not because of the avoidance of using, but due to the lower proportion of relative clauses in the Chinese language. To assess this hypothesis, the researcher compared the number of relative clauses in Chinese and English. The number of relative clauses in the first five chapters of the novel "The Great Gatsby" in English and its corresponding Chinese translation were counted. The results showed that there were ninety-two relative clauses in the English version, but only thirty-two in the Chinese



version. This indicates that the lower proficiency in the usage of relative clauses in Chinese results directly results in the lower production of English relative clauses (Bley-Vroman & Houn, 1988).

Bley-Broman & Houn (1988) were challenged by Kamimoto et al. (1992) and Collier-Sanuki (1993), who criticized that Bley-Broman & Houn (1988) just counted the relative clauses in the English version and their counterbalance clauses in Chinese, but did not count all the relative clauses in both English and in Chinese. Thus, their data cannot support their conclusion, since there are no two languages that can match each other perfectly. Some English relative clauses may have corresponding Chinese relative clauses by translation, others may not, and vice-versa (Collier-Sanuki, 1993; Kamimoto et al., 1992).

Based on the study by Bley-Broman & Houn (1988), and the criticism by Kamimoto et al. (1992) and Collier-Sanuki (1993), Zhao (1989) conducted a study by counting all the relative clauses of the novel in both the English version and Chinese version. The results showed that there were one hundred and twenty-four English relative clauses and ninety-one Chinese relative clauses. Only fifty-nine relative clauses had direct counterparts in the other language. Sixty-five English and thirty-one Chinese relative clauses did not have counterparts in the other language. See Figure 6.

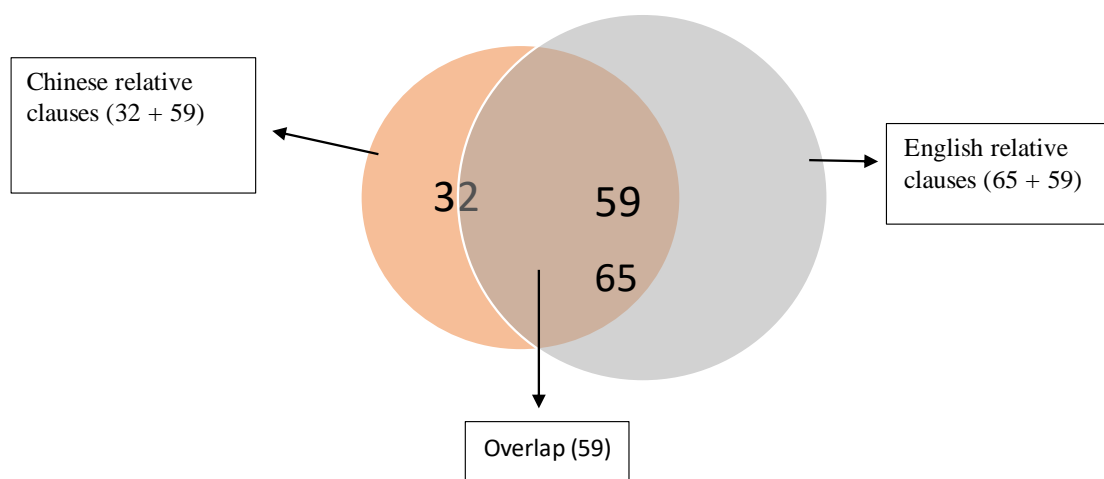


Figure 6 Relative clauses in English and Chinese by Zhao (1989)

Zhao (1989) compared the two languages in terms of the semantic and discourse functions of relative clauses. He found that there was only one function for relative clauses in Chinese, which is restricting the reference of the head noun. In contrast, there are several functions for English relative clauses, in addition to restricting the reference of the head noun, such as providing additional information and emphasizing the head noun. Chinese uses alternative syntactic structures other than relative clauses to realize these functions. According to these findings, Zhao concluded that Chinese learners use fewer relative clauses than English speakers in discourses, and the distribution of relative clauses in the two languages is different (Zhao, 1989). Hence, Zhao (1989) claimed that Chinese learners' under-production of English relative clauses cannot be ascribed as avoidance, but to a kind of language transfer at the discourse level (Zhao, 1989).

Following-up Zhao (1989), Li (1996) conducted research to investigate whether L1 Chinese learners of English consciously or subconsciously under-produced English relative clauses. Two writing tests and an interview were conducted. The first

test was a grammatical test concerning English relative clauses, the second test was a Chinese-English translation test, and the sentences were adopted from Zhao (1989), in which all the English relative clauses did not have Chinese counterparts. The interview was about whether the participants consciously or subconsciously under-produced English relative clauses. The results showed that, although the participants were not able to produce almost half of the possible English relative clauses, they were not consciously avoiding their use. In the translation test, although they were required to use English relative clauses, many of the participants were unable to produce English relative clauses. Therefore, Li (1996) concluded avoidance, but because of the special pragmatic functions of English relative clauses, for which the Chinese language uses other syntactic structures such as “two simple sentences” and “adj. + noun”. Thus, the under-production of English relative clauses can be attributed to language transfer at the pragmatic level (Li, 1996).

In short, concerning the avoidance of using English relative clauses by L1 Chinese learners, some of the previous research have demonstrated that L1 Chinese learners avoid using English relative clauses because they are afraid of making mistakes; however, other studies have claimed that L1 Chinese learners produced fewer English relative clauses, because there are fewer relative clauses in the Chinese language than in English, and there is only one function for a Chinese relative clause, while there are several in English. Thus, the under-production of English relative clauses by L1 Chinese learners is not because of avoidance, but due to a kind of language transfer at the pragmatic level and the discourse level.

Table 12 is a summary of the previous studies reviewed in this subsection.

Table 12 Previous studies concerning avoidance of using English relative clauses by L1 Chinese learners

Study	Participants	Data collection instrument	Main results	Implications
Schachter (1974)	Chinese, Japanese, Arabic and Persian native speakers who were studying English at the American Language Institute, at the University of Southern California	Corpus	Both the Chinese and Japanese native speakers made fewer mistakes than the native speakers of Arabic and Persian when using English relative clauses. Also, they produced fewer English relative clauses than the Arabic and Persian native speakers. It is not because the Chinese and Japanese students had a good command of English relative clauses, but it could be due to the avoidance of using English relative clauses.	The results indicate that contrastive analysis can predict the acquisition of a foreign language.
Chiang (1980)	L1 Chinese, Japanese, Arabic, Persian and Spanish learners of English	Questionnaire	Among language background, language proficiency and the types of input questions, the best predictor was language proficiency, and the second one was language background. But all the two best predictors only accounted for 10% of the variances.	The results indicate that noun of the predicators can predict avoidance of English relative clauses.
Bley-Vronman & Houng (1988)	The first five chapters of the novel "The Great Gatsby"	Corpus	There were ninety-two relative clauses in the English version, but only	The results indicate that the lower proficiency in

	in English and its corresponding Chinese translation		thirty-two in the Chinese version.	the usage of relative clauses in Chinese results directly results in the lower production of English relative clauses.
Kamimoto et al. (1992) Collier-Sanuki (1993)	They criticized that Bley-Broman & Houghton (1988) just counted the relative clauses in the English version and their counterbalance clauses in Chinese but did not count all the relative clauses in both English and in Chinese, since there are no two languages that can match each other perfectly. Some English clauses may have corresponding Chinese relative clauses by translation, others may not, and vice-versa.			
Zhao (1989)	The novel "The Great Gatsby" in English and its Chinese version	Corpus	There were one hundred and twenty-four English relative clauses and ninety-one Chinese relative clauses. Only fifty-nine relative clauses had direct counterparts in the other language. Sixty-five and thirty-one Chinese relative clauses did not have counterparts in the other language. Considering the semantic and discourse functions of relative clauses, there was only one function for relative clauses in Chinese, which is restricting the reference of the head noun. In contrast there were several functions for English relative clauses.	Chinese learners' under production of English relative clauses cannot be ascribed as avoidance, but to a kind of language transfer at the discourse level.

Li (1996)	L1 Chinese learners of English	Writing test Translation test Interview	The participants were not able to produce almost half of the possible English relative clauses, they were not consciously avoiding their use. it is not because of avoidance but could be due to the special pragmatic functions of English relative clauses, for which the Chinese language uses other syntactic structures.	The under production of English relative clauses can be attribute to language transfer at the pragmatic level.
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### 2.3.2 Previous studies concerning structural priming

The previous studies concerning structural priming mainly focused on a) Structural priming and mental representation of syntax, and its implications to b) Language production, c) Language comprehension, as well as d) Different populations' Language acquisition. In the following sections, 2.3.2.1 contributes to previous studies concerning structural priming and mental representation of syntax; 2.3.2.2 mainly focuses on the preceding research related to structural priming and language production; 2.3.2.3 deals with earlier studies about structural priming and language comprehension; and 2.3.2.4 concentrates on structural priming and different populations' language acquisition.

#### 2.3.2.1 Structural priming and the mental representation of syntax

The status of syntax is an important issue regarding language processing in psycholinguistics, and related research began at the very initial stage of this field (Miller & Isard, 1963). There are two different standpoints, one is functionalist (Bates et al., 1982; Bates & McWhinney, 1979), and the other is autonomous (Bock, 1987; Frazier & Fodor, 1978). According to the functionalist view, language is a tool,

and each part of its structure can be analyzed according to its function in communication, such as the topic, agent, patient, etc. (Bates et al., 1982). Regarding the autonomous view, the structure of a sentence is an abstract form, and it is independent of other factors. Each part of the sentence structure should be categorized according to its syntactic category, such as noun, verb, adjective, etc. (Bock, 1987; Frazier & Fodor, 1978).

Bock (1986) found that structural priming could explain that people's mental representation of syntax is autonomous (Bock, 1986). He conducted three experiments to explore syntactic persistence using a picture depiction paradigm. Experiment one indicated that when the priming sentences were prepositional dative sentences, the participants were more likely to produce prepositional dative sentences rather than double-object dative sentences. When the priming sentences were double-object dative sentences, the production of double-object dative sentences would be greater. However, in active and passive sentences, the participants seemed to prefer to use active sentences when the agent was human, and passive sentences when the agent was non-human, irrespective of whether the priming sentence was in the active or passive voice. In order to know whether the feature of the agent played an important role in syntactic repetition, a second experiment was conducted. Experiment two showed that the participants preferred to produce passive sentences after passive priming, and active sentences after active priming. However, the effect of the agent still persisted but was weaker than that for syntactic structure persistence. Since the effect of the agent still existed in experiment two, although weaker than in experiment one, experiment three was conducted with the purpose of making sure whether the agent played a role in syntactic persistence. The results indicated that the production

of passive sentences increased for both non-human and human agent events. These three experiments indicated that the effects of priming were specific to the features of the sentence form, but independent of its content, and the results supported the autonomous view point (Bock, 1986).

Levelt & Kelter (1982) found a corresponding effect in the situation Q :( At) what time will you close? A: (At) five o' clock (Levelt & Kelter, 1982). It seems that repetition of the specific sentence structure is caused by repetition of the function words which support the functionalist standpoint. With the intention of assessing this possibility, Bock (1989) conducted two experiments with a syntactic priming procedure. The results showed that the participants were inclined to use the same structure as in the priming sentences and changing the function words had no impact on the participants' production. These results indicate that the function words are not the inherent constituents of English sentence structure, and in priming, what is repeated is the structure of the sentence, not the function words, which means that structural priming is structurally based, not lexically based (Bock, 1989). This study is also a support of the autonomous view.

Following Bock's (1989) work, there were some other studies which demonstrated that priming is not absolutely lexically based (Ferreira, 2003; Hartsuiker et al., 2004; Loebell & Bock, 2003; Pickering & Branigan, 1998; Saffran & Martin, 1997).

Saffran & Martin (1997) investigated the effect of structural priming on sentence production by aphasics using a picture depiction paradigm. Five aphasic patients participated in the experiment, and the results showed that the participants' production



of passives and locatives increased significantly after passive priming, since they have the same constitute structure NP-V-PP. And the production was always phonologically aberrant compared with the normal form. For example:

71. The book is written by the professor. (Passive)

72. The girl is dancing on the stage. (Locative)

The results indicate that the effect of priming is caused by the abstract structures other than closed-class morphology (Saffran & Martin, 1997), which is consistent with Bock's (1986, 1989) findings. Pickering & Branigan (1998) found that there was no different priming effect irrespective whether the priming sentence is "*the racing driver showed the torn overall*" or "*the racing driver shows the torn overall*". The findings indicate that the closed-class morphemes have no impact on priming (Pickering & Branigan, 1998). Ferreira (2003) conducted three experiments, employing a recall-based sentence production task, to investigate if the mention of an optional *that* in a sentence complement structure (e.g., "*the teacher noticed (that) the falling students skipped class*") could be primed by a preceding sentence which consisted of a lexically or lexically and syntactically similar "*that*".

73. The teacher noticed (that) the falling students skipped class. (Target sentence)

74. The director announced (that) casting decision last week. (Lexically similar prime)

75. The director announce (that) Hollywood's hottest actor would be playing that part. (Lexically and syntactically similar prime)

(Ferreira, 2003, p. 394)

The results showed that the target sentence was affected by the lexically and syntactically similar “*that*”, rather than only the lexically similar “*that*”. The results indicate that priming is independent of the lexical items, and this result is consistent with the autonomous view (Ferreira, 2003). In addition, the studies by Loebell & Bock (2003) and Hartsuiker, Pickering, & Velkamp (2004) found that structural priming could occur between languages (e.g. English passives could prime Spanish passives although they belong to different languages) (Hartsuiker et al., 2004; Loebell & Bock, 2003), which made the lexical dependent standpoint improbable.

Bock & Loebell (1990) conducted research to explore whether sentence frames were purely structural configurations or if they were affected by conceptual and metrical factors (e.g., *rhyme, number of syllables, and lexically stress patterns*). A picture depiction paradigm was employed but disguised as a memory test. Three sentence structures were used, a prepositional object dative, a locative structure, and a double object dative. In each set, all the three sentence structures were included, and they described the same event. The results showed that changing of the event had no impact on repetition of the prime sentence structure within the target sentences. Moreover, the structural frames were independent of the metrical and conceptual factors, and they were independent syntactic representations (Bock & Loebell, 1990).

Different from other researchers’ attention of function words, Pickering & Branigan (1998) focused on content words. A written sentence completion task was employed in the experiments, and the sentences were prepositional object dative (PO) and double object dative (DO) structures. The results indicate that structural priming could occur if the priming and the target sentence did not share the same verb, but, if

the verb was repeated the effect of structural priming was enhanced (Pickering & Branigan, 1998).

The previous studies concerning structural priming and the mental representation of syntax indicate that syntax is autonomous, which means that the structure of a sentence is an abstract form, and it is independent of other factors. In the process of structural priming, the function words have no impact whereas repetition of content words can enhance the effect of structural priming. Considering the content words, the study by Pickering & Branigan (1998) only assessed verbs in simple sentences, whether the other content words have the same effect still needs to be assessed. Therefore, in the present study, we assess whether the repetition of the head noun in “Noun +rRelative Clause” has the same effect.

Table 13 is a summary of the previous studies reviewed in this subsection.

Table 13 Previous studies concerning structural priming and the mental representation of syntax

Study	Participants	Data collection instruments	Main results	Implications
Bock (1986)	48 Cornell University students, 48 Pennsylvania university students, and 48 Michigan State University students	Picture description task	Participants produced more double-object dative, prepositional dative, active and passive after double-object dative, prepositional dative, active and passive, respectively, irrespective of the human or non-human agent events.	The results indicate that the effects of priming were specific to the features of the sentence form, but independent of its content.

Bock (1989)	288 Michigan State University undergraduates	Picture description task	The participants were inclined to use the same structure as in the priming sentences and changing the function words had no impact on the participants' production.	The results indicate that the function words are not the inherent constituents of English sentence structure, and in priming, what is repeated is the structure of the sentence, not the function words, which means that structural priming is structurally based, not lexically based.
Saffran & Martin (1997)	5 aphasic patients	Picture description task	The participants' production of passives and locatives increased significantly after passive priming, since they have the same constitute structure NP-V-PP. And the production was always phonologically aberrant compared with the normal form.	The results indicate that the effect of priming is caused by the abstract structures other than closed-class morphology.
Pickering & Branigan (1998)	188 students from the University of Glasgow	Written completion task	Priming occurs if the prime and target contain different verbs, but if the verb is repeated, the priming effect would stronger. And the priming effect is irrespective of tense, aspect or number of the verbs.	The findings indicate that the closed-class morphemes have no impact on priming.
Ferreira (2003)	128 students from the University of California, San Diego	Recall-based sentence production task	The participants' production of the target sentence was affected by the lexically and syntactically similar "that", rather than only the	The results indicate that priming is independent of the lexical items.

			lexically similar “ <i>that</i> ”.	
Loebell & Bock (2003)	48 fluent German-English bilinguals living in Southeastern Michigan	Picture description task	German dative sentences primed the subsequent use of the English dative sentences, and vice versa. German and English passives with different structure didn’t prime one another.	The results indicate that structural priming is lexical independent.
Hartsuiker, Pickering, & Veltkamp (2004)	24 Spanish-English bilinguals live in Edinburgh	Card description in a dialogue game	Participants used English passives more common after they heard Spanish passive sentences.	The results indicate that structural priming is lexical independent.
Bock & Loebell (1990)	192 students from Michigan State University	Picture description task	Changing of the event had no impact on repetition of the prime sentence structure within the target sentences. The structural frames were independent of the metrical and conceptual factors, and they were independent syntactic representations.	The findings indicate that structural priming is structure dependent.

### 2.3.2.2 Structural priming and language production

Although there are many languages production models (Dell, 1986; Fromkin, 1971, 1973; Garrett, 1975, 1976), the most influential one is Levelt (1989). According to Levelt and Speaking (1989), several stages are involved in language production. Firstly, speakers have an intention to speak, a preverbal message which needs to be presented, followed by the grammatical encoding stage. In this stage, the preverbal message is mapped to lexicons and coded according to the appropriate grammatical

structure. The next stage is encoding the phonological features. Finally, the subject would use their vocal organs and muscles to articulate the message (Levelt, 1993; Levelt & Speaking, 1989). As shown in Figure 7.

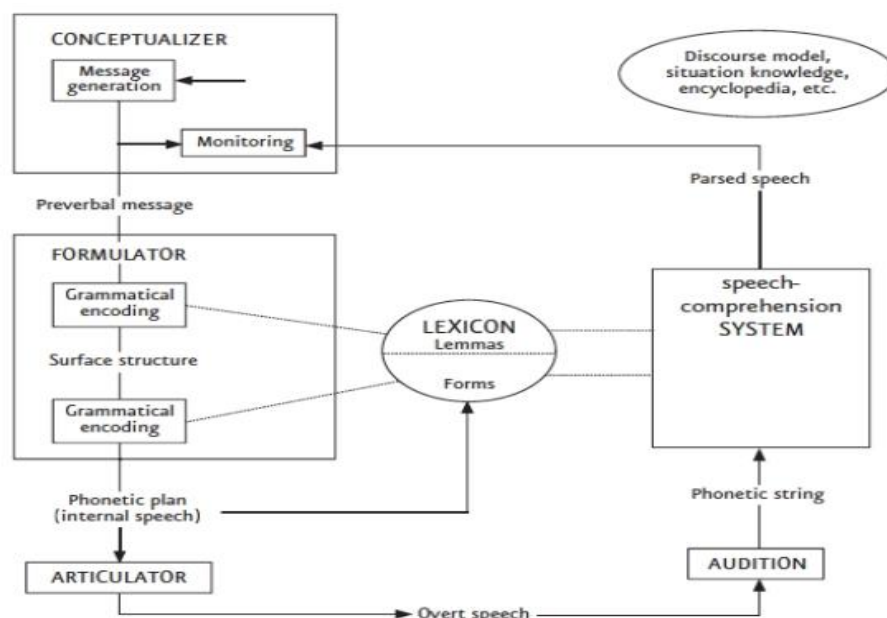


Figure 7 The speech blueprint by Levelt and Speaking (1989)

Previous studies related to structural priming covered three aspects of language production, the process from message to syntax, the different stages involved in grammatical encoding, and the essence of syntactic knowledge. In the following sections, 2.3.2.2.1 focuses on previous studies concerning structural priming and the process from message to syntax during the process of language production, 2.3.2.2.2 concentrates on structural priming and the different stages involved in grammatical encoding, and 2.3.2.2.3 discusses preceding studies related to structural priming and the essence of syntactic knowledge.

### 2.3.2.2.1 The process from message to syntax

The structure of a preverbal message is difficult to see, since it is hard to design approaches to assess this factor (Pickering & Ferreira, 2008). Nonetheless, investigating what properties are attached to or connected to such structures is possible. For example, if we want to express the meaning *an alarm clock awakened a boy*, the preverbal message stands for the information that a household object (an alarm) is the acting entity (agent) of an awakened event (awakened a boy), and a human being (a boy) is the act-upon entity (patient) of the same awakened event. If the subject produces an active sentence, the household object is connected to the subject. If the speaker produces a passive sentence, the human being is bounded to the subject. Previous research was related to what specific message representation properties are linked to the performance of such kinds of attachment (Bock et al., 1992; Branigan et al., 2008; Chang et al., 2003; Chang et al., 2006; Griffin & Weinstein-Tull, 2003; Hare & Goldberg, 1999; Salamoura & Williams, 2007a, 2007b).

Bock et al. (1992) conducted an experiment to investigate the relationship between the underlying and superficial linguistic structures. One hundred and ninety-two Michigan State University undergraduates participated. Three kinds of materials were included, priming sentences, pictures, and filler materials. Regarding the priming sentences, sixteen sets were included, each set consisted of two active and two passive sentences. They contained the same two noun phrases, one animate and the other inanimate. They also contained the same base verb.

Table 14 Examples of priming sentences in the experiment by Bock et al. (1992)

Priming conditions	Example sentences
Active, animate subject	Five people <u>carried</u> the boat.
Active, inanimate subject	The boat <u>carried</u> five people.
Passive, animate subject	Five people were <u>carried</u> by the boat.
Passive, inanimate subject	The boat was <u>carried</u> by five people.

In total, sixteen pictures were included, with each set of the priming sentences sharing one picture.



Figure 8 Example of experimental pictures in the experiment by Bock et al. (1992)

The priming sentences “the boy was awakened by the alarm” and “the alarm awakened the boy” shared the same picture.

Considering filler materials, forty-eight filler sentences and forty-eight filler pictures were included. The experiment was conducted in the form of a running recognition memory test, and the participants were divided into two groups, one group was the “meaning focus” group, and the other group was the “form focus” group. With respect to the “meaning focus” group, the participants focused only on the meaning of the sentences, as long as the sentences have the same meaning, no matter what kind of forms they have, they could be treated as the same. Regarding the “form focus” group, the participants should focus on the form, as long as the two sentences have the same form and same meaning, they could be regarded as the same sentence. The results revealed that there were more inanimate-subject actives produced after



inanimate subject-arguments primes than after animating subject-arguments primes, and after active than after passive primes. The magnitude of the increase after active primes relative to passives, was the same regardless of the animacy of the subject argument. It also showed that the animacy effects were larger and the form effects were smaller in meaning-focus group than in form focus group. There was a significant difference due to animacy and form in meaning-focus group and form-focus group, respectively. There was no significant difference due to form in meaning-focus group, and there was no significant difference due to animacy in form-focus group. The results indicated that both the format of the prime and the animate arguments affected the production of the sentences, and the effect of structural priming is independent of the animate to priming structure. This implies that animate priming is equal, no matter the effective of the animate feature in arguments with the same or different thematic roles. It also suggests that it is the primitive semantic features other than the thematic roles that underlie binding of the message-level elements to the grammatical relations (Bock et al., 1992; Pickering & Ferreira, 2008).

Different from Bock et al (1992), the studies by Griffin and Weinstein-Tull (2003) and Chang et al. (2003) demonstrate that there are some effects by the thematic roles on sentence production. Griffin and Weinstein-Tull (2003) explored whether an additional conceptual role can affect structural priming. Fifty-four undergraduates, native speakers of American English at Stanford University, participated in the study, and sentence recall task was employed. The results showed that the participants were most likely to paraphrase a finite complement clause (*e.g. the police suspected that Joan was the criminal*) as a noun phrase plus an infinitive clause (*e.g. the police man suspected Joan to be the criminal*) when they were paired with an infinitive object-

raising construction (*e.g. a teaching assistant reported the exam to be too difficult*), and least when paired with intransitives (*e.g. the UN peacekeeping force finally intervened*). The object-control (*e.g. Rover begged his owner to be more generous with the food*) and subject-infinitive (*e.g. Jenny actually intended to be a runner in the race*) resulted in an intermediate percentage of infinitive paraphrases (Griffin & Weinstein-Tull, 2003). This revealed that any differences in the participants' performance are most likely to come from the fact that infinitives with object-control verbs have an extra thematic role relative to object-raising verbs. This indicates that the thematic role<sup>4</sup> is an important factor in structural priming.

Chang et al. (2003) investigated whether thematic-role identity is sufficient to prime the order of noun phrases in sentence, within the same general structural configuration. Spray-load sentences with an alternative order of themes and locations were employed as primes, and different spray-load sentences presented with the same or contrasting order of thematic roles were used as the targets, and the sentence recall task was employed.

Table 15 is a summary of the previous studies reviewed in this subsection.

Table 15 The prime and target sentences in (Chang et al., 2003, p. 35)

Prime	Target
<p><b>Theme-location</b></p> <p>The maid rubbed polish onto the table.</p> <p><b>Location-theme</b></p> <p>The maid rubbed the table with polish</p>	<p><b>Theme-location</b></p> <p>The farmer heaped straw onto the wagon.</p>

<sup>4</sup> Thematic role: a term to express the role that a noun phrase plays with respect to the action or state described by a governing verb. Chomsky, N. (1981)

<p><b>Theme-location</b></p> <p>The maid rubbed polish onto the table.</p> <p><b>Location-theme</b></p> <p>The maid rubbed the table with polish</p>	<p><b>Location-theme</b></p> <p>The farmer heaped the wagon with straw.</p>
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Eighty-three students from the University of Illinois participated in the experiment. The results showed that the participants were significantly more likely to produce location-theme sentences after location-theme primes than after theme-location primes. This means that the order of the roles is influenced by the priming manipulation, and indicates that the thematic roles or features are active within the mapping between the messages and sentence structures. (Chang et al., 2003)

The studies by Hare and Goldberg (1999) and Salamoura and Williams (2007a) even showed much stronger effect of thematic role order. Hare and Goldberg (1999) replicated Bock and Loebell (1990) ditransitive and dative experiment but included the “provide with” sentence as a prime. The “provide with” sentences have the same syntactic structure as the prepositional dative but have the same semantic role assignment as the ditransitive sentences. And a picture description task was employed.

76. His editor offered Bob the hot story. (Ditransitive)

77. His editor promised the hot story to Bob. (Prepositional dative)

78. His editor credited Bob with the hot story. (Provide-with)

(Bock & Loebell, 1990, p. 2)

Forty-eight subjects participated in the experiment. The results showed that there were significantly more ditransitive responses following the “provide with” and ditransitive sentences than following the dative sentences, and there was no difference of the number of ditransitive responses following the ditransitive and the “provide with” primes. The results indicate that semantic factors did play a role during the process of mapping from the message to the sentence structure. Salamoura and Williams (2007a) evaluated the role of the constituent order and thematic roles in cross-language (Greek and English) syntactic priming, and they found similar results as Hare and Goldberg (1999) (Salamoura & Williams, 2007a).

#### **2.3.2.2.2 Structural priming and the levels within grammatical encoding**

According to Chomsky (1965), there are two levels of syntactic structure, the deep structure, and the surface structure. The surface structure is transformed from the deep structure and it is the representation of the deep structure (Chomsky, 1965). Later, Chomsky (1981) developed it, and assumed further levels, such as the logical form and the existence of traces. Regarding the logical form, it is a syntactic level that encodes certain lexical and semantic information by, considering the existence of traces, as it refers to the record in surface structure of the deep structure location of phrases that have subsequently been moved (Chomsky, 1981; Pickering & Ferreira, 2008). This theory is well known as transformational grammar. See Table 16.

Table 16 The examples of deep structure and surface structure in the trace theory Chomsky (1981, p. 79)

1.	It is certain that [John is here].
2.	John is certain [X to be here].

*Note: X is NP in the bracket of the second sentence, and it is the trace of movement.*

Bock et al (1992) assessed the viability of transformational grammar. The result showed that participants mapped the messages to syntax directly, and it indicates that the subjects did not construct the syntax via the movement of the deep structure (Bock et al., 1992). Bock et al's (1992) study is assumed as the one stage account, which means that the messages map to syntax directly. It is different from the two stages account, which claims that the speakers form a deep structure first, and then move to the surface structure.

Different from Bock et al. (1992), Hartsuiker (1999) assessed the existence of the linearization process, which imposes order on the constituent structure, of language production. The subjects were eighty-four undergraduate native Dutch speaking students at the University of Nijmegen. A picture description task was employed. The materials were twelve prime sentence sets and twelve target pictures, as well as twenty-four filler pictures and twenty-four filler sentences. With respect to the prime sentence sets, each set contained three sentences, a Locative State sentence, a Frontal Locative sentence, and a baseline sentence which is a "what" question and it cannot be used to describe a picture.

79. A ball is on the table. (Locative State sentence)

80. On the table is a ball. (Frontal Locative sentence)

(Hartsuiker, 1999, p. 135)

What should be mentioned is that both the Locative State sentence and Frontal Locative sentence could be used to describe the same situation, the only difference is the word order (see the previous example sentences). The results showed that there was syntactic persistence for the Locative State sentence and the Frontal Locative

sentence in Dutch. This indicates that the linearization process exists in language production, and it imposes order on the constituent structure (Hartsuiker, 1999).

Similar to Hartsuiker (1999), Hartsuiker and Westenberg (2000) investigated whether there is word order priming of auxiliary verbs and past participles in Dutch subordinate clauses in both speaking and writing. Sixty-six Dutch native speaking students at the University of Nijmegen participated in the experiment. The materials were twenty-four prime-target pairs. The prime sentence fragments were constrained so as to ensure that they can only be completed with one word order. The target sentence fragments could be completed with the same word order of the prime and an alternative order. See Table 17.

Table 17 is a summary of the previous studies reviewed in this subsection.

Table 17 Examples of priming fragments and target fragments in the experiment of Hartsuiker and Westenberg (2000)

Priming fragments	Auxiliary-final	Ik kon er niet door omdat de weg geblokkeer... (I couldn't pass through because the road blocked...)
	Participle-final	Ik kon er niet door omdat de weg was... (I couldn't pass through because the road was...)
	Noun-final	Ik kon er niet door want het wrak stond over... (I couldn't pass through because the wreck stood across...)
Target fragments		De skieEr lag in het ziekenhuis omdat hij zijn been... (The skier lay in the hospital because he his leg...)

The results revealed a strong priming effect, and that the participants were more likely to use the word order of the prime sentence for the target sentence completion

task. It indicates that there is a linearization process during language production (Hartsuiker & Westenberg, 2000). Both Hartsuiker et al (1999) and Hartsuiker & Westenberg (2000) were considered as the two stages account in language production. The explanation supplied by Hartsuiker et al. is that during language production, speakers first have some unordered words based on their function, and then they linearize them in order to make the utterance fluent and accurate, and structural priming occurs in the second stage (Hartsuiker, 1999; Hartsuiker & Westenberg, 2000).

However, Hartsuiker et al.'s explanation is just one possibility, there is another possibility that speakers linearize word order along with the function representation, which means that constituent structure formulation is a one-stage account. Pickering et al (2002) asked the participants to execute sentence completion tasks with a prepositional dative, double object dative, and baseline prime.

81. The racing driver showed the torn overall... (PO-inducing prime)
82. The racing driver showed the helpful mechanic... (Do-inducing prime)
83. The racing driver fainted... (Baseline prime)
84. The racing driver showed to the helpful *mechanic* .... (*Shifted prime*)
85. The patient showed... (Target)

(Pickering et al., 2002, p. 8)

Totally, four experiments were conducted. Experiment one showed that structural priming is a two-way process by comparing the prepositional object, the double object dative, and the intransitive priming. Experiment two and experiment

three showed that the performance of the “shifted primes” (The racing driver showed to the helpful mechanic...) is the same as the baseline sentences but cannot prime the production of prepositional object sentences. Experiment four showed similar results as experiment three for the speaking sentence completion task. This indicates that syntactic formulation is a one stage account (Pickering et al., 2002).

To summarize so far, the previous studies concerning structural priming and levels within grammatical encoding have mainly focused on whether it is a one-stage account or a two-stage account. All the results of the preceding research have suggested that structural priming cannot be entirely based on repetition of the grammatical relations (Pickering & Ferreira, 2008).

#### **2.3.2.2.3 Previous studies related to structural priming and the nature of syntactic knowledge**

Previous studies concerning structural priming and the nature of syntactic knowledge can be divided into three categories: some of the research has shown that the nature of syntactic knowledge is independent of the lexical (Bock, 1986; Bock, 1989; Bock & Loebell, 1990; Pickering & Branigan, 1998; Tree & Meijer, 1999); some studies have supplied evidence that the nature of syntactic knowledge is lexically dependent (Branigan et al., 2000; Cleland & Pickering, 2006; Corley & Scheepers, 2002; Pickering & Branigan, 1998; Schoonbaert et al., 2007); others concerned syntactic knowledge and modality, and the previous research demonstrated that no matter whether the language producers are writing or speaking, they use the same representation of syntactic knowledge (Cleland & Pickering, 2006).

With respect to lexically independent view, this means that speakers are prone to reuse the same syntactic structure regardless of the content or lexical of the sentence.



Bock (1986) conducted research on syntactic persistence in language production by means of three experiments. In experiment one, the participants were forty-eight members of the University of Pennsylvania campus community. There were two phases in the experiment. In the first phase, the participants were asked to listen to some priming sentences and observe some pictures. In the second phase, they were asked to listen to some sentences and observe some pictures, and then answer yes or no in terms of whether they had encountered them in phase one. Finally, they were asked to listen to some priming sentences and repeat the sentences they had heard, and describe the pictures presented immediately after their repetition of the sentence. The sentences and pictures had no content relationship with the previous sentences and pictures. The priming sentences were prepositional dative, double-object dative, active transitive and passive transitive, respectively.

86. A rock star sold some cocaine to an undercover agent. (Prepositional dative)

87. A rock star sold an undercover agent some cocaine. (Double-object dative)

88. One of the fans punched the referee. (Active transitive)

89. The referee was punched by one of the fans. (Passive transitive)

(Bock, 1986, p. 361)

The results indicated that, when the priming sentences were prepositional dative sentences the participants were more likely to produce prepositional dative sentences rather than double-object dative sentences. When the priming sentences were double-object dative sentence, the production of double-object dative sentence would be more. However, with the active and passive sentences, the participants seemed to

prefer to use active sentences when the agent was human, and passive sentences when the agent was nonhuman, irrespective of whether the priming sentence was in the active or passive voice. In order to know whether the feature of the agent played an important role in syntactic repetition, a second experiment was conducted.

Regarding the second experiment, the participants were forty-eight Cornell University students. Twenty-four sets of transitive priming sentences and twenty-four sets of target pictures were used. For the priming sentences, half were human agents, and half nonhuman agents. The proportion of passive and active sentences was one to one. The procedure was the same as that for experiment one. The participants were required to describe pictures after four kinds of priming, which were active human agent, passive human agent, active nonhuman agent, and passive nonhuman agent. The results showed that the participants preferred to produce passive sentences after passive priming, active sentences after active priming. However, the effect of agent persisted but was weaker than for syntactic structure persistence.

In experiment three, the researcher examined the floor effect which means the effect of different order of agent and patient to structural priming and strengthened the priming manipulation of the passive sentences associated with the agent factor. The participants were forty-eight members of Michigan State University. The materials were the same as for experiment two. What was especially significant was that the left-to-right relationship between the agent and patient was balanced, and the human agent and nonhuman agent were also balanced. In addition, the priming sentences were suitably manipulated. The results showed that the production of passive sentences increased for both nonhuman agent events and the human agent events.

These three experiments indicated that the effects of priming were specific to the features of the sentence form, and independent of the sentence content.

The above experiments involved open-class words in structural priming, besides, Bock (1989) also assessed the closed-class hypothesis, which claims that function words play a privileged role in language production (Bock, 1989). Bock (1989) conducted two experiments to investigate whether closed-class words are inherent in the syntactic structure, more specifically, whether *for* and *to* are inherent in the prepositional dative and double object dative structures. Two experiments were conducted, and the participants were undergraduate students in Michigan State University. The experiment instrument was a picture description task. Both prepositional dative and double object dative sentences with *for* and *to* were used as the prime materials. The results showed that the participants were more likely to produce prepositional dative sentences after the prepositional dative, and more prone to reuse double object dative after the double object dative. But when manipulated the closed-class words *for* and *to* in the prepositional dative priming sentence, there was no significant difference of the production. And for double-object dative, things were the same. This indicates that closed-class words are not inherent in the components of syntactic structures of English sentences (Bock, 1989).

Besides open-class words and closed class words, Bock & Loebell (1990) explored whether sentence forms are purely structural constructions or derived from the meaning. Three experiments were conducted with ninety-six undergraduates from Michigan State University as the participants. The research instrument was a picture description paradigm. Prepositional dative, prepositional locative and double object

dative sentences were used as primes in experiment one; passive, locative and active sentences were employed as primes in experiment two; and prepositional dative, infinitive and double object sentences were adopted as the priming sentences in experiment three. Examples as follows:

90. The hospital showed the bill to the patient by mistake. (Prepositional dative)

91. The hospital returned the bill to the patient by mistake. (Prepositional locative)

92. The hospital sent the patient the bill by mistake. (Double object dative)

93. The 747 was alerted by the airport's control tower. (Passive)

94. The 747 was landing by the airport's control tower. (Locative)

95. The 747 radioed the airport's control tower. (Active)

96. Susan brought a book to Stella. (Prepositional dative)

97. Susan brought a book to study. (Infinitive)

98. Susan brought the student a book. (Double object dative)

(Bock & Loebell, 1990, pp. 11,18,25)

The results of the first and second experiments indicated that event-structure changes had no impact on the reliable tendency to replicate the phrase structure of the pictures within the target sentences. Experiment three revealed that this tendency cannot be attributed to metrical or closed-class lexical similarities. The results indicate that sentence frames are comparatively independent syntactic configurations, and are not identifiable with metrical or conceptual information (Bock & Loebell, 1990).

According to Bock et.al. (1986, 1989) research, syntactic frames are independent with open-class words and closed-class words, as well as the metrical and conceptual factors of the sentence. If so, then irrespective of the other aspects of the prime and target sentences, as long as they share the same structure, the effect of priming should be equal. Studies by Fox Tree & Meijer (1999) and Pickering & Branigan (1998) demonstrated this.

Tree and Meijer (1999) explored the production of simple and complex sentences by people using a sentence recall task. Seventy students attending the University of California, Santa Cruz participated. The materials were simple target sentences containing two simple noun phrases in the double-object (NP-NP) construction and their counterpart NP-PP structure with the preposition *to*, as well as Complex sentences containing a relative clause in the direct object. Each target sentence was paired with three priming conditions, the switch complexity match, the switch complexity mismatch, and the no switch complexity mismatch. Considering the switch complexity match, it refers to that the prime sentence contained an NP-PP construction, and its phrases had the same complexity as the target sentence. Regarding the switch complexity mismatch, it means that the prime sentence contained the NP-PP construction, but its phrases were different in complexity from the target sentence. With respect to the no switch complexity mismatch, it refers to that the prime sentence contained the NP-NP construction, and its phrases were different in complexity from the target sentence. Examples as follows:

Table 18 Examples of priming sentences in the experiment by Tree and Meijer (1999, p. 29)

Simple target		The representative of the western nation offered the country an agreement.
Prime	Switch, match	The nurse read the most recent letter to the wounded soldier.
	Switch, mismatch	The nurse read the most recent letter to the soldier who was wounded.
	No switch, mismatch	The nurse read the soldier who was wounded the most recent letter
Complex target		The professor offered his students the theories that had insulted many people.
Prime	Switch, match	The politician read the memo that would ruin his career to the intern.
	Switch, mismatch	The famous politician read the disturbing memo to the new intern
	No switch, mismatch	The famous politician read the new intern the disturbing memo.

The results showed that more switches were found in the switch complexity matched and switch complexity mismatched situations, and less in the situation of the no switch complexity mismatch. The number of switches in the first two situations were similar. The results indicate that simple and complex noun phrases are created by the same syntactic routines during language production (Tree & Meijer, 1999).

Pickering and Branigan (1998) conducted five experiments to investigate syntactic priming. A written completion task was employed through all the five experiments. Experiments one and two showed that syntactic priming occurred if the priming sentence and the target sentence contained different verbs, but if they shared the same verb, the effect of syntactic priming would be enhanced. Experiments three, four, and five revealed that syntactic priming is irrelevant to the tense, aspects, or the number of verbs. The results indicate that syntactic information is represented in the lemma stratum<sup>5</sup>, rather than by any form of the verb (Pickering & Branigan, 1998).

In addition, Branigan, Pickering, McLean, and Stewart (2006) investigated the role of the local and global syntactic structure in language production. According to the researchers, the local syntactic structure refers to the subordinate clause, while the global syntactic structure refers to the main clause (Branigan, Pickering, McLean, & Stewart, 2006). The experiments were conducted in different situations, the first situation was that the verb phrase structures were in the main clauses, but the sentence structures of the priming and the target were not included in the consideration. The second situation was that the verb structures were in subordinate clauses, and there were two situations included in this case---when the prime sentence and target sentence were both in the subordinate clauses, or when one of them was in the subordinate clause and the other in the main clause. The results revealed that, no matter in which situation, the effect of priming is similar, and there was no significant difference. The results indicate that the language producer uses the same procedure to

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<sup>5</sup> Lemma stratum: It refers to a stage in which abstract conceptual form of words were mentally selected for utterance in the early stages of speech production. Levelt (1989)

process the language structures, which means that the local and the global clauses share the same language process procedure (Branigan et al., 2006).

In sum, the previous studies have demonstrated that the sentence structures or phrase structures could be primed, and the process of structural priming and language production have suggested that syntactic knowledge is independent from lexical knowledge. However, some studies have demonstrated that this is dependent upon lexical knowledge, as shown below.

Considering the lexical dependent standpoint, when the priming and the target sentences share the same structure, and the content words are shared, the effect of priming would be enhanced. Pickering and Branigan (1998) were the first researchers to demonstrate this view. Totally, one hundred students attending the University of Glasgow participated, and a written sentence completion task was employed. The results revealed that, if the priming and the target sentences have different verbs, the prepositional dative and the double object dative sentence have a similar priming effect, which means that similar numbers of prepositional dative sentences and double object dative sentences was produced after the prepositional dative and double object dative priming, respectively. But if the priming and the target sentence share the same verb, the priming effect is enhanced. The results indicate that structural priming is lexically dependent (Pickering & Branigan, 1998).

After Pickering and Branigan (1998), other researchers replicated their study. Some of them adopted a sentence completion task (Cleland & Pickering, 2006; Corley & Scheepers, 2002), some used dialogue (Branigan et al., 2000; Schoonbaert et al., 2007), and the results were similar.



Cleland and Pickering (2006) replicated Pickering and Branigan (1998) with participation by sixty-four students from the University of Glasgow, sentence completion task was employed. The results showed that there was a priming effect, irrespective of whether the priming and the target sentences shared the same verb or not, but if they shared the same verb, the priming effect was enhanced (Cleland & Pickering, 2006).

99.

1a. The neighbor lends the mower (Prepositional- Object-inducing prime)

1b. The neighbor lends the friend (Double-Object-inducing prime)

2. The cook lends (Target)

(Cleland & Pickering, 2006, p. 188)

Corley and Scheepers (2002) replicated Pickering and Branigan's (1998) study based on the Web. Sixty-six native English speakers were recruited via Internet posters or links. A type of sentence completion task was employed, since it can not only inspect the participants' production, but also detect their response onset latency (time taken to press the first key of the response following presentation of the target). The materials came from Pickering and Branigan (1998), the priming sentences were followed by the target fragments. Regarding the priming sentences, in each set, there were four sentences that shared the same subject noun phrases, while the first two also shared the same verb used in a Prepositional-Object construction and a Double-Object construction, respectively. The situation of the other two sentences was similar to the

first two. The target sentence fragments were open to the using of the Prepositional-Object construction and the Double-Object construction. Examples are as follows:

100.

*1a. The bank manager handed the cheque...*

*1b. The bank manager handed the customer...*

*1c. The bank manager gave the cheque...*

*1d. The bank manager gave the customer...*

*2. The junior surgeon handed...* (Target fragments)

Priming sentences

(Corley & Scheepers, 2002, p. 127)

The results exhibited the same priming effect as Pickering and Branigan (1998), moreover, when the priming sentence and the target sentence shared the same verb, the response onset latency was much less than that when they used different verbs, and the difference was significant. The results supported the view of Pickering and Branigan (1998), and provided evidence of the response onset latency (Corley & Scheepers, 2002).

With a novel developed technique called confederate scripting (Some of the participants were not really participants, actually they were confederates of the experimenter, and had the script of the description of the pictures or cards that they hold. The script was supplied by the experimenter according to the purpose of the experiment), Branigan, Pickering, and Cleland (2000) investigated whether language producers coordinated the structure of the sentences during the process of language

production. Twenty-four subjects from the University of Glasgow participated. The participants and the confederates took turns to describe their cards. Two sets of forty-eight cards were used as the materials, each set included twelve cards describing ditransitive actions consisting of an agent, a patient, and a beneficiary. The other thirty-six cards described a simple action comprising an agent and a patient, and they acted as filler cards. With respect to the two sets of cards, one set was the participants' cards, the other set was the confederates' cards, and the two sets of cards were ordered before the experiment. Regarding the order, the confederates' cards were treated as the priming cards, and the order of the participants' experimental cards was the same as the priming cards, when the confederate described his/her cards, and then it was the participants' turn, he/she would describe the cards which corresponded with the confederates' card. The results showed that the participants were more likely to reuse the structures that the confederates used when describing their cards. Moreover, if the priming card and the target card used the same verb, the effect of priming was enhanced. This indicates that language producers did coordinate the structure of the sentence, and the process was not only structurally dependent, but also lexically dependent (Branigan et al., 2000).

Apart from investigation of the function of the verb in structural priming, Cleland and Pickering (2003) explored the effect of noun repetition in structural priming, using the confederate scripting task. Sixteen students attending the University of Edinburgh participated, and four equivalent sets of one hundred and fifty cards, including fifteen shapes in ten colors, were used as the materials. Each participant and confederate had two sets of cards, one set was used to describe and the other set was used to match the interlocutor's description. Regarding the content of the cards, each

shape appeared three to four times as prime, and each color appeared four to five times as prime. With respect to whether the target and the prime shared shape, color, or pre-nominal adjective or head noun and relative clause, there were eight conditions as included as in the following examples.

101.

1a. The red square. (Same adjective, same noun, prenominal)

1b. The square that is red. (Same adjective, same noun, relative clause)

1c. The red diamond. (Same adjective, different noun, prenominal)

1d. The diamond that is red. (Same adjective, different noun, relative clause)

1e. The green square. (Different adjective, same noun, prenominal)

1f. The square that is green. (Different adjective, same noun, relative clause)

1g. The green diamond. (Different adjective, different noun, prenominal)

1h. The diamond that is green. (Different adjective, different noun, relative clause)

(Cleland & Pickering, 2003, p. 219)

The results showed that, when there was structural priming between the prime and the target, the participants were more likely to produce prenominal adjective and relative clauses when following the prenominal adjective and relative clause prime, respectively. Moreover, when the prime and the target shared the same noun, the priming effect was enhanced, and the effect was significant. When the prime and the target shared the same adjective, the effect of priming was increased. The results indicate that the structure of the sentence can affect structural priming, and repetition

of the content words can enhance the effect (Cleland & Pickering, 2003). This supports the study by Branigan et al. (2000).

In short, previous studies concerning lexical dependent standpoint demonstrated that, when the priming sentence and the target sentence share different content words, structural priming exists; but when they share the same content word (E.g., verb), the effect of structural priming would be enhanced. Considering function words, previous research found that structural priming was independent of the function words, such as prepositions (Bock, 1989; Tree & Meijer, 1999) and complementizers (Ferreira, 2003).

Considering syntactic knowledge and modality, the previous studies have demonstrated that this is independent from modality, which means that no matter whether the language producers are writing or speaking, they use the same representation of syntactic knowledge (Cleland & Pickering, 2006).

Cleland and Pickering (2006) explored whether writing and speaking employed the same syntactic representations via a sentence completion task. The subjects were students attending the University of Glasgow, the materials were sets of prepositional-object-inducing prime sentences, double-object-inducing prime sentences, and target fragments, with examples as follows:

102.

1a. The neighbor lends the mower (Prepositional-object-inducing prime)

1b. The neighbor lends the friend (Double-object-inducing prime)

## 2.The cook lends (Target)

(Cleland & Pickering, 2006, p. 188)

The effect of structural priming within modality and between modality was assessed. Considering priming between modality, written priming and the spoken target, and spoken priming and the written target were included. Regarding priming within modality, spoken priming and the spoken target, and written priming and the written target were included. The effect of repetition of the verb was also assessed. The results revealed that there was structural priming both within and between modality, but there was no significant difference between the priming effects. What is more, if the priming sentence and the target shared the same verb, the priming effect was enhanced. These results indicate that writing and speaking shared the same representation of syntactic, and structural priming is lexically dependent (Cleland & Pickering, 2006), which supports Pickering and Branigan (1998).

To sum up, previous studies concerning structural priming and the nature of syntactic knowledge mainly focused on three aspects, lexically independent, lexically dependent, and modality dependent.

Table 19 is a summary of the previous studies reviewed in this subsection.

Table 19 Previous studies concerning structural priming and language production

<b>Study</b>	<b>Participants</b>	<b>Data collection instruments</b>	<b>Main results</b>	<b>Implications</b>
Bock et al. (1992)	192 Michigan State University undergraduates	Picture description task	There were more inanimate-subject actives produced after inanimate subject-arguments primes than after	The results indicate that both the format of the prime and the animate arguments

			animating subject-arguments primes, and after active than after passive primes. The magnitude of the increase after active primes relative to passives, was the same regardless of the animacy of the subject argument.	affected the production of the sentences, and the effect of structural priming is independent of the animate to priming structure. This implies that animate is equal, no matter the effective of the animate feature in argument with the same or different thematic roles. It also suggests that it is the primitive semantic features other than the thematic roles that underlie binding of the message-level elements to the grammatical relations.
Griffin and Weinstein-Tull (2003)	54 undergraduates, native speakers of American English at Stanford University	Sentence recall task	The participants were most likely to paraphrase a finite complement clause as a noun phrase plus an infinitive clause when they were paired with an infinitive object-raising construction, and least when paired with intransitives. The object-control	The results indicate that any differences in the participants' performance are most likely to come from the fact that infinitives with object control verbs have an extra thematic role relative to object-raising

			and subject-infinitive resulted in an intermediate percentage of infinitive paraphrases.	verbs, and thematic role is an important factor in structural priming.
Chang et al (2003)	83 students from the University of Illinois	Sentence recall task	The participants were significantly more likely to produce location-theme sentences after location-theme primes than after theme-location primes.	The result means that the order of the roles is influenced by the priming manipulation and indicates that the thematic roles or features are active within the mapping between the messages and sentence structures.
Hare & Goldberg (1999)	48 undergraduates from Bowling Green State University	Picture description task	There were significantly more ditransitive responses following the “provide with” and ditransitive sentences than following the dative sentences, and there was no difference of the number of ditransitive responses following the ditransitive and the “provide with” primes.	The results indicate that semantic factors did play a role during the process of mapping from the message to the sentence structure.
Salamoura & Williams (2007)	108 Greek-English bilinguals	Oral sentence completion task	The participants were more likely to produce L2 English prepositional dative and double-	The results indicate that structural priming is structural based, and not lexical



			object dative sentences after the corresponding L1 Greek priming, and the effect was significant. There was no enhanced priming effect when the L1 Greek priming sentence and the L2 English target sentence shared the same verb (translation equivalent).	based.
Hartsuiker et al. (1999)	84 undergraduate native Dutch speaking students at the University of Nijmegen	Picture description task	There was syntactic persistence for the Locative State sentence and the Frontal Locative sentence in Dutch.	The results indicate that the linearization process exists in language production, and it imposes order on the constituent structure.
Hartsuiker & Westenberg (2000)	66 Dutch native speaking students at the University of Nijmegen	Sentence completion task	The participants were more likely to use the word order of the prime sentence for the target sentence completion task.	The results indicate that there is a linearization process during language production.
Pickering et al (2002)	117 students from the University of Glasgow, and 32 students from the University of Edinburgh.	Sentence completion task	Experiment one showed that structural priming is a two-way process by comparing the prepositional object, the double object dative, and the intransitive priming. Experiment two showed that the performance of the “shifted primes”	The results indicate that structural priming is a one-way account.

			(The racing driver showed to the helpful mechanic...) is the same as the baseline sentences but cannot prime the production of prepositional object sentences.	
Fox Tree & Meijer (1999)	70 students attending the University of California, Santa Cruz	Sentence recall task	More switches were found in the switch complexity matched and switch complexity mismatched situations, and less in the situation of the no switch complexity mismatch.	The results indicate that simple and complex noun phrases are created by the same syntactic routines during language production.
Branigan, Pickering, McLean, and Stewart (2006)	54 students from the University of Glasgow, and 54 students from the University of Edinburgh	Sentence completion task	The local and the global clauses share the same language process procedure	The results indicate that the language order uses that same procedure to process the language structures, which means that the local and the global clauses share the same language process procedure.
Cleland & Pickering (2006)	64 students attending the University of Glasgow	Sentence completion task	There was a priming effect, irrespective of whether the priming and the target sentences shared the same verb or not, but if they shared the same verb, the	The repetition of content word can facilitate structural priming.

			priming effect was enhanced.	
Corley & Scheepers (2002)	66 native English speakers	A type sentence completion task	There was a priming effect, irrespective of whether the priming and the target sentences share the same or verb or not, but if they shared the same verb, the priming effect was enhanced. Moreover, when the priming sentence and the target sentence shared the same verb, the response onset latency was much less than that when they used different verbs.	The repetition of content word can facilitate structural priming.
Branigan, Pickering & Cleland (2000)	24 subjects from the University of Glasgow	Confederate scripting task	The participants were more likely to reuse the structures that the confederates used when describing their cards. Moreover, if the priming card and the target card used the same verb, the effect of priming was enhanced.	The results indicate that language producer does coordinated the structure of the sentence, and the process was not only structurally dependent, but also lexically dependent.
Cleland & Pickering (2003)	16 students attending the University of Edinburgh	Confederate scripting task	There was structural priming between the prime and the target, the participants were more likely to produce	The results indicate that the structure of the sentence can affect structural priming, and the repetition of the

			<p>prenominal adjective and relative clauses when following the prenominal adjective and relative clause prime, respectively. Moreover, when the prime and the target shared the same noun, the priming effect was enhanced. When the prime and the target shared the same adjective, the effect of priming was increased.</p>	<p>content word can enhance the effect.</p>
<p>Cleland &amp; Pickering (2006)</p>	<p>48 students attending the University of Glasgow. 16 students attending the University of Edinburgh</p>	<p>Sentence completion task</p>	<p>The results showed that there was structural priming both within and between modality, but there was no significant difference between the priming effects. What is more, if the priming sentence and the target share the same verb, the priming effect was enhanced.</p>	<p>The results indicate that writing and speaking shared the same representation of syntactic, and structural priming is lexically dependent.</p>

### 2.3.2.3 Structural priming and language comprehension

Apart from structural priming and language production, structural priming and language comprehension is another research direction (Branigan et al., 2005; Thothathiri & Snedeker, 2008a; Traxler, 2008a, 2008b; Traxler & Tooley, 2008). In

the following sections, previous studies concerning structural priming and language comprehension are reviewed.

Branigan, Pickering, and McLean (2005) performed experiments to investigate whether comprehension could be primed. The participants were students attending the University of Edinburgh. A description and matching task were employed. Sentences like *the waitress was prodding the clown with the umbrella* were used as the priming sentence, since it is an ambiguous sentence and could be comprehended as *the waitress use the umbrella prodding the clown* or *the waitress prodding the clown and the clown hold an umbrella*. The former one is called high-attachment, because the PP *with the umbrella* attached with the VP *prodding*, and the VP is higher in the phrase structure tree. The latter one is called low-attachment, since the PP *with the umbrella* was attached with the NP *the clown*, and the NP is low in the phrase structure tree. The participants were first exposed to the priming sentence, then two pictures were shown, and they were asked to match the picture with the sentence. One picture corresponded with either the high-attachment sentence or the low-attachment sentence, the other one corresponded with none of the two comprehensions. For the next session, an ambiguous sentence similar to the priming sentence was shown to the participants, the same description and matching task was given, but the difference was that one of the pictures was corresponded to the high-attachment sentence, whereas the other one corresponded to the low-attachment sentence. The results revealed that when the priming sentence and the target sentence shared the same verb, the effect of priming was significant, but when the priming sentence and the target sentence contained different verbs, although there were some effects of priming, it was not significant. It also showed that, when the priming sentence and the target sentence

shared the same verb, the matching time was faster. The results therefore indicate that comprehension could be primed, and it is related to the structure and the verb (Branigan et al., 2005).

Unlike Branigan et al. (2005), Traxler (2008a) found lexically independent priming in online sentence comprehension. Two eye-tracking experiments were performed, forty-eight and fifty-four native English speakers participated, respectively. The materials for experiment one were pairs of sentences like the following.

103.

1a. The girl tossed the blanket on the bed into the laundry this morning. (Same-structure priming)

1b. The girl tossed the blanket into the laundry this morning. (Different-structure priming)

1c. The vendor tossed the peanuts in the box into the crowd during the game. (Target)

(Traxler, 2008a, p. 150)

For experiment two, the materials were the same as for experiment one, except that the main verbs were different from each other. The results revealed that no matter in which experiment, as long as the target sentence and the priming sentence shared the same structure, processing of the target sentence was facilitated. The results indicate that structural priming of sentence on-line comprehension is lexically independent (Traxler, 2008a).

The experiments conducted by Branigan et al. (2005) showed that priming can affect people's comprehension, but the process used by people to develop their interpretation was not clear. In light of this, Traxler (2008b) conducted one eye-tracking experiment to investigate whether prime sentences containing agent or instrument prepositional phrases would facilitate processing of the target sentences including the same or different prepositional phrases.

104. The director watched by the cop was in a bad part of town. (Agent PP)

105. The director watched with the binoculars was in a bad part of town.  
(Instrument PP)

106. The lifeguard watched by the swimmer had a deep dark suntan. (Agent PP)

107. The lifeguard watched with the telescope had a deep dark suntan.  
(Instrument PP)

(Traxler, 2008b, pp. 661-662)

The subjects were forty-eight native English-speaking students attending the University of California Davis, and the instrument was eye-tracking software. The materials were twenty-eight sets of sentences similar to the above examples. The results showed that there was a robust priming effect when processing sentences including an agent PP after the priming sentences containing an agent PP and instrument PP. The effect of priming was also robust when the priming and the target sentences both contained an instrument PP. However, there was no significant priming effect when the priming sentence contained an agent PP, but the target sentence contained an instrument PP (Traxler, 2008b). See Table 20.

Table 20 Results of Traxler (2008b) experiment

Priming sentences	Target sentences	Results
Agent PP	Agent PP	Significant priming effect
Instrument PP	Agent PP	Significant priming effect
Agent PP	Instrument PP	Non-significant priming effect
Instrument PP	Instrument PP	Significant priming effect

The results suggest that priming may be responsive to a level of representation at which different types of adjuncts<sup>6</sup> are differentiated (Cleland & Pickering, 2003).

Similarly, Ledoux et al. (2007) conducted research using the event-related potentials to explore whether priming in on-line comprehension is syntactic or lexical. Thirty right-handed native English-speaking students attending the University of California Davis participated in the experiment. The materials were eighty priming sentences containing forty Main Clauses (MC) and forty Reduced-Relative Clauses (RRC), and eighty target sentences which were all Reduced-Relative Clauses (RRC), as well as one hundred and ninety filler sentences. Examples are as follows:

Table 21 Examples of materials in the experiment (Ledoux et al., 2007, p. 136)

RR Prime	MC Prime	RR Target
The speaker proposed by the group would work perfectly for the program.	The speaker proposed the solution to the group at the space program.	The manager proposed by the directors was a bitter man.

<sup>6</sup> Adjunct: A construction that can give extra information in a sentence. On-line Cambridge Advanced Learner's Dictionary and Thesaurus.



The manager proposed by the directors was a bitter old man.	The manager proposed the changes to the bitter old man.	The speaker proposed by the group would work perfectly for the program.
---	---	---

An Electroencephalograph (EEG) machine was used to record the participants' reaction time. The participants were required to read the RR target sentences, following either the MC prime sentences or the RR prime sentences containing the same verb. The results showed that the RR primes elicited a larger positivity, whereas the MC primes did not, and the RR targets preceded with MC primes elicited a larger positivity, but if preceded with the RR primes they did not. The results also exhibited that there was no significant priming effect caused by repetition of the verbs. The results indicate that syntactic priming in comprehension is syntactically based not lexically based (Ledoux et al., 2007).

In addition, Traxler and Tooley (2008) carried out two eye-tracking experiments and two self-paced reading experiments to investigate whether priming in comprehension was strategic or syntactic. For experiment one, the subjects were twenty-two undergraduates at the University of California Davis, and the instrument was eye-tracking. With respect to the materials, the previous studies had shown that the repetition of verbs could affect the priming effect, and the verb may be the priming cue. The experimenter manipulated the filler sentences, some of the filler sentences shared the same verb, but one was intransitive and, the other transitive. Some of the filler sentences shared the same verb, but some were subject-relative

clauses and, some were object-relative clauses. The prime sentences were reduced relative clauses and main clauses, and the target sentences were reduced relative clauses.

### **Examples of prime sentences**

108. The defendant examined by the lawyer was unreliable. (Reduced-relative clause)

109. The defendant examined the glove but was unreliable (Main clause)

### **Examples of filler sentence pairs**

110. The ship sank in the middle of the ocean after the storm. (Intransitive)

111. The submarine sank the freighter with one torpedo. (Transitive)

112. The painter that the critic liked lived in Paris. (Object relative)

113. The girl that liked the athlete was very shy. (Subject relative)

(Traxler & Tooley, 2008, pp. 615-616)

The result showed a robust priming effect, although the priming cue was eliminated. Regarding experiment two, the participants were from the same university, and the materials were derived from experiment one, but the verbs were not repeated and, the nouns were repeated. The filler sentence pairs were just random sentences. The instrument was also eye-tracking. The results explicated that, although there was noun repetition cue for priming, there was no significant priming effect. Considering experiment three, the subjects came from the same population as for experiment one and two, the materials adopted were from experiment two, the instrument was self-paced reading, and the experimenter gave a strong cue to the participants that half of

the target sentences should be described in reduced-relative clause. The results exhibited that there was no significant priming effect, although there was a strong cue for priming. With regard to experiment four, it demonstrated that self-paced reading is sensitive to the priming effect. The results of the preceding three experiments indicate that priming in comprehension is syntactic rather than strategic (Traxler & Tooley, 2008).

Besides, there were some researchers using visual world paradigm (Eberhard et al., 1995) to investigate structural priming in comprehension (Arai et al., 2007; Scheepers & Crocker, 2004; Thothathiri & Snedeker, 2008a).

Scheepers and Crocker (2004) conducted an experiment to investigate syntactic priming in comprehension, by looking at the resolution of constitute order ambiguity in German. Forty-eight native German speaking undergraduates from Saarland University participated. The priming materials were three types of written sentences, SVO primes, OVS primes, and Neutral primes. Examples as the following:

(114) Der Regisseur lobte insbesondere den Produzenten.

115. The director [nom] commended in particular the producer. (SVO prime)

116. Den Regisseur lobte insbesondere der Produzent.

117. The director commended in particular the producer. (OVS prime)

118. Vor den Wahlen wurde im Fernsehen heftig gestritten.

119. Before the elections there was a lot of debate on TV. (Neutral prime)

(Scheepers & Crocker, 2004, p. 10)

The target materials were twenty-four pictures which contained three characters: a nurse in the middle of the picture, a priest at the right side of the picture, and a sportsman at the left side of the picture. Accompanied with the pictures were sentences that initially had “the nurse” as the subject or object. The prime and target sentences were unrelated and used different verbs. On each trial, the participants were required to read one of the three priming sentences aloud, and then immediately watch the picture and simultaneously they listened to a target sentence which began with “the nurse”, and the participants’ eye movement was monitored and recorded. The results showed a robust priming effect by the constituent order if the prime and the target sentences shared the same constituent order (SVO or OVS). This indicates that the constituent order in comprehension could be primed, and it is independent of the verb (Scheepers & Crocker, 2004).

After Scheepers and Crocker (2004), Arai et al. (2007) performed two experiments to investigate whether structural priming in comprehension was the same as in production considering the ditransitive sentences. With respect to experiment one, the subjects were thirty-two native British English-speaking students attending the University of Dundee. The materials were thirty-two items, in each item, two stimuli were included: a written sentence which served as the prime sentence, and a spoken sentence accompanied with a picture, which served as the target. The prime sentences and the target sentences were either double-object (DO) sentences or prepositional-object (PO) sentences. The prime sentences and the target sentences shared the same verb, but the other constituents were different. Examples are shown as follows:

120. The nanny will give the child the chocolate. (DO)

121. The nanny will give the chocolate to the child. (PO)

(Arai et al., 2007, p. 49)

The participants read the prime sentence first, and then watched the semi-realistic picture while they simultaneously listened to the spoken target sentence, and their eye movement was monitored and recorded. The results revealed that there was a significant structural priming effect when the prime and the target sentence shared the same structure and the same verb. Regarding experiment two, thirty-two new subjects from the same university as experiment one participated, the materials were the same as for experiment one, except that the prime sentence and the target sentence not only did not share the same verb, but also the verbs were not semantically related. The procedure was the same as for experiment one. The results exhibited that there was no significant structural priming in comprehension, although the prime and the target sentences shared the same syntactic structure. The results of experiment one and experiment two indicate that structural priming in comprehension and production are similar, but the priming in comprehension is completely lexically dependent (Arai et al., 2007).

Different from Arai et al. (2007), Thoathiri and Snedeker (2008a) found that structural priming in comprehension could occur across verbs. Thoathiri and Snedeker (2008a) undertook experiments to probe syntactic priming in spoken language comprehension. The subjects were twenty-eight native English speakers from Boston, and the prime sentences and the target sentences were the same as used by Arai et al. (2007), either DO or PO, but they did not share the same verb. The act-

out task and the eye-tracking system were employed. The participants were seated in front of the experimental equipment, with four toys placed on a shelf in front of them, two were animate and two inanimate objects. In the center of the four toys there was a hole, and the participants' eye movement was monitored and recorded. The participants listened to the prime sentences, either DO or PO, and then consecutively listened to the target sentence, either DO or PO, they were then asked to act out the target sentence with the toys placed on the shelf in front of them. The results showed that, when the prime sentence and the target sentence were DOs, the participants preferred to watch the animate item first, but when the prime sentence and target sentence were POs, they preferred to watch the inanimate item first. In the other two situations, this kind of effect did not occur. The results indicate that structural priming in comprehension is similar to that in production, and this is independent of the lexical information (Thothathiri & Snedeker, 2008a).

In short, previous studies concerning structural priming and language comprehension mainly focused on whether it is similar as in language production and whether it is lexically independent or lexically dependent.

Table 22 is a summary of the previous studies reviewed in this subsection.

Table 22 Previous studies concerning structural priming and language comprehension

<b>Study</b>	<b>Participants</b>	<b>Data collection instruments</b>	<b>Main results</b>	<b>Implications</b>
Branigan, Pickering & MaLean (2005)	80 students attending the University of Edinburgh	A description and matching task	The results showed that when the priming sentence and the target	The results indicate that language comprehension could be primed, and it

			<p>sentence shared the same verb, the effect of priming was significant, but when the priming sentence and the target sentence contained different verbs, although there were some effects of priming, it was not significant. It also showed that, when the priming sentence and the target sentence shared that same verb, the matching time was faster.</p>	<p>is related to the sentence structure and the verb</p>
Traxler (2008)	102 native English speakers	Eye-tracking software	<p>No matter whether the prime and the target sentence shared the same verb or not, as long as they share the same sentence structure, processing the target sentence was facilitated.</p>	<p>The results indicate that structural priming of sentence on-line comprehension is lexically independent.</p>
Traxler (2008)	48 native English-speaking students attending the	Eye-tracking software	<p>There was a robust priming effect when processing sentences</p>	<p>The results suggest that priming may be responsive to a level of</p>

	University of California Davis		including an agent PP after the priming sentences containing an agent PP and instrument PP. The effect of priming was also robust when the priming and the target sentences both contained an instrument PP. However, there was no significant priming effect when the priming sentence contained an agent PP, but the target sentence contained an instrument PP.	representation at which different types of adjuncts are differentiated.
Ledoux, Traxler & Swaab (2007)	30 right-handed native English-speaking students attending the University of California Davis	Electroencephalograph (EEG) machine	The results showed that the RR primes elicited a larger positivity, whereas the MC primes did not, and the RR targets preceded with MC primes elicited a larger positivity, but if preceded with the RR primes they	The results indicate that syntactic priming in comprehension is syntactically based not lexically based.



			did not. The results also showed that there was no significant priming effect caused by repetition of the verbs.	
Traxler & Tooley (2008)	Students attending the University of California Davis	Eye-tracking software	Experiment one showed a robust priming effect, although the priming cue was eliminated. Experiment two showed that although there was noun repetition cue for priming, there was no significant priming effect. Experiment three showed that there was no significant priming effect, although there was a strong cue for priming.	The results indicate that priming in comprehension is syntactic rather than strategic.
Scheepers & Crocker (2004)	48 native German speaking undergraduates from Saarland University	Eye-tracking software	If the prime and the target sentences shared the same constituent order, the priming effect would be robust.	This indicates that the constituent order in comprehension could be primed, and it is independent of the verb.

Arai, Van Gompel & Scheepers (2007)	64 native English-speaking students attending the University of Dundee	Eye-tracking software	<p>Experiment one showed that there was a significant structural priming effect when the prime and the target sentence shared the same structure and the same verb.</p> <p>Experiment two showed that there was no significant structural priming in comprehension, although the prime and the target sentences shared the same syntactic structure.</p>	The results indicate that structural priming in comprehension and production are similar, but the priming in comprehension is completely lexically dependent.
Thoathir i & Snedeker (2008)	28 native English speakers from Boston	Eye-tracking software	The results showed that when the prime sentence and the target sentence were <i>Dos</i> , the participants preferred to watch the animate item first, but when the prime sentence and target sentence were <i>Pos</i> , they preferred to see the inanimate item first.	The results indicate that structural priming in comprehension is similar to that in production, and this is independent of the lexical information.

#### **2.3.2.4 Structural priming and different populations**

In addition to the previously mentioned studies related to structural priming, this is further research filed concerning structural priming and different populations. The previous research mainly focused on two aspects: structural priming and children's language learning, and structural priming and bilingualism. In the following sessions, 2.3.2.4.1 mainly focuses on previous studies concerning structural priming and children's language learning; 2.3.2.4.2 concentrates on structural priming and bilingualism.

##### **2.3.2.4.1 Structural priming and children's language learning**

The previous research concerning structural priming and children's language learning focused on whether Children's language acquisition is lexicon-based or abstract structure- based (Huttenlocher et al., 2004; Savage et al., 2003; Shimpi et al., 2007; Thothathiri & Snedeker, 2008b). It also assessed whether structural priming can only occur when children are familiar with the sentence structure, or it can also occur when children do not know the configuration (Brooks & Tomasello, 1999; Huttenlocher et al., 2004).

Concerning whether children's language acquisition is lexicon-based or structure- based, Huttenlocher et al. (2004) conducted an experiment to investigate if repeating a particular sentence structure can affect children's production in a picture description task. The experiment replicated the study of Bock (1986). A picture description task was used, and transitive and dative sentences were used as the priming sentences and target sentences. In addition, the priming sentences and the target sentences did not share any common words. Thirty 4- and 5-year-old children participated. The results showed that the children were more likely to use the sentence

structure in the picture description task if they had heard that structure previously, and the priming effect was significant. The result indicates that structural priming in children's language acquisition is lexically independent (Huttenlocher et al., 2004).

Shimpi et al. (2007) extended the result of Huttenlocher et al. (2004) to 3- and 4-year-old children. Three experiments were conducted, with the aim of the experiments being the same as that by Huttenlocher et al. (2004). The priming and target sentence structures were transitive and dative. Experiment one was applied to get the baseline of the participants' production of transitive and dative sentences. The children were asked to describe the target pictures without any priming. Experiment two was conducted to explore whether the children's production of transitive and dative sentences can be affected by the sentence structures of sentences that they had heard previously. Thirty-two 3-year-old and thirty-two 4-year-old children participated. The experimenter first described some pictures with one specific sentence structure, either transitive or dative. Then the participants were asked to describe the target pictures which could be described with either the transitive or dative structure. The results showed that the 4-year-old children were more likely to reuse the structure that they had heard previously, and the effect was significant. The 3-year-old children produced more dative and transitive sentences after dative and transitive priming, respectively, but the effect was not significant. Experiment three was conducted with only 3-year-old participants, and the materials and procedures were the same as for experiment two, the only difference was that the participants were asked to repeat the experimenter's description in each trial. The result showed that the 3-year-old children's production was similar to the 4-year-old children in experiment two, and

the effect was significant. The results indicate that both the 3- and 4-year-old children's language acquisition is structure-based (Shimpi et al., 2007).

Similarly, Thothathiri and Snedeker (2008b) found that both 3- and 4-year children's language comprehension is abstract structure-based (Thothathiri & Snedeker, 2008b). Thothathiri and Snedeker (2008b) conducted two experiments to investigate whether structural priming could occur with-in verb (priming sentence and target sentence share the same verb) and across verbs (priming sentence and target sentence contain different verbs) during language comprehension for the 3- and 4-year-old children. An eye-tracking system and an act out task were employed. In experiment one, fifty-eight 4-year-old native English-speaking children participated. They were divided into two groups: twenty for group one, thirty-eight for group two. Considering group one, the priming and target sentences were prepositional-object dative and double-object dative structures. Examples as follows:

122. Give the pig the cat food. (Double-object dative)

123. Give the fishbowl to the bear. (Prepositional-object dative)

(Thothathiri & Snedeker, 2008b, p. 210)

The participants were seated in front of an inclined podium with four quadrants, and in the center of the podium was a hole with a camera located and focused on the participants' faces. In the four quadrants, two animate toys and two inanimate toys were located. The set is as follow:

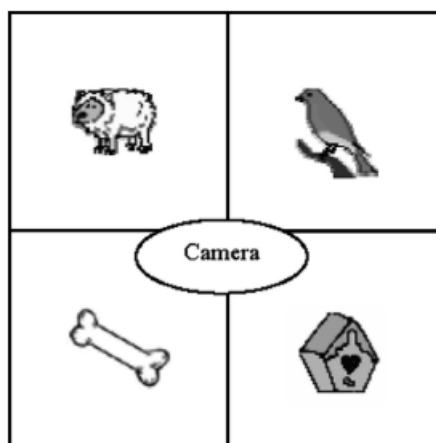


Figure 9 Example scene as viewed by the participants the experiment of Thothathiri and Snedeker (2008b, p. 193)

Participants were asked to act out what they had heard with the toys in the quadrants, and during this process, their eye-movement was recorded. Initially the participants heard two filler sentences which were not dative sentences, then two priming sentences, and finally one target sentence. See figure 10:

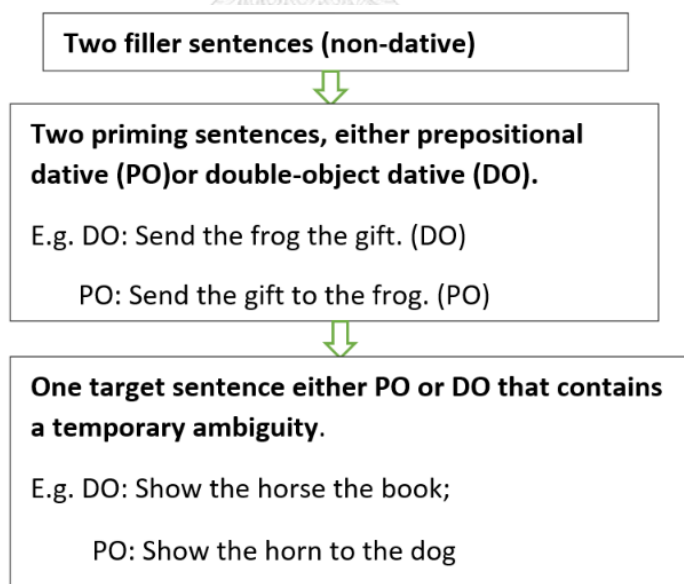


Figure 10 The process of Thothathiri & Snedeker's (2008) experiment

For group one, the priming sentence and the target sentence shared the same verb, while for group two, the priming sentence and target sentence had different verbs. The

results showed that the participants looked more at the inanimate toys when primed with the prepositional-object dative than double-object dative, irrespective of whether the priming sentence and the target sentence shared the same verb or not. Regarding experiment two, everything was the same, except that the participants were 3-year-old children. The results were the same as experiment one. The experiments indicate that both 3- and 4-year-old children's language comprehension is lexically independent (Thothathiri & Snedeker, 2008b).

Different from the prior studies, Savage et al. (2003) conducted research to explore the abstractness of children's linguistic representations. A picture description task was employed, and the priming and the target sentences were passive and active structures. The participants were 3-, 4- and 6-year-old monolingual English-speaking children, and the number in each age group was twenty-eight. The materials were cartoon pictures, which could be described with both active and passive structures. The experimenter described a picture with a priming sentence, either passive or active structure, and the participants repeated the experimenter's description. Then, they were required to describe the target pictures. What should be mentioned is, that for each age group, half the priming sentences and target sentences were highly overlapped lexically, with half overlapping less. See the below examples:

Table 23 Examples of high overlap and low overlap in (Savage et al., 2003, p. 560)

	Active example	Passive example
High overlap	It is pushing it.	It got pushed by it.
Low overlap	The digger pushed the bricks.	The bricks got pushed by the digger.

The results showed that for the 3- and 4-year-old children, more passive and active sentences were produced after passive and active priming, when subject to the condition of high lexical overlap between the priming and target sentences, respectively. The effect of the priming was significant. There was no obvious priming effect after the low lexical overlap condition. With respect to the 6-year-old children, there was a significant priming effect in both the high overlap condition and low overlap condition. The results indicate that the 6-year-old children's syntactic representation is abstract. In contrast, the 3- and 4-year-old children's syntactic representation, at least in part, was influenced by certain specific lexical items (Savage et al., 2003).

Another study by Savage et al. (2006) also demonstrated that syntactic representations by young children, especially if less than 6 years old, was not completely abstract but incorporated some level of lexical constitution (Savage et al., 2006).

Savage et al. (2006) undertook an experiment to explore whether time and frequency factors can affect structural priming. A picture description task was employed, and transitive sentences were used as the priming sentences. The priming and target sentences were high lexical overlap like in Savage et al. (2003). Sixty-six monolingual English-speaking children were divided into two groups, an experimental group with forty-four subjects, and a control group with twenty-two subjects. With respect to the experimental group, it was divided into two groups, experimental group one and experimental group two, each group included twenty-two participants. Experimental group one received the same priming sentence five times.



Experimental group two received five different priming sentences (same structure but different verbs). Considering the control group, they did not receive any priming at all, and were just asked to describe the target pictures. Their production of transitive structures was regarded as the baseline. Considering the procedure, the experimenter first described a prime picture with a transitive sentence, then he asked the participants to repeat the sentence. Finally, the participants were asked to describe the target picture. This procedure lasted until the end of the experiment. One week later, half the participants in experimental groups one and two were asked to describe the target pictures. One month later, all the participants were asked to describe the target pictures. The design of the task is shown in figure 11:

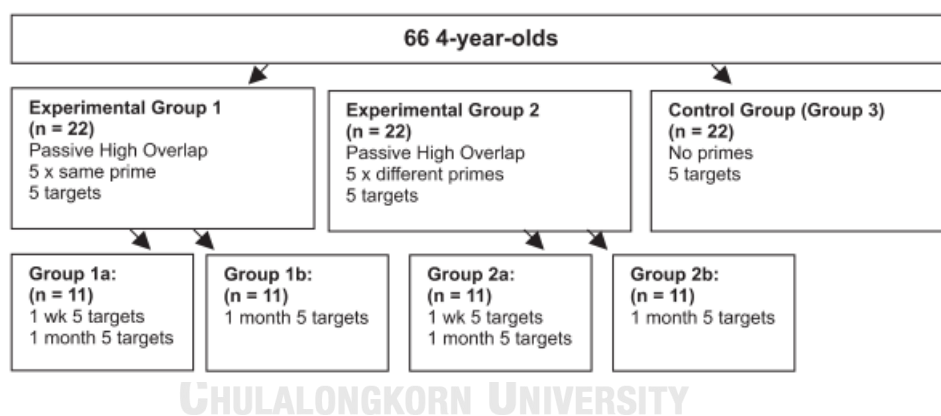


Figure 11 Design for experimental groups in the experiment of Savage et al. (2006, p. 33)

The results showed that both the varied priming (five different priming sentences) and the identical priming (the same priming sentence repeated five times) lead to more passive production, and the priming effect was significant. What is more, the varied priming lead to more passive production than the identical priming, and also the effect was significant. In addition, the varied priming effect could last for one month if the participants have an opportunity to describe the target picture one week

after the priming activity. By contrast, the identical priming could not be the same. The results support Savage et al. (2003) in that young children's syntactic representation is integral with the lexical items. The results indicate that young children's language acquisition via structural priming is implicit learning (Savage et al., 2006).

The participants in the above studies knew the sentence structures, the experimenter's task was just to elicit their production. There was also some research concentrating on children's learning of novel structures (Brooks & Tomasello, 1999).

Brooks and Tomasello (1999) conducted research to explore whether young children can learn to produce passives with nonce verbs. Two nonce verbs ("meek" and "tam") were created. The participants were native English-speaking young children, aged from 33 months to 44 months. Some were trained with passive; others were trained with active structures. The experimenter then showed some pictures and asked them questions, like "What happened?", "What is happening?", "What happened to the dog?" etc. The participants' responses were collected and analyzed. The results showed that the participants trained with passives were more likely to produce passive sentences with the nonce verbs. The others trained with actives preferred to produce actives with the nonce verbs. The results indicate that young children's acquisition of passives could be primed at a very early age with nonce verbs (Brooks & Tomasello, 1999).

To sum up, previous studies concerning structural priming and children's language acquisition concentrated mainly on whether it is lexical-based or abstract structure-based, or both. The findings show that children demonstrate both lexical-

based and abstract structure-based responses, but at different ages, the proportion was different. Previous research also found that children can be primed with both a familiar construction and a nonce construction.

Table 24 is a summary of the previous studies reviewed in this subsection.

Table 24 Previous research concerning structural priming and children's language acquisition

<b>Study</b>	<b>Participants</b>	<b>Data collection instruments</b>	<b>Main results</b>	<b>Implications</b>
Huttenlocher et al. (2004)	30 children aged 4- and 5-.	Picture description task	The participants were more likely to reuse the sentence structure if they had heard the structure previously, and it is independent of the lexical.	The results indicate that structural priming in children's language acquisition is lexically independent.
Shimpi, Gamez, Huttenlocher & Vasilyeva (2007)	32 3-year-old and 32 4-year-old children	Picture description task	The experiments showed that both the 3- and 4-year-old children were more likely to reuse the structure that they had heard previously, and the effect was significant.	Both the 3- and 4-year-old children's language acquisition is structure-based.
Thonthathiri & Snedeker (2008)	58 3- and 4-year-old children	Eye-tracking software	The results showed that the participants looked more at the inanimate toys when primed with the prepositional-object dative than double-object dative, irrespective whether the priming sentence and the target	Both the 3-and 4-year-old children's language comprehension is structure-based, and lexically independent

			sentence shared the same verb or not.	
Savage et al. (2003)	3-, 4- and 6-year-old children, and the number in each age group was 28.	Picture description task	The results showed that for the 3- and 4-year-old children, more passive and active sentences were produced after passive and active priming, when subject to the condition of high lexical overlap between the priming and target sentences, respectively. The effect of priming was significant. There was no obvious priming effect after the low lexical overlap condition. With respect to the 6-year-old children, there was a significant priming effect in both the high overlap condition and low overlap condition.	6-year-old children's syntactic representation is abstract. 3- and 4-year-old children's syntactic representation, at least in part, was influence by certain specific lexical items.
Savage et al. (2006)	66 monolingual English-speaking children	Picture description task	The results showed that both the varied priming (five different priming sentences) and the identical priming (the same priming sentence repeated five times) lead to more passive productions, and the priming effect	The results indicate that young children's syntactic representation is integral with the lexical items, and their language acquisition via structural

			was significant. What is more, the varied priming leads to more passive production than the identical priming, and the varied priming effect could last for one month if the participants have the opportunity to describe the target picture one week after the priming activity. By contrast, the identical priming could not be the same.	priming is implicit learning.
Brooks & Tomasello (1999)	Native English-speaking children, aged from 33 months to 44 months	Elicited picture description task	The participants trained with passives or active were more likely to use passives and actives, respectively.	The results indicate that young children's acquisition of passives could be primed at a very early age.

#### 2.3.2.4.2 Structural priming and bilingualism

Previous studies concerning structural priming and bilingualism have mainly concentrated on two issues: Firstly, do bilinguals represent and process the sentence structures of L2 in the same way as they do in L1 (Sarah Bernolet et al., 2007; McDonough, 2006; Schoonbaert et al., 2007); Secondly, to what extent do bilinguals share the represented syntactic structure of their L1 and L2 (Desmet & Declercq, 2006; Loebell & Bock, 2003; Schoonbaert et al., 2007).

Considering the first issue, previous research has found that bilinguals represent and process sentence structures of their L1 and L2 in the same way (Sarah Bernolet et al., 2007; Cleland & Pickering, 2003; McDonough, 2006; Schoonbaert et al., 2007)

Schoonbaert et al. (2007) undertook research to explore whether the representation and processing of L2 is the same as L1 by bilinguals. A confederate scripting task (Branigan et al., 2000) was used as the instrument. Thirty-two students attending Ghent University participated as naive subjects, and one female student was a confederate of the experimenter, which means that the female student knew the experimenters' aim, and cooperated with him to conduct the experiment, but she pretended as a normal participant. All the participants were L1 Dutch and L2 English speakers. Both prepositional dative and double-object dative sentences were used as the priming sentences and target sentences. Pictures which could be described with both prepositional dative and double-object dative sentences were used as the target pictures. The participants and the confederate sat face-to-face, and each held a set of pictures, but the confederate also had the relevant script. The confederate and the participants took turns to describe the pictures in English and had to find the picture corresponding with the interlocutor's description. The results showed that the participants were more likely to produce prepositional datives and double-object datives after prepositional dative and double-object dative structures, respectively. The effect was significant. In the other experiment, all the materials and instruments were the same, the priming language and the target language was Dutch, and the effect was the same and with a similar level of magnitude. The results indicate that bilingual's represent and process L2 and L1 in the same way (Schoonbaert et al., 2007).

Similarly, McDonough (2006) conducted research to investigate whether structural priming occurs during interaction between English L2 speakers. A confederate scripting task was used, and fifty English L2 speakers participated. Prepositional dative and double-object dative structures were used as the priming and target structures. The results showed that there was a significant priming effect by the prepositional dative structures, but there was no priming with the double-object dative structure. The explanation for this is that the English L2 speakers had not developed the abstract representation for the double-object dative structure, and so they were not sensitive to narrow-range rules<sup>7</sup>. The results indicate that English L2 speakers represent and process their L2 in the same way as their L1 (McDonough, 2006).

S. Bernolet et al. (2007) also found that speakers represent and process L2 and L1 in the same way as bilinguals. S. Bernolet et al. (2007) used a confederate scripting task to explore whether structural priming could work for English L2 speakers, if they were primed by “adjective + noun” and “noun + relative clause” structures. Thirty-two students attending Ghent University participated in the experiment. The procedure was the same as that by Schoonbaert et al. (2007). The results showed that the participants were more prone to reuse “noun + relative clause” and “adjective + noun” after the “noun + relative clause” and “adjective + noun” priming structures, respectively. The priming effect was significant. The result was similar to structural priming by L1 speakers. This indicates that English L2 speakers

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<sup>7</sup> Narrow range rules: According to Pinker (1989), Children learn the Broad range rule which changes “X causes Y to go to Z (Prepositional dative)” to “X causes Z to have Y (Double object dative)” when a given verb is compatible with causation to possession change. But it is just a necessary, not sufficient. Narrow range rules pose a sufficient condition for a verb to alternate, and the sufficient condition is that the verb belongs to one of the dativizable subclasses of verbs. (Inagaki, 1997)

represent and process syntactic structures in the same way as English L1 speakers (Sarah Bernolet et al., 2007).

With respect to the second issue concerning the extent to which that bilinguals share the represent syntactic structure of their L1 and L2, the previous research found: a) When the structures of the two languages are similar, they share the representative syntactic structure; b) When the structures or the two languages differ from each other, they represent the syntactic structure separately (Loebell & Bock, 2003; Meijer & Fox Tree, 2003; Salamoura & Williams, 2007a).

Loebell and Bock (2003) undertook research to explore whether bilinguals share the syntactic structures of their L1 and L2 in the way of structural priming. A picture description task was used. Four-eight German-English bilinguals<sup>8</sup>, whose native language was German, participated in the experiment. The priming and target sentences were datives (prepositional dative and double-object dative) and transitives (active and passive). For each participant, two sessions of the experiment were involved. In the first session, they heard English priming sentences, and were asked to describe pictures in German; in the second session, they listened to German priming sentences, but were asked to describe the pictures in English. The results showed that the participants produced more German prepositional datives after English prepositional datives than double-object datives, and vice versa. The effect was significant. There was no priming effect for German and English passives, since the structures of the German and English passives are different. This indicates that if the structures of two languages are similar, then the bilinguals share the representation of

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<sup>8</sup> Bilinguals: it refers to the people who can speak two languages, and their mother tongue is the dominant language, while the second language is weaker than their mother tongue. Myers-Scotton, C. (2006) This is a broad definition of bilinguals.



the syntactic structure; but if the structure of the two language differ, the bilinguals store the syntactic structures for each language separately (Loebell & Bock, 2003).

Similarly, Meijer and Fox Tree (2003) used a sentence recall task to investigate whether the Spanish prepositional dative structure could prime the English prepositional dative structure. Forty-six students attending the University of California Santa Cruz participated in the experiment. Fifteen dative verbs, such as “bring”, “give”, and “offer” were used to create double-object dative target sentences, and for each verb two sentences were created. Half the target English double-object dative sentences were combined with prepositional dative Spanish prime sentences, and half combined with non-prepositional-dative sentences. The participants read the target English sentence first, then read a Spanish prime sentence, either prepositional dative or non-prepositional dative. This part of the task was followed by a distract task, in which the participants were asked whether a specific Spanish word appeared in the Spanish prime sentence. Finally, the participants were asked to recall the English target sentence, as shown in figure 12:

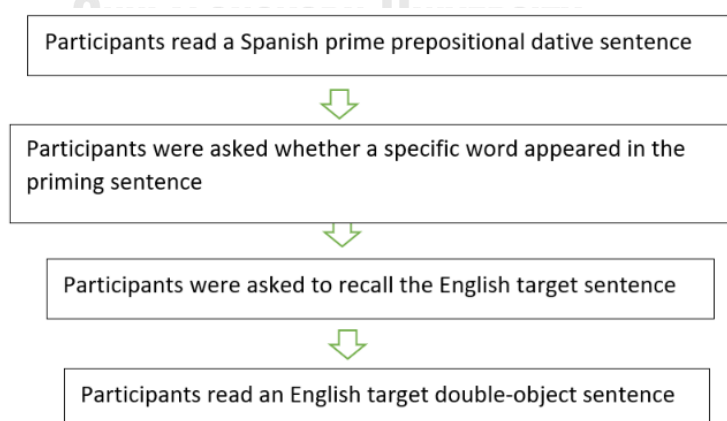


Figure 12 The process for the sentence recall task by Meijer and Fox Tree (2003)

The results showed that more prepositional dative sentences switched from double-object dative after the prepositional dative Spanish prime sentences, than after the Spanish non-prepositional-dative prime sentences. The effect was significant. The results correspond with similar previous research about monolinguals (Tree & Meijer, 1999). This indicates that bilinguals share the syntactic structures for L1 and L2 (Meijer & Fox Tree, 2003)

Hartsuiker et al. (2004) found similar priming effects for English passives after Spanish passive primes (Hartsuiker et al., 2004). Hartsuiker et al. (2004) conducted an experiment to explore whether syntax is shared or separate between languages. A confederate scripting task was used (See Figure 12). Twenty-four Spanish-English bilinguals whose native language is Spanish participated. The priming sentences were Spanish active and passive transitive sentences, as well as intransitive sentences and active sentences. The target pictures can be described using both the active and passive in English. The results showed that the participants produced more English passive sentences after Spanish passives than after other Spanish sentence structures. This indicates that syntactic structures are shared between Spanish and English for Spanish-English bilinguals, when the structures in the two languages are similar (Hartsuiker et al., 2004).

Schoonbaert et al. (2007) used Dutch-English bilinguals and found a similar priming effect from Dutch to English and from English to Dutch. A confederate scripting task was used as the instrument. Thirty-two students from Ghent University participated, all of whom were Dutch-English bilinguals with Dutch as their L1. The priming and target sentences were prepositional dative and double-object dative

structures. The priming sentences were L1 Dutch, and the participants were required to describe the pictures in L2 English. The results showed that the participants were more prone to use prepositional dative and double-object dative after the prepositional dative and double-object dative priming sentences, respectively. It also showed that, when the priming and the target sentences share the same verb (translation equivalent), the priming effect was enhanced. In another experiment, everything was the same, except that the priming direction was from L2 English to L1 Dutch. The result was similar to the previous experiment, but there was no enhanced priming effect when the priming and target sentence shared the same verb (translation equivalent). The results indicate that bilinguals share the syntactic knowledge for their L1 and L2, and independently of the lexicon (Schoonbaert et al., 2007).

Different from Schoonbaert et al. (2007), Salamoura and Williams (2007a) did not find lexical boost from L1 Greek to L2 English. Salamoura and Williams (2007a) used an oral sentence completion task to investigate whether bilinguals share the syntactic knowledge of their L1 and L2. The participants were Greek-English bilinguals with Greek as their L1. The priming and target sentences were prepositional dative and double object dative structures. The priming sentences were always L1 Greek, and the target sentences L2 English. After a priming Greek sentence and an intervening transitive English sentence, the participants were required to complete the L2 target sentence fragments. The results showed that the participants were more likely to produce L2 English prepositional dative and double-object dative sentences after the corresponding L1 Greek priming, and the effect was significant. There was no enhanced priming effect when the L1 Greek priming sentence and the L2 English target sentence shared the same verb (translation equivalent). This

indicates that structural priming does occur across L1 and L2. For bilinguals, they represent syntactic knowledge of L1 and L2 in an integrated way, and this is independent of the lexical items (Salamoura & Williams, 2007a).

In order to exclude any possibility of lexical item affection, Desmet and Declercq (2006) used priming ambiguity relative clause attachment (e.g., *Someone shot the servant of the actress who was on the balcony*. The relative clause could be attached to “the servant” or “the actress”.) to investigate whether syntactic information related to the hierarchical tree is shared across two languages or represented separately by bilinguals. Twenty-four Dutch-English bilingual students from Ghent University participated. Three kinds of priming sentences were created, high-attachment, low-attachment, and baseline sentences. The priming sentences were all in Dutch, in which the attachment could be determined by the gender of the relative pronoun. The target sentences were all in English. The results demonstrated that the participants produced more high-attachment English relative clauses after Dutch high-attachment relative clause prime than after the low-attachment and baseline, and vice-versa. This indicates that structural priming occurs across languages, and bilinguals share the syntactic knowledge for their L1 and L2 (Desmet & Declercq, 2006).

From a different perspective, Salamoura and Williams (2006) investigated lexical activation of across language priming (Salamoura & Williams, 2006). An oral sentence completion task was used as the instrument. Twenty-six Dutch-English bilinguals participated. The priming materials were two categories of Dutch verbs, with one category only using in prepositional dative structure (PO-only), with the

other category only using in double-object dative structure (DO-only). The target materials were English dative sentence fragments (e.g., *The hotel receptionist gave...*). The participants were required to complete the English dative sentence fragments after they listened to the priming Dutch verb, either PO-only or DO-only, and filler items. The results showed that more double-object dative and prepositional English dative sentences were completed after the Dutch DO-only verb and PO-only verb priming, respectively. This indicates that structural priming is lexically activated, and syntactic knowledge between L1 and L2 is shared by bilinguals (Salamoura & Williams, 2006).

To sum up, previous studies concerning structural priming and bilingualism, demonstrated that bilinguals share syntactic knowledge as much as possible when the structures of the two languages are similar, but store the syntactic knowledge separately when the structures of the two languages differ from each other. Moreover, bilinguals process the syntactic structures of L1 and L2 in the same way.

Table 25 is a summary of the previous studies reviewed in this subsection.

Table 25 Previous studies concerning structural priming and bilingualism

Study	Participants	Data collection instrument	Main results	Implications
Schoonbaert et al. (2007)	32 Dutch-English bilingual students attending Ghent University	Confederate scripting task	No matter the priming sentence is Dutch or English, the priming effect was the same.	Bilingual's represent and process L2 and L1 in the same way.
McDonough (2006)	104 English L2 speakers enrolled in graduate-degree	Confederate scripting task	There was a significant priming effect by the prepositional dative structures, but there	The results indicate that English L2 speakers represent and process their

	programs at a large public university in the Mideast		was no priming with the double-object dative structure, because the English L2 speakers had not developed the abstract representation for the double-object dative structure, and they were not sensitive to narrow-range rules.	L2 in the same way as their L1.
Bernolet, Hartsuiker & Pickering (2007)	32 English L2 speaking students attending Ghent University	Confederate scripting task	The participants were more prone to reuse “noun + relative clause” and “adjective + noun” after the “noun + relative clause” and “adjective + noun” priming structure, respectively. The result was similar to structural priming by L1 English speakers.	The result indicates that English L2 speakers represent and process syntactic structures in the same way as English L1 speakers.
Loebell & Bock (2003)	48 German-English bilinguals	Picture description task	The participants produced more German prepositional datives after English prepositional dative than double-object dative. And vice versa. There was no priming effect for German and English passives, since the structures of the German and English passives are different.	The results indicate that if the structures of two languages are similar, then the bilinguals share the representation of the syntactic structure; but if the structure of the two languages differ, the bilinguals store the syntactic structure for each language separately.
Meijer & Fox Tree (2003)	46 students attending the University of California Santa Cruz	Sentence recall task	More prepositional dative sentences switched from double-object dative after the prepositional dative Spanish prime sentences, than after the Spanish non-prepositional-dative prime sentences.	The results indicate that bilinguals share the syntactic structures for L1 and L2.

Hartsuiker et al. (2004)	24 Spanish-English bilinguals whose native language is Spanish	Confederate scripting task	Participants produced more English passive sentences after Spanish passives than after other Spanish sentence structures.	The result indicates that syntactic structures are shared between Spanish and English for Spanish-English bilinguals, when the structure in the two languages are similar.
Schoonbaert et al. (2007)	32 Dutch-English bilingual students attending Ghent University with Dutch as their L1	Confederate scripting task	Experiment one showed that the participants were more prone to use prepositional dative and double-object dative after the prepositional dative and double-object dative priming sentences, respectively. It also showed that when the priming and target sentences share the same verb (translation equivalent), the priming effect was enhanced. The result of experiment two was similar to experiment one, but there was no enhanced priming effect when the priming and target sentence shared the same verb (translation equivalent).	Bilinguals share the syntactic knowledge for their L1 and L2, and independently of the lexicon.
Salamoura & Williams (2007)	Greek-English bilinguals with Greek as their L1	Oral sentence completion task	The participants were more likely to produce L2 English prepositional dative and double-object dative sentences after the corresponding L1 Greek priming. There was no enhanced priming effect when the L1 Greek priming sentence and the L2 English target	The results indicate that structural priming does occur across L1 and L2. For bilinguals, they represent syntactic knowledge of L1 and L2 in an integrated way, and this is independent of the lexical items.

			sentence shared the same verb.	
Desmet & Declercq (2006)	24 Dutch-English bilingual students attending Ghent University	Picture description task	The participants produced more high-attachment English relative clauses after Dutch high-attachment relative clause than after the low-attachment and baseline, and vice-versa.	The results indicate that structural priming occurs across languages, and bilinguals share the syntactic knowledge for their L1 and L2.
Salamoura & Williams (2006)	26 Dutch-English bilinguals	Oral sentence completion task	More double-object dative and prepositional English dative sentences were completed after the Dutch DO- only verb and PO-only verb priming, respectively.	The results indicate that structural priming is lexically activated, and syntactic knowledge between L1 and L2 is shared by bilinguals.

### 2.3.3 Previous studies concerning structural priming and English relative clauses

Previous studies concerning structural priming and relative clauses have mainly focused on four aspects, and each of the following sections deals with one aspect:

2.3.3.1 Mainly focuses on previous studies concerning structural priming and the “Noun + relative clause”; 2.3.3.2 Deals with previous research concerning attachment of relative clauses; 2.3.3.3 Mainly focuses on previous studies concerning structural priming and the comprehension of relative clauses; 2.3.3.4 Deals with previous studies concerning structural priming and the production of relative clauses.

#### 2.3.3.1 Previous studies concerning structural priming and the “Noun + relative clause”

Cleland and Pickering (2003) explored the use of lexical and syntactic information in language production. The structures that applied in the research were “Noun +



relative clause” and “adjective + noun”, and the research instrument was the confederate scripting task. Sixteen students attending the University of Edinburgh participated, and four equivalent sets of one hundred and fifty cards, including fifteen shapes in ten colors, were used as the materials. Each participant and confederate had two sets of cards, one set was used to describe and the other set was used to match the interlocutor’s description. Regarding the content of the cards, each shape appeared three to four times as prime, and each color appeared four to five times as prime. With respect to whether the target and the prime shared shape, color, or pre-nominal adjective or head noun and relative clause, there were eight conditions as included as in the following examples.

124.

- 1a. The red square. (Same adjective, same noun, prenominal)
- 1b. The square that is red. (Same adjective, same noun, relative clause)
- 1c. The red diamond. (Same adjective, different noun, prenominal)
- 1d. The diamond that is red. (Same adjective, different noun, relative clause)
- 1e. The green square. (Different adjective, same noun, prenominal)
- 1f. The square that is green. (Different adjective, same noun, relative clause)
- 1g. The green diamond. (Different adjective, different noun, prenominal)
- 1h. The diamond that is green. (Different adjective, different noun, relative clause)

(Cleland & Pickering, 2003, p. 219)

The results showed that, when there was structural priming between the prime and the target, the participants were more likely to produce prenominal adjective and relative clauses when following the prenominal adjective and relative clause prime, respectively. Moreover, when the prime and the target shared the same noun, the

priming effect was enhanced, and the effect was significant. When the prime and the target shared the same adjective, the effect of priming was increased. The results indicate that the structure of the sentence can affect structural priming, and repetition of the content words can enhance the effect (Cleland & Pickering, 2003) .

Sarah Bernolet et al. (2007) used a confederate scripting task to explore whether structural priming could work for English L2 speakers, if they were primed by the “adjective + noun” and “noun + relative clause” structures. Thirty-two students attending Ghent University participated in the experiment. The results showed that the participants were more prone to reuse the “noun + relative clause” and “adjective + noun” structure after the “noun + relative clause” and “adjective + noun” priming structure, respectively. The priming effect was significant. The result was similar to structural priming by L1 speakers. This indicates that English L2 speakers represent and process syntactic structures in a similar way to English L1 speakers (Sarah Bernolet et al., 2007).

Liesbeth M van Beijsterveldt and Janet G van Hell (2009) investigated structural priming of the “adjective + noun” (E.g., a blue ball), “noun + relative clause” (a ball that is blue), and the main clause (E.g., the ball is blue.) in hearing and deaf children. Picture description tasks were applied in the experiments. 20 hearing 7- and 8-year-old children, 20 hearing 11- and 12-year-old children, and 26 deaf 11- and 12-year-old children participated in the experiment. The materials were the same as those in the study by Cleland and Pickering (2003), the only difference was that this experiment was conducted in Dutch while Cleland and Pickering’s (2003) study was conducted in English. The procedure was as follows: the participants read a priming

structure first, “noun + relative clause” or “adjective + noun” or a main clause, and then they described a picture in writing. Half of the target pictures contained the same noun as the priming structure, and half contained a different noun. The results showed that hearing 7- and 8-year-olds and 11- and 12-year-olds, as well as deaf 11- and 12-year-olds, showed priming effects for all three structures in both the same-noun and different-noun conditions. Structural priming was not boosted by lexical repetition in the hearing and deaf 11- and 12-year-olds; the lexical boost effect was only observed in the 7- and 8-year-olds and only in the relative clause structure. The findings suggest that hearing and deaf children possess abstract representations of the “adjective + noun” structure independent of the particular lexical item (Liesbeth M van Beijsterveldt & Janet G van Hell, 2009).

To sum up, previous studies concerning structural priming and “noun + relative clause” show, that no matter whether L1 English, L2 English, or L1 Dutch speakers, structural priming can work, and the effect is significant. What is more, if the priming and the target sentence contained the same noun, the effect is enhanced.

### **2.3.3.2 Previous research involved in the attachment of relative clauses**

Scheepers (2003) investigated the effect of structural priming on the production of German relative clause attachment. More specifically, the researcher explored whether structural priming could affect high attachment (HA) and low attachment (LA) of relative clauses. HA refers that the NP is higher up in the syntactic tree, LA means that the NP is lower in the tree. For example, Don mentioned the servant of the actress who was on the balcony. For HA, it means that the servant was on the balcony, while for LA it means that the actress was on the balcony. Sentence completion tasks were employed. 90 native German speakers attending Saarland

University participated. In Experiments one and two, examples of the HA, LA, BL (baseline), and T (target) sentence fragments were as follows.

125.

**HA** Die Assistentin verlas den Punktestand der Kandidatin, der ...

The assistant announced the score [masc, sing] of the candidate [fem, sing] that [masc, sing] ...

**LA** Die Assistentin verlas den Punktestand der Kandidatin, die ...

The assistant announced the score [masc, sing] of the candidate [fem, sing] that [fem, sing] ...

**BL** Die Assistentin verlas den Punktestand der Kandidatin, bevor ...

The assistant announced the score [masc, sing] of the candidate [fem, sing] before...

**T** Der Rentner schimpfte u"ber die Autorin der Flugbla"tter, die ...

The pensioner railed about the author [fem, sing] of the fliers [neut, plur] that [?] ...

(Scheepers, 2003, p. 185)

The results showed that there were more HA and LA relative clauses produced after HA and LA priming, respectively. It also showed that both the syntactic structure and the pragmatic factor that affected the priming effect. In Experiment three, everything was the same as in the previous two experiments, except that the priming sentence fragments were adverbial clauses. The results showed that there was

no priming effect between the priming sentence and the target sentence. Overall, the three experiments indicate that RC attachment priming is dependent on a syntactic overlap between the primes and the targets (Scheepers, 2003).

Desmet and Declercq (2006) investigated cross-linguistic priming of syntactic hierarchical configuration information using priming ambiguity relative clause attachment (E.g., *Someone shot the servant of the actress who was on the balcony*. The relative clause could be attached to “the servant” or “the actress”.) to investigate whether syntactic information related to the hierarchical tree is shared across two languages or is represented separately by bilinguals. Twenty-four Dutch-English bilingual students from Ghent University participated. Three kinds of priming sentences were created, high-attachment, low-attachment, and baseline sentences. The priming sentences were all in Dutch, in which the attachment could be determined by the gender of the relative pronoun. The target sentences were all in English. The results demonstrated that the participants produced more high-attachment English relative clauses after Dutch high-attachment relative clause prime than after the low-attachment and baseline, and vice-versa. This indicates that structural priming occurs across languages, and bilinguals share the syntactic knowledge of their L1 and L2 (Desmet & Declercq, 2006).

Different from the previous two studies, Scheepers et al. (2011) explored structural priming across cognitive domains from simple arithmetic to relative clause attachment. More specifically, they investigated if mathematical equation can prime relative clause attachment. A sentence completion task was employed. One hundred

and thirty-five students attending Glasgow University participated. Examples of the materials were as follow.

Table 26 Examples of the materials in Scheepers et al. (2011) study

Category	Sample item
High attachment equation	$90 - (5+15)/5$
Low attachment equation	$90 - 5 + 15/5$
Base line equation	$5 + 15$
Target sentence fragment	The tourist guide mentioned the bells of the church that ...

The results showed that when the mathematical equations were solved correctly, their structure influenced the attachment of the relative clauses: there were more high attachment and low attachment relative clauses after the high attachment equation and low attachment equation. These experiments provide the first demonstration of cross-domain structural priming from mathematics to language. They highlight the importance of global structural representations at a very high level of abstraction, which have potentially far-reaching implications regarding the domain generality of structural representations (Scheepers et al., 2011).

### 2.3.3.3 Previous studies concerning structural priming and the comprehension of relative clauses

Kidd et al. (2015) conducted research to explore whether bilinguals represent syntactic structure in a shared way or not, in terms of relative clause comprehension. The research instrument was a sentence and picture matching task. Twenty-seven English-German bilingual people, whose first language is English, participated. The

priming sentences were all in English, and the target sentences were all in German.

The following are examples of the priming sentences and target sentences.

Table 27 Examples of the priming sentences and target sentences in Kidd et al. (2015) study

Priming sentence one	The woman that kisses the man. (Subject RC) (NVN)
Priming sentence two	The woman that the man kisses. (Object RC) (NNV)
Target sentence	Die Frau, die das Mädchen küsst. the woman [Subj/Obj] that the girl [Subj/Obj] kisses

The participants were divided into three groups, the priming sentences for each group were subject RCs, object RCs, and simple sentences, respectively. The group using the simple sentence as the priming sentence was regarded as the baseline. The procedure was like this: the participants listened to the English priming sentence and then selected the corresponding picture from two pictures, and for several filler sentences and pictures, they were required to conduct the same task. Finally, they heard an ambiguous German relative clause, which could be understood as priming sentence one or priming sentence two in the above table. They were also asked to select a corresponding picture from two picture options. The result showed that English object RCs primed significantly greater object RC interpretations in German compared with the baseline and subject RC prime condition, but that English subject RC primes did not change the participants' baseline preferences. This is the first study to report abstract crosslinguistic priming in comprehension. The results specifically suggest that word order overlap supports the integration of syntactic structures from different languages in bilingual speakers, and that these shared representations are used in comprehension as well as production (Kidd et al., 2015).

Brandt et al. (2017) investigated whether increasing the number of object relative clauses (RCs) in German-speaking children's input changes their processing preferences for ambiguous RCs. A sentence picture matching task was employed. Fifty-one six-year-old and fifty-four nine-year old German-speaking children participated. There were three phases of the experiment, which were the baseline phase, prime phase and post-test phase. In the baseline phase, ambiguous relative clauses, which could be interpreted as subject relative clauses or object relative clauses, were posted, and the participants were required to select pictures that matched the sentence. During the prime phase, unambiguous object relative clauses were displayed, and the participants were asked to choose the corresponding picture. With respect to the post-test phase, it was the same as the baseline phase, in order to test whether the participants' comprehension was primed by the prime phase. The results showed that there was no significant priming effect for the six-year-old children, but there was robust priming effect for the nine-year old children. What is more, the results also showed that, there was no enhanced priming effect if the priming and the target sentences shared the same head noun. This indicates that increasing the exposure to object relative clauses can facilitate children's comprehension of this infrequent syntactic structure, but only in older children (Brandt et al., 2017).

#### **2.3.3.4 Previous studies concerning structural priming and the production of English relative clauses**

Shen (2015) conducted research to explore the effect of structural priming on the production of English relative clauses by Chinese EFL learners. A picture description task was employed. Fifty-six non-English major students attending Nantong



University participated. There were three phases of the experiment, the pretest phase, the priming phase and the post test phase. In the pretest phase, the participants were required to describe pictures with some reference words (relative pronouns). During the priming phase, the participants were divided into two parallel groups, for one group, the priming sentences were acoustic English relative clauses, for the other group, the priming sentences were written English relative clauses. With respect to the post-test phase, it was similar to the pretest phase. The participants' response time, latency and correctness were recorded and analyzed. The result showed that there was a significant priming effect in the production of English relative clauses by Chinese EFL learners. Furthermore, the effect of the spoken priming was stronger than the written priming. This indicates that structural priming can facilitate Chinese EFL learners' production of English relative clauses (Shen, 2015).

Table 28 is a summary of the previous studies reviewed in this subsection.

Table 28 Previous studies concerning structural priming and English relative clause

Study	Participants	Data collection instruments	Main results	Implications
Cleland and Pickering (2003)	Sixteen students attending the University of Edinburgh	Confederate scripting task	When there was structural priming between the prime and the target, the participants were more likely to produce prenominal adjective and relative clauses when following the prenominal adjective and relative clause prime, respectively. Moreover, when the prime and the target shared the same	The results indicate that the structure of the sentence can affect structural priming, and repetition of the content words can enhance the effect.

			noun, the priming effect was enhanced, and the effect was significant. When the prime and the target shared the same adjective, the effect of priming was increased.	
Sarah Bernolet et al. (2007)	Thirty-two students attending Ghent University	Confederate scripting task	The participants were more prone to reuse the “noun + relative clause” and “adjective + noun” structure after the “noun + relative clause” and “adjective + noun” priming structure, respectively. The priming effect was significant. The result was similar to structural priming by L1 speakers.	English L2 speakers represent and process syntactic structures in a similar way to English L1 speakers
Liesbeth M van Beijsterveldt and Janet G van Hell (2009)	20 hearing 7- and 8-year-old children, 20 hearing 11- and 12-year-old children, and 26 deaf 11- and 12-year-old children	Picture description task	Hearing 7- and 8-year-olds and 11- and 12-year-olds, as well as deaf 11- and 12-year-olds, showed priming effects for all three structures (adj + noun, noun + relative clause, simple clause) in both the same-noun and different-noun conditions. Structural priming was not boosted by lexical repetition in the hearing and deaf 11- and 12-year-olds; the lexical boost effect was only observed in the	The findings suggest that hearing and deaf children possess abstract representations of the “adjective + noun” structure independent of the particular lexical item

			7- and 8-year-olds and only in the relative clause structure.	
Scheepers (2003)	90 native German speakers attending Saarland University	Sentence completion task	There were more HA (high-attachment) and LA (low-attachment) relative clauses produced after HA and LA priming, respectively. It also showed that both the syntactic structure and the pragmatic factor that affected the priming effect.	RC attachment priming is dependent on a syntactic overlap between the primes and the targets.
Desmet and Declercq (2006)	Twenty-four Dutch-English bilingual students from Ghent University	priming ambiguity relative clause attachment	The participants produced more high-attachment English relative clauses after Dutch high-attachment relative clause prime than after the low-	Structural priming occurs across languages, and bilinguals share the syntactic knowledge of their L1 and

			attachment and baseline, and vice-versa.	L2.
Scheepers et al. (2011)	One hundred and thirty-five students attending Glasgow University	Sentence completion task	When the mathematical equations were solved correctly, their structure influenced the attachment of the relative clauses: there were more high attachment and low attachment relative clauses after the high attachment equation and low attachment equation.	These experiments provide the first demonstration of cross-domain structural priming from mathematics to language. They highlight the importance of global structural representations at a very high level of abstraction, which have

				<p>potentially far-reaching implications regarding the domain generality of structural representations</p>
Kidd et al. (2015)	<p>Twenty-seven English-German bilingual people, whose first language is English</p>	<p>Sentence and picture matching task</p>	<p>English object RCs primed significantly greater object RC interpretations in German compared with the baseline and subject RC prime condition, but that English subject RC primes did not change the participants' baseline preferences.</p>	<p>This is the first study to report abstract crosslinguistic priming in comprehension. The results specifically suggest that word order overlap supports the integration of syntactic structures from</p>

				different languages in bilingual speakers, and that these shared representations are used in comprehension as well as production.
Brandt et al. (2017)	Fifty-one six-year-old and fifty-four nine-year old German-speaking children	Sentence picture matching task	There was no significant priming effect for the six-year-old children, but there was robust priming effect for the nine-year old children. What is more, the results also showed that, there was no enhanced priming	Increasing the exposure to object relative clauses can facilitate children's comprehension of this infrequent syntactic structure, but only in older

			effect if the priming and the target sentences shared the same head noun.	children.
Shen (2015)	Fifty-six non-English major students attending Nantong University	picture description task	There was a significant priming effect in the production of English relative clauses by Chinese EFL learners. Furthermore, the effect of the spoken priming was stronger than the written priming.	Structural priming can facilitate Chinese EFL learners' production of English relative clauses.

## **CHAPTER 3**

### **METHODOLOGY**

This chapter announces the methodology adopted for the study in six sections: 3.1 Concentrates on the participants; 3.2 Describes the materials; 3.3 Focuses on the Latin Square design of the present study; 3.4 Reports on the procedure of the experiment; 3.5 Illustrates the scoring criteria; 3.6 Focuses on data analysis.

#### **3.1 Participants**

The participants were ninety native Chinese speakers and ten native English speakers. Considering the native English speakers, they were people from New Zealand, the USA, and England. All the participants had a bachelor's degree and received their education in their respective countries. At the time of the experiment, they were working in Bangkok, Thailand. They were treated as the control group (Group Four). The researcher recruited the participants through posters. Six native speakers who were interested in the experiment reached out to the researcher directly. The remaining four participants were referred to by individuals who had contacted the researcher.

With respect to the native Chinese speakers, they were first-year students from the Faculty of Humanities and Law attending Guizhou University of Finance and Economics, Guiyang, Guizhou, China. The English exposure for all of them had been through the Chinese education system.

They were selected by considering two factors. The first was availability, as the researcher was working in the Faculty of Humanities and Law at Guizhou University of Finance and Economics, which makes access to the participants practical. The



second factor was their English proficiency level. They were selected by taking the Oxford Quick Placement Test Version Two (Syndicate, 2001).

All of the participants were students who can achieve 30 to 47 correct answers from the 60 test items, which the intermediate level was according to the criteria of the Oxford Quick Placement Test, as shown in Table 29.

Table 29 Criteria of the Oxford Quick Placement Test (Score out of 60)

Alte Level	Paper and Pen Test Score	Council of Europe Level
0 Beginner	0-17	A1
1 Elementary	18-29	A2
2 Lower intermediates	30-39	B1
3 Upper intermediate	40-47	B2
4 Advanced	48-54	C1
5 Very advanced	55-60	C2

Students were excluded from the experiment if: a. The number of correct answers in the Oxford Quick Placement Test was less than 30, which was recognized as a lower professional English level, b. The number of correct answers in the Oxford Quick Placement Test was more than 47, which was categorized as a higher professional English level; c. Color blinded were excluded, since there were many pictures in the picture description task involving colors.

The researcher selected intermediate level students as the participants, since if the subjects were lower level English learners, they might not understand the instructions, or be unable to describe the pictures in the experiment; if the subjects were higher

level English learners, the tasks could be too easy for them to do, thus, the results would not truly reflect whether it was because of structural priming or the participants' higher English proficiency level. They were divided into three parallel groups: Group One, Group Two, and Group Three.

The researcher recruited the participants by posting volunteer recruitment information in the applicable WeChat groups. In Guizhou University of Finance and Economics, there was a WeChat group for each class. The researcher asked the administrator of each WeChat group for help to post the information. Any color blinded student was excluded from this step. All the students know if they were color blinded since they have received a very detailed health examination before joining the university. Volunteers who were interested in the experiment were asked to join the WeChat group called "Psycholinguistic experiment volunteers". After the Oxford Quick Placement Test, the participants were invited to join another WeChat group called the "Psycholinguistic experiment". All the information in the following experiment were posted in the WeChat group called "Psycholinguistic experiment", such as the schedule and address information of the experiment.

The demographic information of the subjects was collected at the preparation stage by administering a questionnaire (see Appendix II). The questionnaire comprised two sections for general information and educational experience concerning English education. The demographic information of the participants was reported in Table 30 below:

Table 30 Participants' demographic information

Demographic information of the subjects acquired from the questionnaire		
General information	Average age	<u>19</u> years old
	Gender	<u>93</u> % female, <u>7</u> % male
	Nationality	<u>89.9</u> % Chinese <u>10.1</u> % Other
	L1 Chinese	100%
	Faculty	Faculty of Humanities and Law
Educational background concerning English education	Years of learning English	6-8 years <u>32.9</u> % >8 years <u>67.1</u> %
	Experience of studying English in an English-speaking country	<u>0</u> %

### 3.1.1 General information

All the native Chinese speaking participants were students attending the same faculty, with an age range from 18 to 21 years, with the average age of 19 years. Considering gender, males and females are 93 % and 7 %, respectively. With respect to nationality, 89.9% are Chinese, and 10.1 % are others. The first language for all the subjects was Mandarin Chinese.

### 3.1.2 English education background

Regarding English education background, 67.1% of the participants have been learning English for six to eight years, and 32.9% of them had been studying English

for more than eight years. None of them had the experience of learning English in an English-speaking country.

### 3.2 Materials

The materials for the experiment consisted of a set of pictures and a set of spoken sentences. Regarding the pictures, place holder pictures and target pictures were included. The spoken sentences included priming sentences and place-holder sentences. Half of the place-holder materials were repeated for the sake of ensuring that the experiment looks like a memory test. The reason why the experiment was disguised as a memory test was that we do not want the participants to know the purpose of the experiment. In other words, for the sake of validity. Details of each type of material are as follows:

#### 3.2.1 Place-holder pictures and target pictures

The place-holder pictures were used for trial segmentation (between one experimental trial and the other one), and to disguise the experiment as a memory test. (The participants were asked to answer whether they have encountered the picture or sentence in the experiment). Sixteen place-holder pictures were included, which could be described with a simple sentence, a compound sentence, or other structures other than “Noun + Relative Clause” and “Adj + Noun” phrases.

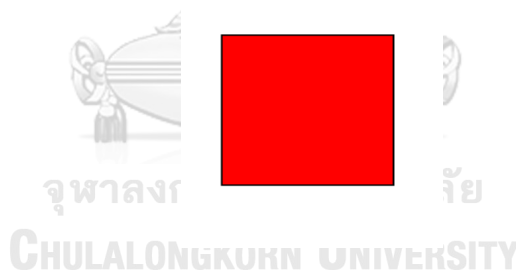
Table 31 Picture type and number for the experiment

Type of picture	Place-holder pictures	Target pictures
Number	16	24



*Picture 1 Example of a place-holder picture*

Regarding the target pictures, they could be described with a “Noun + Relative Clause”, “Adj. + Noun”, or other structures, such as a simple sentence “there is a square” (for Picture 2). The participants’ descriptions of these pictures were collected and analyzed. Twenty-four target pictures were used. This is an example of a target picture:



*Picture 2 Example of a target picture*

All the pictures were drawn on A4 paper, photographed, stored on a disk, and uploaded to the E-prime 2.0 system.

### **3.2.2 Priming phrases and place-holder sentences**

There were three groups of priming phrases consisting of twenty-four “Adj + Noun” structures, twenty-four “Noun + Relative Clause” structures (the priming phrase and target picture has a different head noun), and twenty-four “Noun + Relative Clause” structures (the priming phrase and target picture shared the same

head noun). The place-holder sentences were similar to the place-holder pictures and were used for the trial segmentation and to disguise this as a memory test. Sixteen simple English sentences were used as the place-holder sentences, and half of them were repeated for the sake of making the experiment appear as a memory test. The sentence types and number were shown in Table 32, and examples of the place-holder sentences and priming phrases were shown in Tables 33 and 34, respectively:

Table 32 Sentence types and number for the experiment

Sentence type	Placeholder sentences	Priming phrases and sentences
Number	16	24 + 24 +24

Table 33 Example place-holder sentences for the experiment

1. The teacher went to school.
2. A boy is drinking water.
3. The girl loves cats.

Table 34 Examples of the priming structures for the experiment

1. A square that is blue	} “N + RC” structure, the priming phrase and the target have different head nouns
2. A cake that is yellow	
3. A car that is black	
4. A blue square	} “Adj + N” structure
5. A yellow cake	
6. A black car	
7. A square that is blue	} “N + RC” structure, the priming phrase and the target share the same head noun
8. A cake that is yellow	
9. A car that is black	

The place-holder sentences and the priming phrases were read by a native English speaker at normal speed and recorded by an audio microphone. The audio data were stored on a disk and uploaded to the E-prime 2.0 system.

### 3.2.3 Repetition materials and practice materials

To make the experiment appear as a memory test, half the place-holder sentences, place-holder pictures were repeated. Moreover, a small set of pictures and sentences were used as instructional and practice materials, consisting of eight target pictures, three place-holder pictures, eight priming phrases and three place-holder sentences. The types and number of the materials for instruction and practice for Experiment One were shown in Table 35.

Table 35 Instruction and practice materials for Experiment One

Materials	Target picture	Priming phrases	Place-holder pictures	Place-holder sentences
Number	8	8	3	3

### 3.2.4 Validity of the pictures and spoken sentences

For the present experiment, the Index of Item Congruence (IOC) were used to ensure the validity of the pictures and spoken sentences. Each item was rated by three experts in applied English linguistics. The judgment criteria were that if the item was congruent with the object, one point was given; if the item was judged as congruent or incongruent, a zero point was given; if judged as incongruent, a minus one point was given. The IOC Criteria was shown in Table 36:

Table 36 IOC Criteria in the experiment

Item	Congruent	Congruent/incongruent	Incongruent
Score	1	0	-1

The total score was calculated by the following formula:

$$\text{IOC} = R/N$$

Here, R refers to the total number from the three experts, and N refers to the number of experts. The IOC indices for the place-holder sentences, place-holder pictures, target pictures, and the priming phrases are all 100%.

### 3.3 Design of the Experiment

This section includes three subsections: 3.1.3.1 Concentrates on the preparation of the participants and materials; 3.1.3.2 Focuses on the Latin Square Design in the current study; and 3.1.3.3 Reports the location of the place-holder sentences and place-holder pictures.

#### 3.3.1 Preparation of the participants and materials

Considering the participants, as stated above, the native Chinese speaking participants were divided into three parallel groups, named Group One, Group Two, and Group Three. The native English speakers formed one group, named Group Four.



Table 37 Groups of participants and the numbers in each group

Participants	Native Chinese speakers			Native English speakers
Groups	Group One	Group Two	Group Three	Group Four
Participants per group	30	30	30	10

Regarding the materials, there were twenty-four items, which include eight humans, eight animals and eight objects. For each item there were four conditions, “Adj + Noun”, “Noun + RC (the priming and target have different head nouns) (DN)” and “Noun + RC (the priming and target share the same head noun) (SN)”. The fourth condition was a simple sentence, neither “adj + noun” nor “noun + RC”, which means that it was neither “Adj + Noun” nor “Noun + RC” priming. See Table 38 for examples:

Table 38 Examples for one item in the present study

Item one	Adj + noun	Noun + RC(DN)	Noun + RC(SN)	Simple sentence
Examples	A red ball (The target picture was not a ball.)	A ball that is red (The target picture was not a ball.)	A ball that is red (The target picture was a ball but of a different color.)	Jack is playing football. (The target picture was not a ball.)

As shown above, item one is a “red ball”. There are four conditions for item one, “Adj + Noun (a red ball)”, “Noun + RC (DN) (a ball that is red)”, “Noun+ RC (SN) a ball that is red”, and a “Simple Sentence (Jack is playing football)”.

The twenty-four items formed four lists of phrases and sentences, as shown in Table 39:

Table 39 List of the materials in the current study

Items	List one (a) Adj + noun)	List two (b) Noun + RC (DN)	List three (c) Noun + RC (SN)	List four (d) Simple sentences
1	A red square	A square that is red	A square that is red	Jack is playing football.
2	A blue star	A star that is blue	A star that is blue	Lucy likes animals.
3	A fat man	A man who is fat	A man who is fat	Mike is good at jumping
4	A black bird	A bird that is black	A bird that is black	Tom is a student.
5	A white cat	A cat that is white	A cat that is white	We are friends.
6	A pretty girl	A girl who is pretty	A girl who is pretty	She gave me a cake.
...				

### 3.3.2 The Latin Square Design

This section reports the Latin Square Design: 3.1.3.2.1 Focuses on the Latin Square Design principle; 3.1.3.2.2 Concentrates on the Latin Square Design that will be used in the current study.

#### 3.3.2.1 The Latin Square Design

This subsection focuses mainly on two concepts, what is a Latin Square and what is a Latin Square Design.

A Latin Square is an  $n * n$  layout filled with symbols in such a way that each symbol appears only once in each row and only once in each column (Gao, 2005).

Two examples are shown in Table 40 and Table 41:

A	B	C
B	C	A
C	A	B

Table 40 3\*3 Latin Square

a	b	c	d
b	c	d	a
c	d	a	b
d	a	b	c

Table 41 4\*4 Latin Square

Table 40 is a 3\*3 Latin Square. In each row, the letters A, B, C occur only once, and in each column the letters A, B, C also appears only once. Table 41 shows a 4\*4 Latin Square, in which in each row and each column the letters a, b, c, d occur exactly once only.

The Latin Square Design is an experimental method that places treatments in a balanced way within a square or field, in such a way that each treatment occurs exactly once only in each row and each column. There are two main properties of the

Latin Square Design: First, there are equal numbers of rows and columns; Second, the treatments are assigned in random in such a way that each treatment may appear only once in each row and each column (Gao, 2005).

There are two advantages of the Latin Square Design. The first is that it can handle the situation when there are several nuisance factors that we either wish to separate or we cannot combine into one factor. The second is that it allows an experiment to be run in a relatively small number, which makes conducting the experiment easier (Gao, 2005).

### 3.3.2.2 The Latin Square Design in the current study

Considering the Latin Square Design in the current study, the details were shown in Table 42:

Table 42 The Latin Square Design in the current study

Groups	Materials
Group One	1a 2b 3c 4d 5a 6b 7c 8d 9a 10b 11c 12d 13a 14b 15c 16d 17a 18b 19c 20d 21a 22b 23c 24d
Group Two	1b 2c 3d 4a 5b 6c 7d 8a 9b 10c 11d 12a 13b 14c 15d 16a 17b 18c 19d 20a 21b 22c 23d 24a
Group Three	1c 2d 3a 4b 5c 6d 7a 8b 9c 10d 11a 12b 13c 14d 15a 16b 17c 18d 19a 20b 21c 22d 23a 24b
Group Four	1d 2a 3b 4c 5d 6a 7b 8c 9d 10a 11b 12c 13d 14a 15b 16c 17d 18a 19b 20c 21d 22a 23b 24c

*Note: 1, 2, 3, 4...represent the order of items shown in Table 39, a, b, c, d represent "Adj + Noun", "Noun + RC (DN)", "Noun + RC (SN)", and "simple sentences".*

As shown above, this is a 4\*4 Latin Square Design, which means that there are four rows and four columns, and in each row and each column "a", "b", "c", "d" appears only once. There are twenty-four items, and each item has four conditions, which are "a", "b", "c" and "d", so there are six 4\*4 Latin Squares, which are in different colors.

The reason why we use the Latin Square Design is that it ensures that the experiment is random and balances all the factors that may affect the experiment, such as the items of the materials that the participants receive, the sequence of the materials, and the format of the materials. In the present 4\*4 Latin Square, each group receives all the four priming phrases and sentences “a”, “b”, “c” and “d”. Each group receives one condition of each of the four items. For example, see Table 43.

Table 43 One example of the 4\*4 Latin Square Design in the current study

Groups	Treatments			
Group One	A red square	A star that is blue (DN)	A man who is fat (SN)	Tom is a student.
Group Two	A square that is red (DN)	A star that is blue (SN)	Mike is good at jumping.	A black bird
Group Three	A square that is red (SN)	Lucy likes animals.	A fat man	A bird that is black (DN)
Group Four	Jack is playing football.	A blue star	A man who is fat (DN)	A bird that is black (SN)

Table 43 shows one example of the 4\*4 Latin Square design which were used in the current study. It corresponded with the yellow Latin Square in Table 42, and all the materials were derived from Table 39. Each group received four different priming treatments at random.

### 3.3.3 The location of the place-holder pictures and place-holder sentences

The place-holder sentences, and place-holder pictures were used to segment the priming trials, and half of the place-holder sentences, places-holder pictures were

repeated in order to ensure that the experiment looks like a memory test. Table 44 shows the location of the place-holder pictures and place-holder sentences:

**Table 44** Location of the place-holder pictures and place-holder sentences

Groups	Materials
Group One	1a 2b 3c 4d  5a 6b 7c 8d  9a 10b 11c 12d  13a 14b 15c 16d  17a 18b 19c 20d  21a 22b 23c 24d
Group Two	1b 2c 3d 4a  5b 6c 7d 8a  9b 10c 11d 12a  13b 14c 15d 16a  17b 18c 19d 20a  21b 22c 23d 24a
Group Three	1c 2d 3a 4b  5c 6d 7a 8b  9c 10d 11a 12b  13c 14d 15a 16b  17c 18d 19a 20b  21c 22d 23a 24b
Group Four	1d 2a 3b 4c  5d 6a 7b 8c  9d 10a 11b 12c  13d 14a 15b 16c  17d 18a 19b 20c  21d 22a 23b 24c

*Note: 1,2,3,4...represent the order of items as shown in Table 36, “a”, “b”, “c”, “d” represent “adj + noun”, “Noun + RC (DN)”, “Noun + RC (SN)”, and “simple sentences”. “|” represents one place-holder sentence and one place-holder picture.*

As shown in Table 44, the materials for each group begin with a place-holder sentence and a place-holder picture; then, in the following sequence, the place-holder sentences and place-holder pictures are placed between the successive priming trials.

### 3.4 The procedure for the experiment

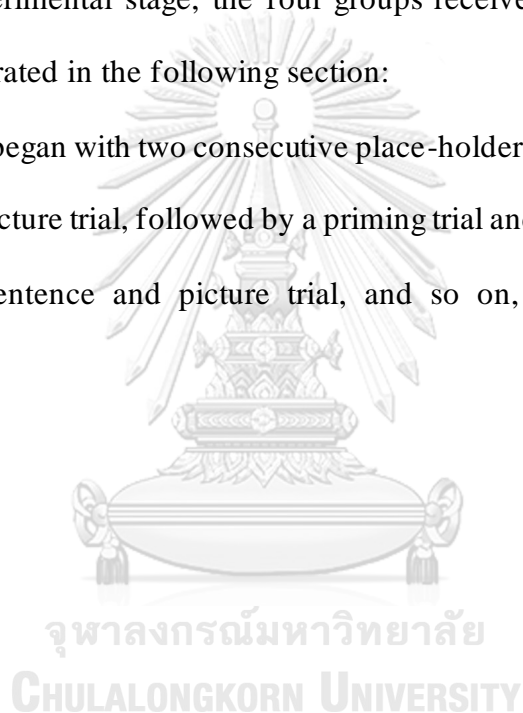
The experiment was conducted in a computer laboratory using the E-prime 2.0 software system. There were two main stages for the procedure: the preparation stage, and the experimental stage. The duration for the experiment ranged from 30 to 50 minutes, depending on each individual participant. Details of each stage were as follows.

For the preparation stage, the participants were instructed that they must conduct the memory test individually and without talking to each other. They were also instructed that they would hear a list of sentences and look at a set of pictures, and the order of the pictures and sentences were random. Some of the sentences and pictures may appear twice. The participants’ main task was to listen to the sentences and look

at the pictures and pay close attention to detect whether the pictures or the sentences had appeared previously in the experiment. In addition, they were asked to repeat the sentences that they have heard, and describe the pictures observed. The instruction for the description task was “Please describe the picture”. Finally, a practice session was given to the participants in order to ensure that they can handle the tasks for the experiment.

In the experimental stage, the four groups received similar stimuli, and the process was illustrated in the following section:

The process began with two consecutive place-holder trials, one was a sentence trial, the other a picture trial, followed by a priming trial and a target picture trial, then a place-holder sentence and picture trial, and so on, until completion of the experiment.



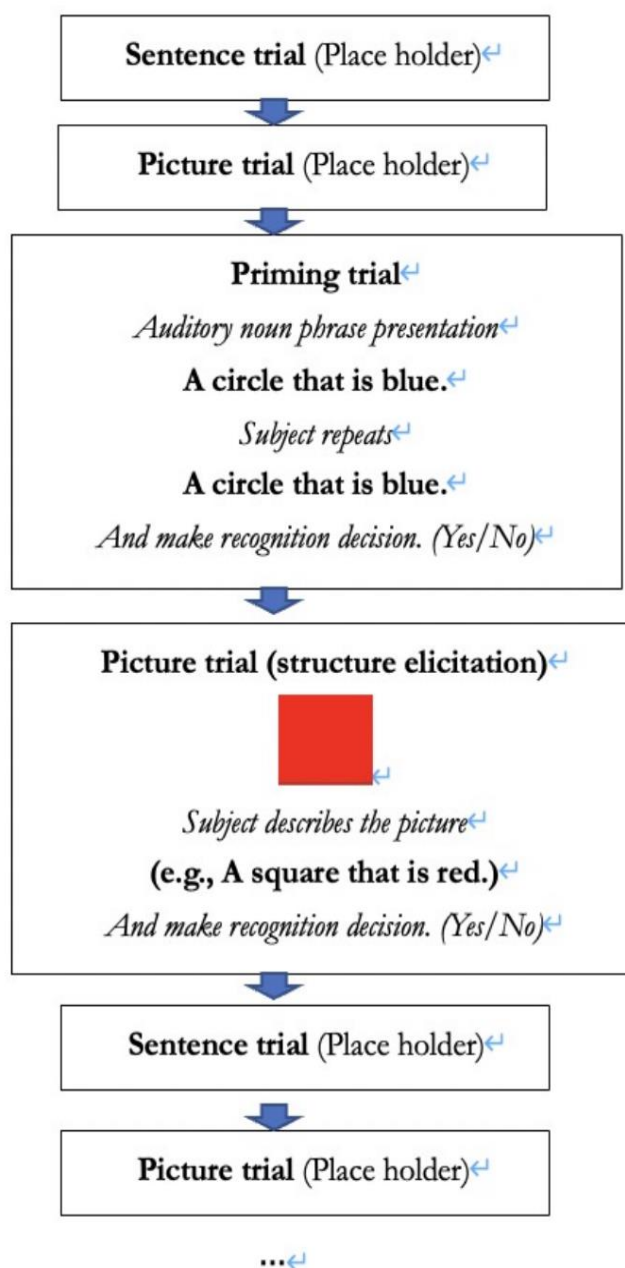


Figure 13 Process for a sample structural priming trial for the participants


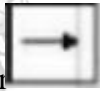
For each sentence trial, the participants listened to the auditory sentence, then repeated it aloud, and made a recognition decision whether it had appeared previously in the experiment or not. The participants were told that repeating the auditory sentence aloud can help them to memorize it. The real aim of repeating the auditory sentence was to ensure that the subjects had heard the sentence clearly. The same





process was used for all the sentence trials, no matter whether the place-holder sentence trial or priming trial, so that the participants could not distinguish the trial type.

For the picture trials, the participants were required to describe the picture, and then made a recognition decision whether the picture had appeared previously in the experiment. Regardless of whether the picture was a place-holder picture trial or a target picture trial, the process was the same, in order to ensure that the trial types were indistinguishable by the participants. What should be mentioned was that the priming sentences were always followed immediately by the target pictures.

All the tasks for the experiment were controlled by the E-prime 2.0 software. The experiment began when the participant pressed the button on the screen.

For the sentence trial, after pressing the “Listen” button, the auditory sentence was heard. By pressing the “Repeat” button, the participants can repeat and record their spoken repetition. Then, by pressing  or , the message “Have you heard this sentence in this test?” was displayed on the screen. Below the sentence, there were two buttons, “Yes” and “No”. The participants made the recognition decision by pressing “Yes” if they had heard the sentence before, or “No” if they had not heard the sentence.

For the picture trial, the picture appeared on the screen, the “Describe” button was placed beneath the picture. The subjects were asked to record their description by pressing the “Describe” button. Then by pressing  or , the question “Have you ever seen the picture in this test?” appeared on the screen, with the buttons

“Yes” and “No” beneath. The participants pressed the “Yes” button if they had seen the picture before, and the “No” button if they had not seen the picture.

The participants’ descriptions and repetitions were recorded by headset microphones connected to the computers. The auditory sentences were also played through the same headset microphones.

During the experiment, the researcher and the laboratory assistant were in the computer laboratory. Should the participants have a problem with the equipment, they can raise their hand, and the researcher or the laboratory assistant would come to help them.

The native English speakers participated in the experiment individually as they worked in different international schools in Bangkok, Thailand. The experiment procedure was identical to that of the Chinese participants.

### **3.5 Scoring**

The participants’ production was categorized as “Adj + Noun”, “Noun + Relative Clause”, and “Others”. In scoring the production, the omission of articles and the use of definite articles and indefinite articles was allowed (Liesbeth M van Beijsterveldt & Janet G van Hell, 2009). If the production includes “Adj + Noun”, it was categorized as “Adj + Noun”, if the production consisted of a “Noun + Relative Clause”, it was categorized as “Noun + Relative Clause”, and any other kind of production was categorized as “others”.

### **3.6 Data analysis**

The data analysis comprised two steps, the statistical stage, and the ANOVA stage.

Concerning the statistical stage, the measurement of each type of production was the number, and the participants’ production of “Noun + Relative Clause”, “Adj +

Noun”, and “Others” in each group were collected, counted, and illustrated in a table.

The proportion of each type of structure was calculated, as shown in (1) below:

$$(1) \quad \frac{\text{NRC}}{\text{NRC} + \text{NADJ} + \text{No}} * 100\% = \text{RC} (\%)$$

$$\frac{\text{NADJ}}{\text{NRC} + \text{NADJ} + \text{No}} * 100\% = \text{ADJ} (\%)$$

$$\frac{\text{No}}{\text{NRC} + \text{NADJ} + \text{No}} * 100\% = \text{O} (\%) ^9$$

The number of “Noun + Relative Clause” divided by the sum of the number of “Noun + Relative Clause”, “Adj. + Noun”, and other sentence structures multiplied by 100% was the percentage proportion of the “Noun + Relative Clause” phrases. For example, if the total number of “noun + relative clause” was 36, and the sum of the number of “Noun + Relative Clause”, “Adj + Noun”, and other sentence structures was 72, the calculation was  $\text{RC}\% = 36/72 * 100\% = 50\%$ . For the proportion of “Adj + Noun”, and other sentence structures, the calculation process was the same.

The IBM SPSS Statistic 23 process were employed, and the two-way ANOVA process used to analyze the variance of the production under different stimulus situations. The effect was treated as significant if the probability related to each is less than .05.

<sup>9</sup> RC refers to “Noun + Relative Clause”, NRC is the number of “Noun + Relative Clause”; ADJ is “Adj + Noun”, and NADJ is the number of “Adj + Noun”; O is others, and No is the number of Others.

## **CHAPTER 4**

### **FINDINGS AND DATA ANALYSIS**

This chapter reports findings of the experiments and data analyses in three sections: 4.1 focuses on findings and data analyses of L1 Chinese learners' production of English sentences and phrases; and 4.2 concentrates on those of English native speakers' production of English sentences and phrases.

#### **4.1 Findings and data analyses of L1 Chinese learners' production of English sentences and phrases**

This section concentrates on findings of L1 Chinese learners' production of English sentences and phrases in four subsections: 4.1.1 focuses on findings of L1 Chinese learners' production of English sentences and phrases primed by the English "Adj + N"; 4.1.2 concentrates on findings of L1 Chinese learners' production of English sentences and phrases primed by the English "Noun + RC" when the priming and target shared different nouns; 4.1.3 reports findings of L1 Chinese learners' production of English sentences and phrases primed by the English "Noun + RC" when the priming and target shared the same noun; 4.1.4 focuses on findings of L1 Chinese learners' production of English sentences and phrases primed by English simple sentences. 4.1.5 concentrates on data analyses.

##### **4.1.1 Findings of L1 Chinese learners' production of English sentences and phrases primed by the English "Adj + N"**

Primed by the English "Adj + N" structure, the L1 Chinese participants produced five different types of sentences or phrases. They were "Adj + N", "N + RC", "Adj + N + RC", "N + 'with phrase'", and "Simple sentence", as well as "Others" (Structures that belonging to none of the above types).

Primed by the English “Adj + N”, such as “a yellow flower”, “a handsome doctor”, and “a blue cup”, the L1 Chinese participants produced 528 sentences and phrases in total, as illustrated in the following table:

Table 45 Different structure types produced by L1 Chinese Learners when the priming was the English “Adj + N”

Structures produced from primed “Adj + N”	Proportions
<b>Adj + N</b>	<b>380 (71.97%)</b>
<b>Simple Sentence</b>	<b>71 (13.45%)</b>
<b>N + RC</b>	<b>57 (10.80%)</b>
<b>N + “prep phrase”</b>	<b>16 (3.03%)</b>
<b>Adj + N + RC</b>	<b>3 (0.57%)</b>
<b>Others</b>	<b>1 (0.19%)</b>
<b>Total</b>	<b>528 (100%)</b>

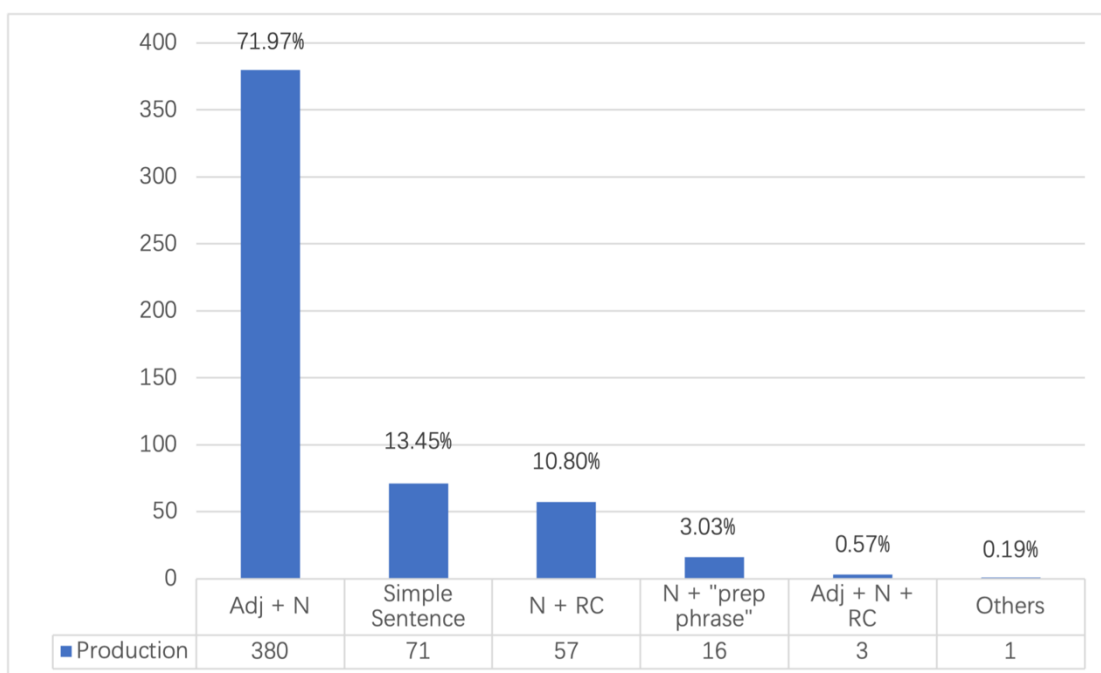


Figure 14 Different structure types produced by L1 Chinese Learners when the priming was the English “Adj + N”

The above table and figure show different structure types produced by the L1 Chinese participants when having been primed by the English “Adj + N”. They produced in total 380 “Adj + N” structures, 71 “Simple sentences”, 57 “N + RC”, 16 “N + ‘with phrase’”, and 3 “Adj + N + RC”, as well as 1 “Others”. The percentages were 71.97%, 13.45%, 10.80%, 3.03%, 0.57% and 0.19%, respectively.

Examples for each type of production are shown below:

Table 46 Examples of different structure types produced by L1 Chinese Learners when the priming was the English “Adj + N”

Structures	Example 1	Example 2	Example 3
Adj + N	a pink cat	a large sofa	an old woman
N + RC	a boy who is smart	a swan that is blue	an umbrella that is yellow
Adj + N + RC	a cute cat that is pink	an old woman that on a yellow shirt	the old woman that wear yellow coat
N+ “with phrase”	a man with brown hair	a chicken with red wings	a sofa with four red legs
Simple sentence	There is a boy.	A sheep is fat.	A girl has yellow hair.
Others	a man’s head		

It can be seen that, after having been primed by the English “Adj + N”, the participants produced the “Adj + N” phrases at the highest percentage (71.97%), the “Simple Sentence” was second (13.45%), and the “N + RC” phrase was third (10.80%).

The distribution of each structural type of production during the priming procedure is demonstrated in Figure 15.

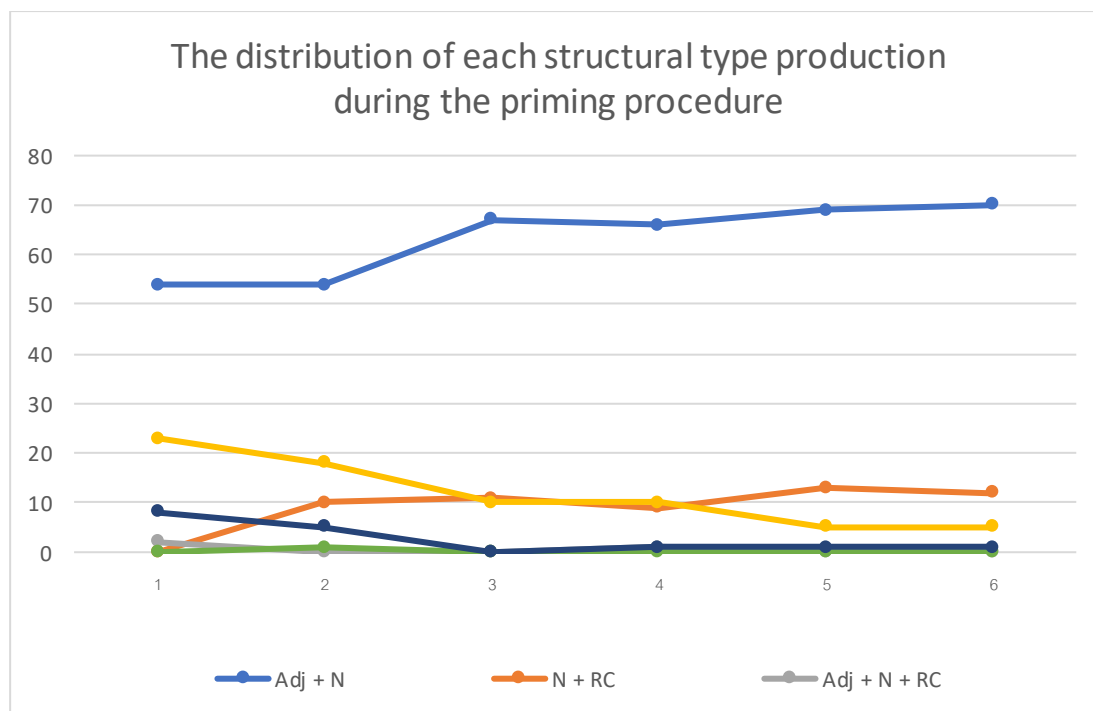


Figure 15 The distribution of different structure types produced by L1 Chinese Learners when the priming was the English “Adj + N”

The horizontal axis represents the experimental trials, in which the total six were labeled as 1, 2, 3, 4, 5, and 6. The vertical axis represents the number of productions.

As the figure shows, the production of “Adj + N” phrases were well above the types of production. And the production increased from 54, to 67, and finally reached 70.

Considering the production of “N + RC” phrases , this was far fewer than the production of “adj + Noun” phrases. And the rate rose, started from 2, up to 10, and finally reached 12.



With respect to the “simple sentence”, the production rate was far behind the “Adj + N” production, beginning with 23, declined to 10, and finally to 5 at the bottom of the trend line.

Regarding the “N + ‘with phrase’”, the rate was similar to that of the “Simple sentence”, but the number was much smaller, declining from 8 to 5, and ended at 1.

The production of “Adj + N + RC” and the “Others” was so rare. For the former, only 3 instances.

To summarize, in line with structural priming, when the L2 learners were primed by the “Adj + N” structure, the production of “Adj + N” was the highest, the “Simple sentence” was the second, and the “N + RC” was the third. The result was similar to S. Bernolet et al. (2007), where the L1 Dutch speaker produced 384 structures after having been primed by “Adj + N”, with 381 “Adj + N”, 1 “N + RC”, and 2 “others”. The results was also consistent with Cleland (2003), in which the participants produced more “Adj + N” after having been primed by “Adj + N” (The researchers didn’t give detailed numbers). The results were also in line with L. M. van Beijsterveldt and J. G. van Hell (2009), in which the participants produced 276 structures in total after having been primed by “Adj + N”, with 247 “Adj + N”, 25 “Main clause”, and 3 “N + RC”.

#### **4.1.2 Findings of L1 Chinese learners’ production of English sentences and phrases primed by the English “Noun + RC” when the priming and target share different nouns**

When the priming structure was the English “N + RC” structure (the priming and the target shared different nouns), the L1 Chinese participants also produced five different types of sentences or phrases : “Adj + N”, “N + RC”, “N + ‘prep phrase’”,

“Adj + N + RC”, simple sentences, and “Others” (structures that belonged to none of the above types), respectively.

The number of different types of production when the priming structure was the English “N + RC” when the priming and target shared different nouns is demonstrated in Table 47.

Table 47 Different structure types produced by L1 Chinese Learners when the priming was the English “N + RC” when the priming and target shared different nouns

Structures produced from primed “N + RC” (DN)	Proportions
<b>N + RC</b>	<b>227 (43%)</b>
<b>Adj + N</b>	<b>225 (42.61%)</b>
<b>Simple sentence</b>	<b>48 (9.10%)</b>
N + “prep phrase”	23 (4.36%)
N	3 (0.57%)
Adj + N + RC	2 (0.38%)
Total	528 (100%)

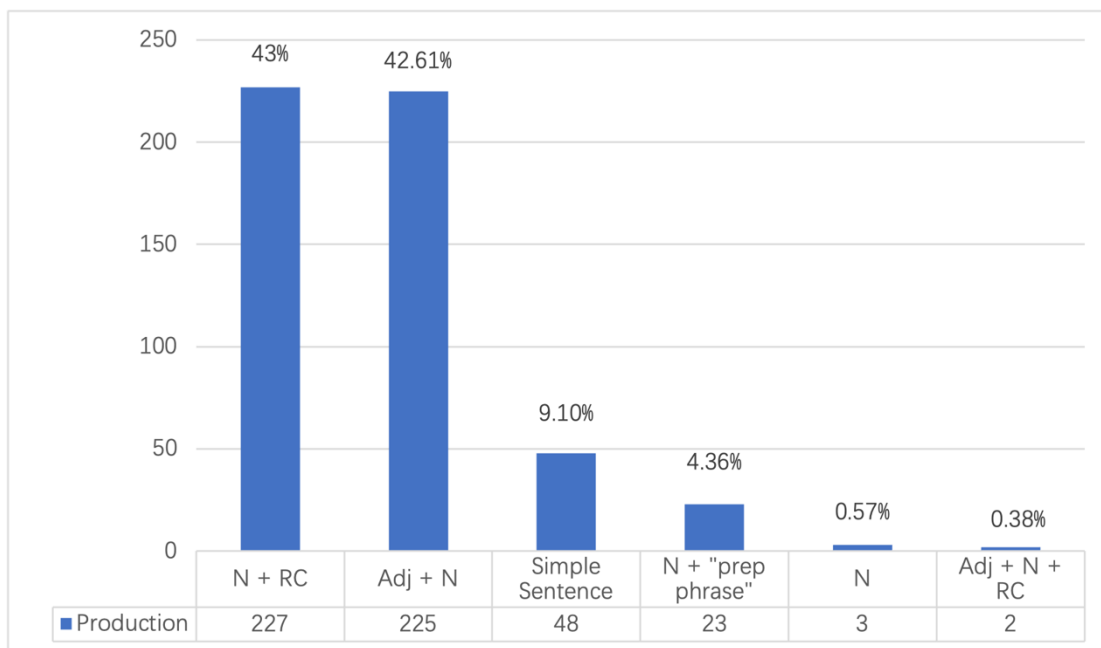


Figure 16 Different structure types produced by L1 Chinese Learners when the priming was the English “N + RC” when the priming and target shared different nouns

As the above table and figure show, the L1 Chinese participants produced 528 sentences and phrases in total, when the priming structure was the English “N + RC”, and when the priming and target shared different nouns, including 227 “N+ RC”, 225 “Adj + N”, 48 “Simple sentences”, 23 “N + ‘prep phrase’”, 3 “N”, and 2 “Adj + N + RC”.

Examples of different types of production are shown in the following table:

Table 48 Examples of Different structure types produced by L1 Chinese Learners when the priming was the English “N + RC” when the priming and target shared different nouns

Structures	Example 1	Example 2	Example 3
N + RC	a policeman who is strong	a pig that is cute	a woman whose cloth is red
Adj + N	a red chair	a strong boy	a dirty boy
Simple sentence	The woman is so ugly.	The sheep is fat.	This is just like star.
N + “prep phrase”	a fireman with red cloth	a boy with yellow hair	a girl with pink dress
N	a fireman	a sheep	a ? <sup>10</sup>
Adj + N + RC	a ugly woman that is have a along and brown hair	a little girl who is dressing a pink dress	

The distribution of production during the priming procedure was shown in

Figure 17.

<sup>10</sup> The participant was describing a picture, but just said “a”, while thinking of a suitable word, but finally gave up.

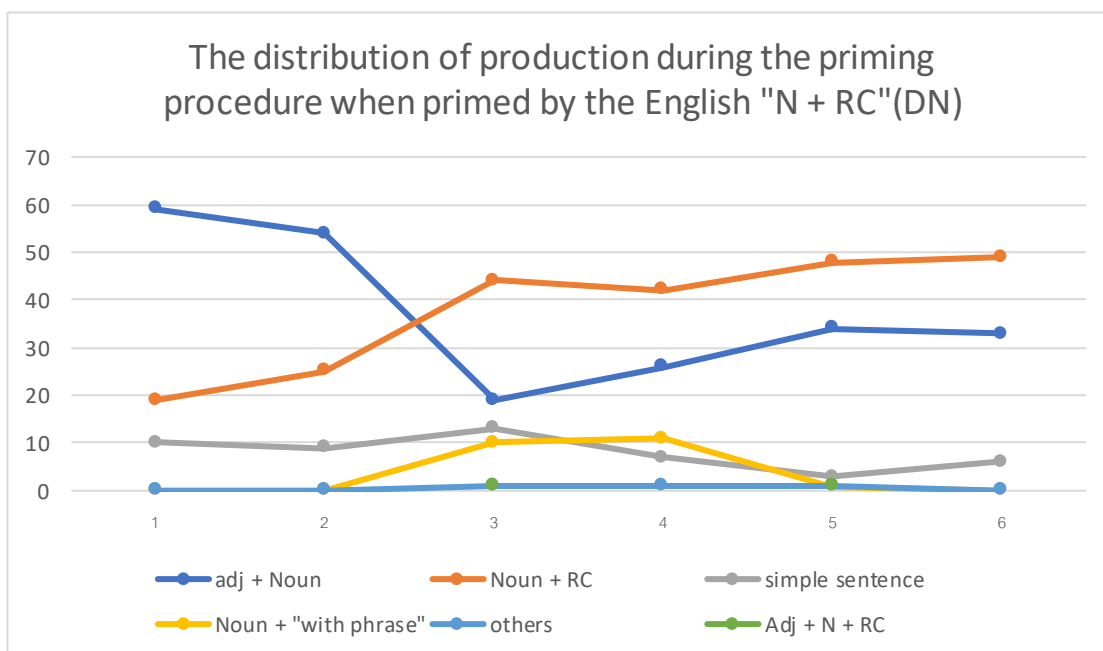


Figure 17 The distribution of different structure types produced by L1 Chinese Learners when the priming was the English “N + RC” when the priming and target shared different nouns

The horizontal axis represents the experimental trials, in which the total six were labeled as 1, 2, 3, 4, 5, and 6. The vertical axis represents the number of productions.

As the above figure shows, the main structures produced were “N + RC”, “Adj + N” and “Simple Sentence”, while “N + ‘with phrase’”, “N” and “Adj + N + RC” were produced only at small numbers.

With respect to the “N + RC”, the line in the figure was the opposite to that of the “Adj + N”. The rate increased a little in the second trial, then with a jump, and the lines surpassed those of the “Adj + N”. It started at 19, climbed to 25, soared to 45, and finally climbed to 49.

Regarding the production of “Adj + N”, the number of productions declined sharply in the third trial, and then increased slowly. The rate began with 59, declined

to 54, and then declined sharply to 19. The rate climbed slowly to 26, then 34, and ended at 33.

Considering the “simple sentence”, the overall trend was down, with a slight increase in the middle. The number was much smaller than that for the “Adj + N” and the “N + RC”. That is, the line began at 10. In the middle trial, it was 13, and finally ended at 6.

Regarding “N + ‘with phrase’”, both at the beginning and the end, the numbers were 0, while in the middle, the numbers were 10 and 11.

The production of “N” was very limited. Only 3 were produced, i.e., “a fireman”, “a sheep”, and “a?”. So was “Adj + N + RC”, only “a ugly woman that is have a long and brown hair” and “a little girl who is dressing a pink dress” were produced.

It is worth observing that after the priming of “N + RC”, the top three productions were “N + RC”, “Adj + N”, and “Simple sentence”. The numbers were 227(43%), 225(42.61%), and 48(9.09%), respectively. The results were in line with L. M. van Beijsterveldt and J. G. van Hell (2009), in which the participants produced 135 structures in total, 64 (47.41%) of which was “Adj + N”, 43(31.85%) “N + RC”, and 28 (20.74%)“Simple sentences”. The results were in accordance with Cleland (2003). The experiment showed that the speakers used a complex noun phrase containing a relative clause (e.g., “the square that is red”) more often after having heard a syntactically similar noun phrase structure. Also, S. Bernolet et al. (2007) found that the participants produced 384 structures in total after having been primed by “N + RC”, in which 292 (76.04%) “Adj + N”, 52 (13.54%) “N + RC”, and

40(10.42%) “others” were included. The main trend of the production of “N + RC”, primed by “N + RC”, increased, compared with that primed by “Adj + N”.

#### **4.1.3 Findings of the L1 Chinese learners’ production of English primed by English “N + RC” with the priming and target shared the same noun**

The L1 Chinese participants produced five different types of structures, when the priming structure was the English “N+ RC” structure (with the priming and the target sharing the same noun). The structure or phrase types were: “Adj + N”, “N + RC”, “Adj + N+ RC”, “N + ‘with phrase’”, and “Simple sentences”.

The number of different structural types of production primed by the English “N + RC” (with priming and target sharing the same noun) is as follow.

Table 49 Different structure types produced by L1 Chinese Learners when the priming was the English “N + RC” when the priming and target shared the same noun

Structures produced from primed “N + RC”	Proportions
(SN)	
<b>N+ RC</b>	<b>412 (78.03%)</b>
<b>Adj + N</b>	<b>78 (14.77%)</b>
<b>Simple sentence</b>	<b>30 (5.68%)</b>
N + “prep phrase”	6 (1.14%)
Adj + N + RC	2 (0.38%)
Total	528 (100%)

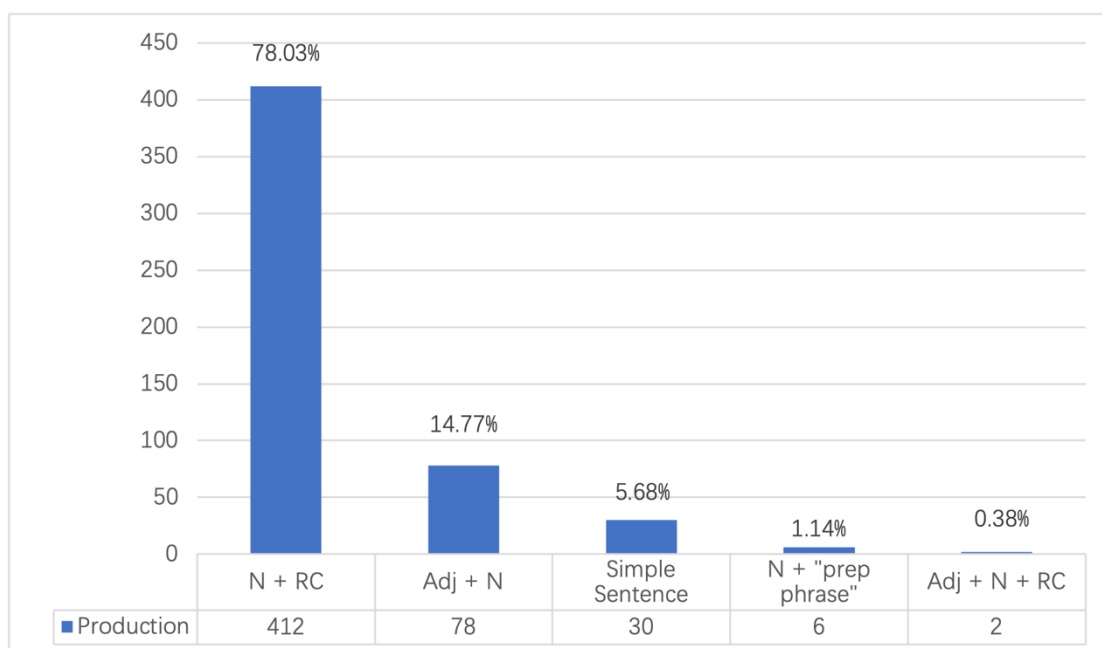


Figure 18 Different structure types produced by L1 Chinese Learners when the priming was the English “N + RC” when the priming and target shared the same noun

The above table and figure show the number of different structural types of production after the L1 Chinese Learners had been primed by the English “N + RC(SN)”. The overall number was 528, consisting of 412 “N + RC”, 78 “Adj + N”, 30 “Simple sentences”, 6 “N + ‘prep phrase’”, and 2 “Adj + N + RC”, respectively. The proportions were 78.03%, 14.77%, 5.68%, 1.14% and 0.38%, respectively.

The following table illustrates examples of different types of productions when the priming structure is “N + RC” (the priming and the target shared the same noun).



Table 50 Examples of different structure types produced by L1 Chinese Learners when the priming was the English “N + RC” when the priming and target shared the same noun

Structures	Example 1	Example 2	Example 3
N + RC	a cup that is yellow	a baby who is cute	a dinosaur that is big
Adj + N	a thin girl	a blue dinosaur	a big green tree
Simple Sentence	The TV is blue.	A woman is tall and thin.	This is a green table.
N + “prep phrase”	a woman with long black hair	a boy with green bag	a nurse with red hair
Adj + N + RC	A woman teacher who wear glasses	A blue dinosaur that is cute	

The distribution of each structural type of production during the priming procedure is demonstrated in Figure 19.

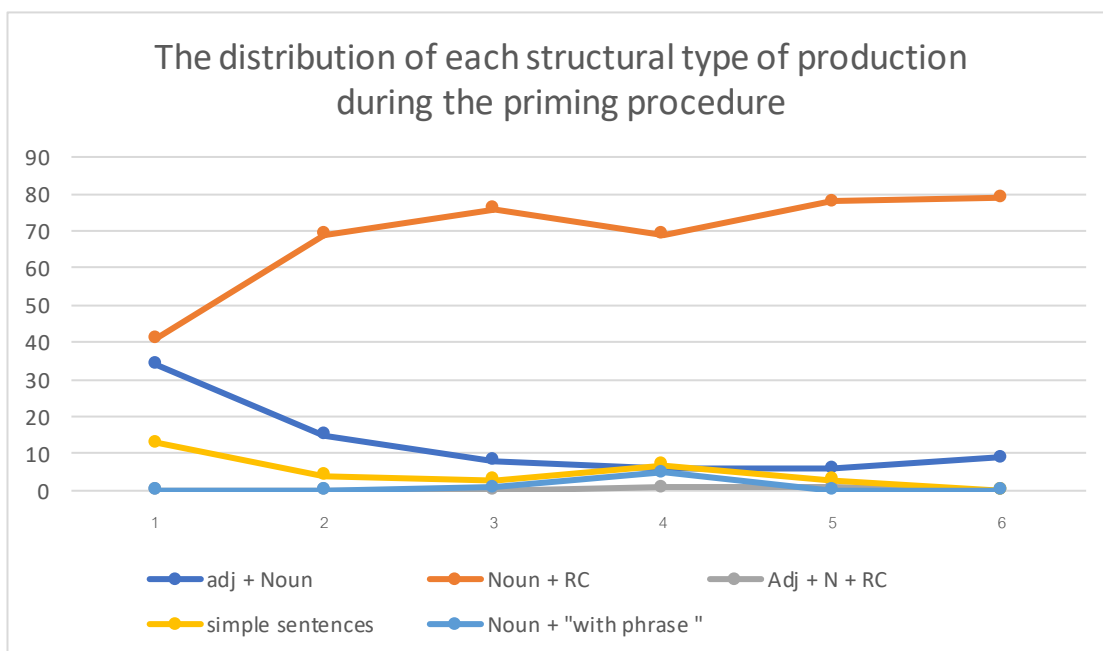


Figure 19 The distribution of different structure types produced by L1 Chinese Learners when the priming was the English “N + RC” when the priming and target shared the same noun

The horizontal axis represents the experimental trials, in which the total six were labeled as 1, 2, 3, 4, 5, and 6. The vertical axis represents the number of productions.

It can be seen that the production number of “N + RC” was high and well above productions of the other structural types.

With respect to “N + RC”, the overall trend was up, with a slight decline in the fourth trial. It began at 41, soared to 69, climbed slowly to 76, and then declined to 70. It finally climbed again and reached 79.

Regarding the production of “Adj + N”, the main trend was a decline with a slight rise at the end. The rate started at 34, declined sharply to 15, and continued declining to 6, ending with a slight rise at 9.

Considering the “Simple sentence”, the overall trend was down. It started at 13, declined to 3; but with a slight increase to 7. The line then declined to 3, and at the end to 0.

With regard to “N + ‘prep phrase’”. The number was very small, with the beginning and the end both at 0, while in the middle trials, the numbers were 1 and 5, respectively.

The last type was “Adj + N + RC”, the number produced was only 2.

It can be observed that, having been primed by “N + RC” with the priming and target sharing different nouns, the learners produced “N + RC”, “Adj + N”, and “Simple sentence” as the top three structural type productions. The number of each structural type of production were “N + RC” 414 (78.41%), “Adj + N” (14.77%), and “Simple Sentence” 5.68%, respectively. The results were in accordance with Liesbeth M van Beijsterveldt and Janet G van Hell (2009) and Cleland (2003). The former study showed that when the participants were primed by “N + RC”, with priming and the target sharing the same noun, they produced more “N + RC” than “Adj + N”. The numbers were 163 (53.44%) and 84 (27.54%), respectively. The latter research found that, when the participants were primed by “N + RC”, with the priming and target shared the semantically related noun, they produced more “N + RC” than “Adj + N”. The results were ascribed to lexical residual activation (Pickering & Ferreira, 2008). Because when the “N + RC” was activated, “N” performed as a node and it connected to “RC”, the relation between them was enhanced. After the activation, the residual activation effect made the speakers reuse the same structure (Pickering & Ferreira, 2008).

#### 4.1.4 Findings of the L1 Chinese learners' structural production primed by the English "Simple Sentence"

When the priming structure was the English "Simple Sentence", the L1 Chinese participants produced five different types: "Adj + N", "N + RC", "Simple Sentence", "N + 'prep phrase'", "N" and "Adj + N + RC".

The number of different types of production when the priming structure was the English "Simple Sentence" was as follow.

Table 51 Different structure types produced by L1 Chinese Learners when the priming was the English "Simple Sentence"

Structures produced from primed "Simple Sentence"	Proportions
<b>Adj + N</b>	<b>268 (50.76%)</b>
<b>N + RC</b>	<b>173 (32.77%)</b>
<b>Simple Sentence</b>	<b>71 (13.45%)</b>
N + "prep phrase"	8 (1.52%)
N	5 (0.95%)
Adj + N + RC	3 (0.57%)
Total	528 (100%)

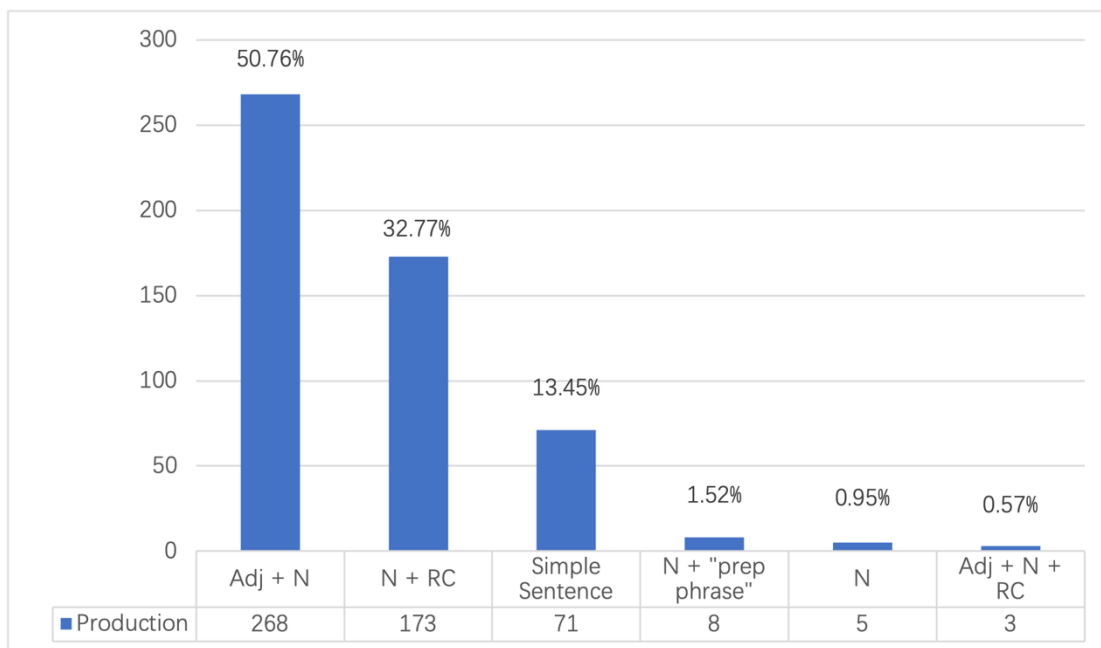


Figure 20 Different structure types produced by L1 Chinese Learners when the priming was the English “Simple Sentence”

Table 51 and Figure 20 show the number of different types of structures produced when the priming structure was the English “Simple Sentence”. The L1 Chinese participants produced 528 structures in total, including: 268 “Adj + N”, 173 “N + RC”, 71 “Simple sentence”, 8 “N + ‘with phrase’”, 5 “N” and 3 “Adj + N + RC”. The proportions were 50.76%, 32.77%, 13.45%, 1.52, 0.95 and 0.57.

Table 52 gives examples of different types of structures produced when the priming structure was the English “simple sentence”.

Table 52 Examples of different types of structures produced when the priming structure was the English “simple sentence”

Structure	Example 1	Example 2	Example 3
Adj + N	a big bus	a handsome man	a blue swan
N + RC	a boy who is wearing a blue shirt	the sheep that is fat	a spoon which is blue
Simple sentence	The chef looks serious	The snail is very cute.	The sheep is yellow.
N + “prep phrase”	a bus with yellow and blue	a boy with yellow T-shirt	a woman with long hair
N	a bus	a fireman	a firefighter
Adj + N + RC	a little kid who is riding on yellow T-shirt and blue pant	the old man who is chef	a white sheep that is fat

Figure 21 demonstrates the distribution of each type of structure produced during the priming procedure when the priming structure is the English “Simple Sentence”

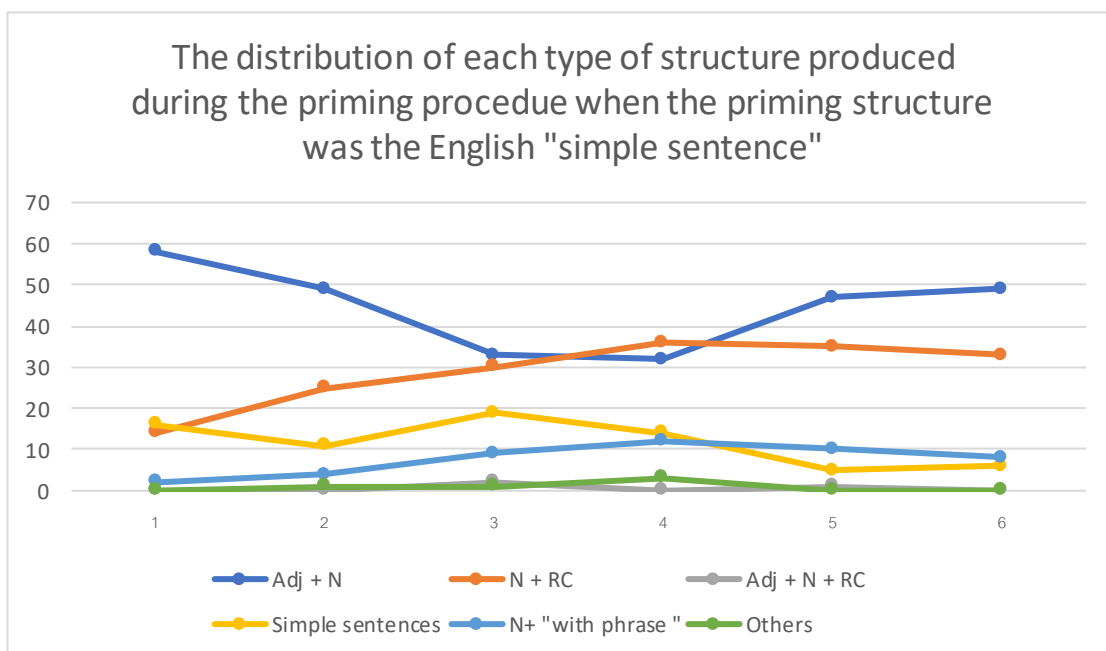


Figure 21 The distribution of different structure types produced by L1 Chinese Learners when the priming was the English "Simple Sentence"

The horizontal axis represents the experimental trials, in which the total six were labeled as 1, 2, 3, 4, 5, and 6. The vertical axis represents the number of productions.

The distribution trend of each type of structure produced during the priming procedure when the priming structure was the English "Simple sentence" was the following. Regarding "Adj + N", the rate started at 58, declined to 49, and reached the bottom at 32. It then rose to 47 and ended at 49.

With respect to the "N + RC", the main trend was up. It began at 14, climbed to 25 and 36, and declined slightly to 33.

Considering the "Simple sentence", the trend was not stable. The rate began at 16, declined to 11 at the second trial, climbed to 19 at the third trial, dropped to 14 at the fourth trial, and down further to 5 at the fifth trial, and rose slightly to 6.

With respect to the “N + ‘prep phrase’”, the overall trend was up. The rate started at 2 in the first trial, increased to 4, 9 and 12 respectively. Then, it declined a little to 10 and finally 8.

Regarding “N” and “Adj + N + RC”, the numbers were 5 and 3. i.e. “a fireman” “a bus” and “the old man who is chef” “a white sheep that is fat”.

It can be seen that, after the priming structure “Simple Sentence”, the top three structural types produced were “Adj + N”, “N + RC”, and “Simple Sentence”. The results were different from Liesbeth M van Beijsterveldt and Janet G van Hell (2009), in which, after “Simple Sentence” priming, the top structural type of production was “Simple Sentence”, the second was “Adj + N”, and the last one was “N + RC” structure. The difference was possibly led by task effects. In the present study, the priming “Simple Sentence” and the target shared different nouns, while in Liesbeth M van Beijsterveldt and Janet G van Hell (2009), half of the priming “Simple Sentence” and the target shared the same noun, and the other half shared different nouns. Therefore, due to the lexical residual activation, the participants produced more “Simple Sentence” than “Adj + N”, and “N + RC”. In the present study, the participants produced 71 “Simple Sentences” after having been primed by the English “Simple Sentence”, which was higher than the production when having been primed by the English “N + RC (DN)” (30) and “N + RC (SN)” (48).

To summarize, different priming structures can be seen in Table 53.



Table 53 The overall results of L1 Chinese participants' production from different priming structures

Production Priming structure	Adj + N	N + RC	Adj + N + RC	N + prep phrase	Simple Sentence	N	Others
Adj + N	380 71.97%	57 10.80%	3 0.57%	16 3.03%	71 13.45%	-----	1 0.19%
N+ RC (SN)	78 14.77%	412 78.03%	2 0.38%	6 1.14%	30 5.68%	-----	-----
N+ RC (DN)	225 42.61%	227 43.00%	2 0.38%	23 4.36%	48 9.10%	3 0.57%	-----
Simple Sentence	268 50.76%	173 32.77%	3 0.57%	8 1.52%	71 13.45%	5 0.95%	-----

#### 4.1.5 Data analysis

The following tables show data analysis.

Table 54 Descriptive Statistics of L1 Chinese Learners' production

Dependent Variable: N+RC				
Group	Priming	Mean	Std. Deviation	N
Group one	Adj+N	4.33	1.966	6
	<b>N+RC(DN)</b>	<b>13.33</b>	<b>4.676</b>	<b>6</b>
	<b>N+RC(SN)</b>	<b>21.00</b>	<b>4.382</b>	<b>6</b>
	Simple Sentence	12.33	2.160	6
	Total	12.75	6.867	24
Group two	Adj+N	4.00	1.789	6
	<b>N+RC(DN)</b>	<b>13.67</b>	<b>5.645</b>	<b>6</b>
	<b>N+RC(SN)</b>	<b>24.00</b>	<b>6.512</b>	<b>6</b>
	Simple Sentence	10.33	3.933	6
	Total	13.00	8.653	24
Group three	Adj+N	1.67	1.366	6
	<b>N+RC(DN)</b>	<b>10.83</b>	<b>5.565</b>	<b>6</b>
	<b>N+RC(SN)</b>	<b>24.17</b>	<b>6.616</b>	<b>6</b>
	Simple Sentence	6.67	3.882	6
	Total	10.83	9.631	24
Total	Adj+N	3.33	2.029	18
	<b>N+RC(DN)</b>	<b>12.61</b>	<b>5.158</b>	<b>18</b>
	<b>N+RC(SN)</b>	<b>23.06</b>	<b>5.765</b>	<b>18</b>
	Simple Sentence	9.78	4.023	18
	Total	12.19	8.398	72

According to the above table, when the primings were “Adj + N”, “N + RC (DN)”, “N + RC (SN)” and “Simple Sentence”, the mean production of “N + RC” by Group one was 4.33, 13.33, 21, and 12.33, respectively.

With respect to Group two, the mean production of “N + RC” was 4, 13.67, 24, and 10.33, respectively.

Considering Group three, the mean production of “N + RC” was 1.67, 10.83, 24.17 and 6.67, respectively.

It could be seen that, L1 Chinese Learners produced “N + RC” the most after having been primed by the “N + RC (SN)”, the mean numbers were 21, 24, and 24.17

for Group one, Group two and Group three, respectively. After having been primed by “N + RC (DN)”, they produced the top two “N + RC”, and the mean numbers for Group one, two three were 13, 13.67, 10.83, respectively. The L1 Chinese Learners produced less “N + RC” after having been primed by “Adj + N” and “Simple Sentence”.

According to two-way ANOVA, as Table 67 in Appendix I shows, the priming effects between Groups were not significant ( $p=0.187 > 0.05$ ), which means the three L1 Chinese Learner Groups produced similar types and amounts of production after having been primed by the four types of structures. The priming effects between priming types were significant ( $p=0 < 0.05$ ), which means different priming structures led to different productions, as shown in Table 54.

Table 55 Multiple Comparisons between Priming Types for L1 Chinese Learners

Multiple Comparisons						
Dependent Variable: N+RC						
LSD						
(I) Priming	(J) Priming	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Adj+N	N+RC(DN)	-9.28*	1.476	.000	-12.23	-6.33
	N+RC(SN)	-19.72*	1.476	.000	-22.67	-16.77
	Simple Sentence	-6.44*	1.476	.000	-9.39	-3.50
N+RC(DN)	Adj+N	9.28*	1.476	.000	6.33	12.23
	N+RC(SN)	-10.44*	1.476	.000	-13.39	-7.50
	Simple Sentence	2.83*	1.476	.049	-.11	5.78
N+RC(SN)	Adj+N	19.72*	1.476	.000	16.77	22.67
	N+RC(DN)	10.44*	1.476	.000	7.50	13.39
	Simple Sentence	13.28*	1.476	.000	10.33	16.23
Simple Sentence	Adj+N	6.44*	1.476	.000	3.50	9.39
	N+RC(DN)	-2.83*	1.476	.049	-5.78	.11
	N+RC(SN)	-13.28*	1.476	.000	-16.23	-10.33

Based on observed means.  
 The error term is Mean Square(Error) = 19.620.  
 \*. The mean difference is significant at the .05 level.

The above table shows that the priming effects between each priming type was significant ( $p < 0.05$ ). That means that, after having been primed by different structures L1 Chinese Learners' production was not by chance. More specifically, after having been primed by "N + RC (SN)" and "N + RC (DN)", the L1 Chinese Learners produced the top amount of "N + RC", as shown in Table 54 , was because of the priming structure.

What should be mentioned was that when the priming effect between other priming types was .000, it was barely significant  $p=.049$  between "N + RC (DN)" and "Simple Sentence", which implies that although barely significant, after having been primed by "Simple Sentence", the L1 Chinese Learners also produced many "N + RC".

Table 56 Multiple Comparisons between Groups for L1 Chinese Learners

Multiple Comparisons						
Dependent Variable: NRC						
LSD						
(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Group one	Group two	-.25	1.279	.846	-2.80	2.30
	Group 3	1.92	1.279	.139	-.64	4.47
Group two	Group one	.25	1.279	.846	-2.30	2.80
	Group 3	2.17	1.279	.095	-.39	4.72
Group 3	Group one	-1.92	1.279	.139	-4.47	.64
	Group two	-2.17	1.279	.095	-4.72	.39

Based on observed means.  
The error term is Mean Square(Error) = 19.620.

The above table shows "Multiple Comparisons between Groups for L1 Chinese Learners". Priming effects between each group were not significant ( $p > 0.05$ ), which

means that there was no significant difference among the three groups of L1 Chinese Learners' production.

#### **4.2 Findings and data analyses of Native English speakers' production of English sentences and phrases**

This section mainly focuses on findings and data analyses of native English speakers' production of English sentences and phrases in four subsections: 4.2.1 focuses on findings of native English speakers' production of English sentences and phrases primed by the English "Adj + Noun"; 4.2.2 concentrates on findings of native English speakers' production of English sentences and phrases primed by the English "Noun + RC" when the priming and target shared different nouns; 4.2.3 reports the findings of native English speakers' production of English sentences and phrases primed by the English "Noun + RC" when the priming and target share the same noun; 4.2.4 focuses on findings of native English speakers' production of English sentences and phrases primed by English simple sentences. 4.2.5 concentrates on data analysis.

##### **4.2.1 Findings of native English speakers' production of English sentences and phrases primed by the English "adj + Noun"**

Having been primed by the English "Adj + N" structure, native English speakers produced seven different types of sentences or phrases. They were "Adj + N", "N + 'prep phrase', Adj +N + 'prep phrase'", "Simple sentence", "N" and "N+N", as well as "Others" (Structures belonging to none of the above types).

Having been Primed by the English "Adj + N", such as "a yellow flower", "a handsome doctor", and "a blue cup", the native English speakers produced 60 sentences and phrases in total, as illustrated in the Table 57:

Table 57 Different structure types produced by native English Speakers when the priming was the English “Adj + N”

Structures produced from primed “Adj + N”	Proportions
<b>Adj + N</b>	<b>32 (53.33%)</b>
<b>Simple sentence</b>	<b>13 (21.67%)</b>
<b>N + “prep phrase”</b>	<b>5 (8.33 %)</b>
Adj + N + “prep phrase”	4 (6.67%)
N	2(3.33%)
N+N	2(3.33%)
Others	2 (3.33%)
<b>Total</b>	<b>60 (100%)</b>

The above table shows different structure types produced by the native English speakers when primed by the English “Adj + N”. They produced in total 32 “Adj + N” structures, 13 “Simple sentences”, 5 “N + ‘prep phrase’”, 4 “Adj +N + ‘prep phrase’”, 2 “N”, and 2 “N+N”, as well as 2 “Others”. Regarding “Others”, “a lady and a top and bikini bottom” and “a cartoon image of a airplane taking off” were produced. The percentages were 53.33%,21.67%, 8.33%, 6.67%,3.33%, 3.33%, 3.33% and 3.33%, respectively.

Examples for each type of production are shown below:

Table 58 Examples of different structure types produced by native English Speakers when the priming was the English “Adj + N”

Structures	Example 1	Example 2	Example 3
Adj + N	a tall man	a fat woman	a yellow chick
N+ “prep phrase”	a peacock with lots of feathers	a peacock with beautiful green feathers	a picture of a spoon
Adj + N + “prep phrase”	a male peacock with others responded	a little yellow chick with a red beak	a large woman in a bikini
Simple sentence	this is a boy with very long legs.	it’s a blue and green peacock.	this is a yellow airplane.
N	a peacock (2times)		
N+N	a peacock image	a baby chick cartoon character	
Others	a lady and a top and bikini bottom	a cartoon image of a airplane taking off	

According to the production, we can see that after priming by the English “Adj + N”, the participants produced the “Adj + N” phrases at the highest percentage (53.33%), the “Simple sentence” was second (21.67%), and the “N + ‘prep phrase” was third (8.33%). Figure 22 below shows in detail.

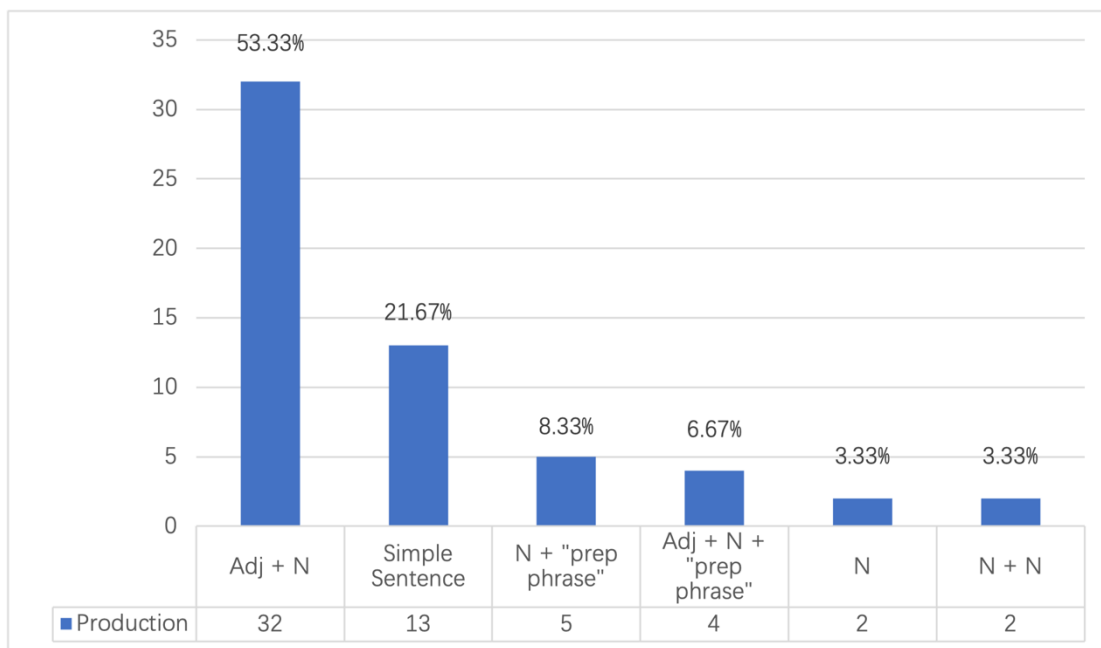


Figure 22 Different structure types produced by native English Speakers when the priming was the English “Adj + N”

The results were consistent with L. M. van Beijsterveldt and J. G. van Hell (2009), in which the top three productions were “Adj + N”, “Main clause”, and “N + RC”, after their participants had been primed by “Adj + N”. It was also in line with Cleland (2003), in which the participants produced more “Adj + N” after having been primed by “Adj + N”.

#### 4.2.2 Findings of native English speakers’ production of English sentences and phrases primed by the English “Noun + RC” when the priming and target shared different nouns

When the priming structure was the English “N + RC” structure (the priming and the target shared different nouns), the native English speakers produced eight different types of sentences or phrases : “Adj + N”, “N + RC”, “Adj + N + RC”, “N + ‘prep phrase’”, “Adj +N + ‘prep phrase’”, “Simple sentences”, “N + participle phrase” and “N” , respectively.



The number of different types of production when the priming structure was the English “N + RC” when the priming and target shared different nouns is demonstrated in Table 47.

Table 59 Different structure types produced by native English Speakers when the priming was the English “N + RC” when the priming and target shared different nouns

Structures produced from primed “N + RC” (DN)	Proportions
<b>Adj + N</b>	<b>25 (41.67%)</b>
<b>Simple sentence</b>	<b>17 (28.33%)</b>
<b>Adj + N + “prep phrase”</b>	<b>6 (10%)</b>
N + “prep phrase”	5(8.33%)
N + “participle phrase”	3 (5%)
N	2 (3.33%)
N + RC	1 (1.67%)
Adj + N + RC	1 (1.67%)
Total	60 (100%)

As the above table shows, the native English speakers produced 60 sentences and phrases in total, when the priming structure was the English “N + RC”, and when the priming and target shared different nouns, including 25 “Adj + N”, 17 “Simple sentences”, 6 “Adj + N + ‘prep phrase’”, 5 “N + ‘prep phrase’”, 2 “N”, 1 “N+ RC” and 1 “Adj + N + RC”.

Examples of different types of production are shown in the following table:

Table 60 Examples of different structure types produced by native English Speakers when the priming was the English “N + RC” when the priming and target shared different nouns

Structures	Example 1	Example 2	Example 3
Adj + N	a blue spoon	a red car	a male doctor
N + RC	a chef who is quite short		
Adj + N + RC	a long handle spoon which is a small spoon.		
N + “prep phrase”	a chef with a hat	a picture of a spoon	doctor with a stright white coat
Adj + N + “prep phrase”	a green frog with two black sparkling eyes	a female snail with a pink bow	a pink snail with a pink bow
Simple sentence	this is a red car.	it's a chef.	it's a green frog.
N + “participle phrase”	a person dressed as a chef (twice)	a chef wearing white	
N	a spoon	a chef	

The distribution of production during the priming procedure is shown in Figure 23.

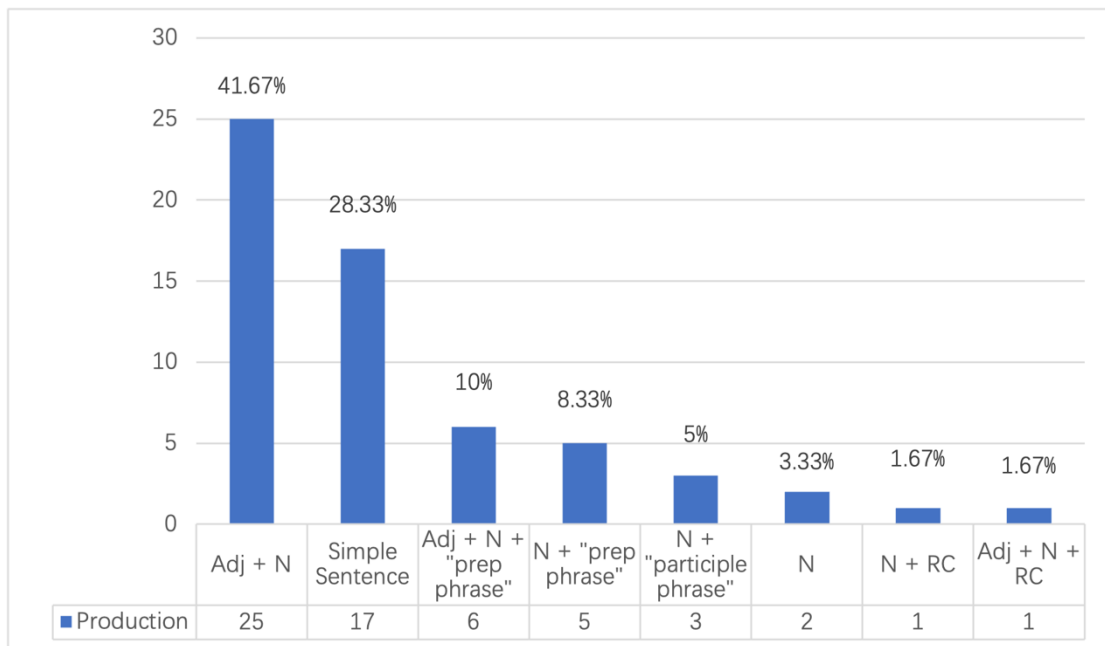


Figure 23 Different structure types produced by native English Speakers when the priming was the English “N + RC” when the priming and target shared different nouns

The results were in line with L. M. van Beijsterveldt and J. G. van Hell (2009), Cleland (2003), and S. Bernolet et al. (2007). Although the primed structure was “N + RC”, the top production was still “Adj + N”. There were also some differences. The main trend of the production of “N + RC”, primed by “N + RC” increased a lot, compared with that primed by “Adj + N” in those previous studies. In the present study, only 1 “N + RC” was produced. Also, In the previous studies, there was no production of “N + ‘participle phrase’”, but in the present study, 3 “N + ‘participle phrases’” were produced.

#### 4.2.3 Findings of native English speakers’ production of English primed by English “N + RC” with the priming and target sharing the same noun

Native English speakers produced eight different types of structures, when the priming structure was the English “N+ RC” structure (with the priming and the target sharing the same noun). The structure or phrase types were: “Adj + N”, “N + RC”, “N

+ ‘prep phrase’”, “Adj + N + ‘prep phrase’”, and “Simple sentences”, “N + N + ‘prep phrase’”, “N + N” and “N”, as well as “Others”.

The number of different structural types of production primed by the English “N + RC” (with priming and target sharing the same noun) is as follows.

Table 61 Different structure types produced by native English Speakers when the priming was the English “N + RC” when the priming and target shared the same noun

Structures produced from primed “N + RC” (SN)	Productions
<b>Adj + N</b>	<b>19 (31.66%)</b>
<b>Simple sentence</b>	<b>12 (20%)</b>
<b>N+ RC</b>	<b>8 (13.33%)</b>
<b>Adj + N + “prep phrase”</b>	<b>8(13.33%)</b>
N + “prep phrase”	5 (8.33%)
N + N + “prep phrase”	3 (5%)
N	2 (3.33%)
N + N	2 (3.33%)
Others	1 (1.67%)
<b>Total</b>	<b>60 (100%)</b>

The above table shows the number of different structural types of production primed by the English “N + RC” produced by native English speakers. The overall number was 60, consisting of 19 “Adj + N”, 12 “Simple sentences”, 8 “N + RC”, 8 “Adj + N + ‘prep phrase’”, 5 “N + ‘prep phrase’”, 3 “N + N + ‘prep phrase’”, 2 “N”,

2 “N + N”, as well as 1 “Others” , respectively. Considering “Others”, the production was “a very familiar looking cat”.

The following table illustrates examples of different types of productions when the priming structure is “N + RC” (the priming and the target shared the same noun).

Table 62 Examples of different structure types produced by native English Speakers when the priming was the English “N + RC” when the priming and target shared the same noun

Structures	Example 1	Example 2	Example 3
Adj + N	a red telephone	a red flower	a blue cat
N + RC	a flower that is red	a woman who looks like a doctor	a fish that is red
N + “prep phrase”	an image of a worker with a helmet	a man with a yellow hat and white hazes jacket	a man with a yellow hard hat
Adj + N + “prep phrase”	a pink telephone with numerical dial	a red flower with a yellow center	a red flower with a yellow in the middle
Simple sentence	it’s a pink telephone.	this is a lady doctor.	it’s a kid cat with big eyes.
N + N + “prep phrase”	a construction worker with a lovely yellow hard hat.	a construction worker with a yellow hat	a cartoon character of a fat kitten
N	a telephone	a workman	
N + N	a construction worker	a lady doctor	
Others	a very familiar looking cat		

The production and proportion of each structural type is demonstrated in Figure 24.

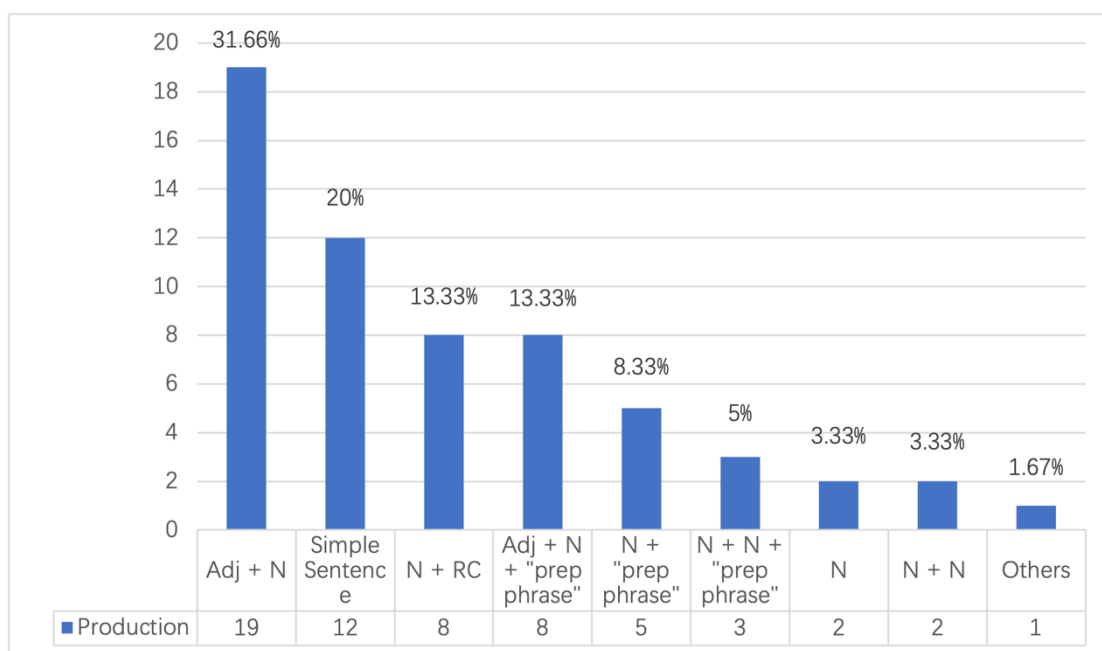


Figure 24 Different structure types produced by native English Speakers when the priming was the English “N + RC” when the priming and target shared the same noun

It can be seen that, having been primed by “N + RC” with the priming and target sharing same nouns, the native English speakers produced “Adj + N”, “Simple Sentence”, and “N+RC”, “Adj + N + ‘prep phrase’”, as the top three structural type productions. The number of each structural type of production was “Adj + N” 19 (31.66%), “Simple sentence” 12 (20%), “N + RC” 8 (13.33%) and “Adj + N + ‘prep phrase’” 8 (13.33%), respectively.

The results were in accordance with Liesbeth M van Beijsterveldt and Janet G van Hell (2009) and Cleland (2003). The previous two studies showed that, after having been primed by “N + RC” with priming and target sharing the same head noun, the participants produced more “N + RC” than “Adj + N”, while the present

study showed that the native English speakers produced more “Adj + N” than “N + RC”. However, compared with the production primed by “Adj + N” and “N + RC” when the priming and target structure shared different nouns, the main trend of the production of “N + RC” was rising. More specifically, When the priming was by “Adj + N”, there was no production of “N + RC”, however, when the priming was “N + RC” with priming and target structures sharing different head nouns, they produced 1 “N + RC”. When the priming and target structures shared the same head noun, the native English speakers produced 8 “N + RC”. The results were ascribed to lexical residual activation (Pickering & Ferreira, 2008) in that, when the “N + RC” was activated, the residual activation made the speaker reuse the same structure. When the head noun was different, the residual activation effect was less strong, but when the head noun was the same, the effect was stronger.

#### **4.2.4 Findings of native English speakers’ structural production primed by the English “Simple sentence”**

When the priming structure was the English “Simple Sentence”, native English speakers produced seven different types: “Adj + N”, “N + RC”, “Adj + N + ‘prep phrase’”, “Simple sentence”, “N + ‘prep phrase’”, “N”, and “Others”.

The number of different types of production when the priming structure was the English “Simple sentence” was as follows.

Table 63 Different structure types produced by native English Speakers when the priming was the English “Simple Sentence”

Structures produced from primed “Simple sentence”	Proportions
<b>Adj + N</b>	<b>23 (38.33%)</b>
<b>Simple sentence</b>	<b>16 (26.67%)</b>
<b>N + “prep phrase”</b>	<b>8(13.33%)</b>
Adj + N + “prep phrase”	7 (11.67%)
N	3 (5%)
N + RC	2 (3.33%)
Others	1 (1.67%)
<b>Total</b>	<b>60 (100%)</b>

Table 63 shows the number of different types of structures produced when the priming structure was the English “simple sentence”. Native English speakers produced 60 structures in total, including: 23 “Adj + N”, 16 “Simple sentence”, 8 “N + ‘prep phrase’”, 7 “Adj + N + ‘prep phrase’”, 3 “N”, 2 “N + RC” and 1 “Others”.

Table 64 gives examples of different types of structures produced when the priming structure was the English “simple sentence”.



Table 64 Examples of different structure types produced by native English Speakers when the priming was the English “Simple Sentence”

Structure	Example 1	Example 2	Example 3
Adj + N	a yellow star	a green pear	a pink pig
N + RC	a policeman who looks quite nervously	a police officer who's going on as the buttle man	
Adj + N + “prep phrase”	a little girl with dark hair and pink dress	a young girl with ponytails and a pink, yellow and blue dress	a little pink pig with a curly tail
Simple sentence	I see a five-pointed yellow star.	it's a green pear.	it's a young girl.
N + “prep phrase”	an image of a green pear	an image of a young girl	an image of an American policeman
N	a star	a policeman	a police-officer
Others	a brown dog sitting up		

Figure 25 shows the productions of native English speakers while priming by English “Simple Sentence”.

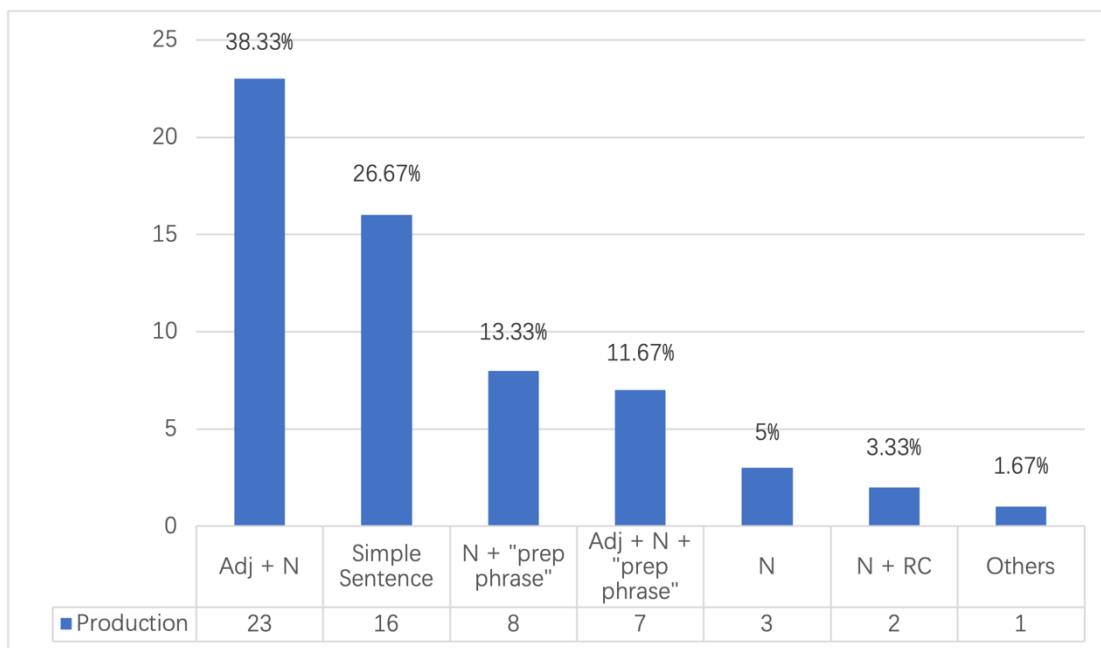


Figure 25 Different structure types produced by native English Speakers when the priming was the English “Simple Sentence”

It can be seen that, when the priming structure was “Simple Sentence”, the top three structural types produced were “Adj + N”, “Simple sentence”, and “N + ‘prep phrase’”.

The results were different from Liesbeth M van Beijsterveldt and Janet G van Hell (2009), in which, after “Simple sentence” priming, the top structural types of production were “Simple sentence”, “Adj + N”, and “N + RC” structure, respectively. The difference possibly came from the design of the experiment. In the present study, the priming “Simple sentence” and the target shared different nouns, while in Liesbeth M van Beijsterveldt and Janet G van Hell (2009), half of the priming “Simple sentence” and the target shared the same noun, and the other half shared different nouns. Because of the lexical residual activation, the participants produced more “Simple sentence” than “Adj + N”, and “N + RC”. But in the present study, the

priming and target shared different nouns, and the the top three were different from the previous studies.

#### 4.2.5 Data analyses

The following tables show data analysis for native English Speakers.

Table 65 Descriptive Statistics for Native English Speakers

Dependent Variable: N+RC			
Priming	Mean	Std. Deviation	N
Adj+N	.00	.000	6
N+RC(DN)	.17	.408	6
N+RC(SN)	1.33	1.506	6
Simple Sentence	.67	1.633	6
Total	.54	1.179	24

The above table shows that after the priming by “Adj + N”, “N + RC (DN)”, “N + RC (SN)”, and “Simple Sentence”, the mean productions of “N + RC” were 0, 0.17, 1.33 and 0.67, respectively.

According to one-way ANOVA, as shown in Table 68 in Appendix I, the priming effects between priming types were non-significant ( $p = 0.202 > 0.05$ ), which means although different priming structures led different productions, the difference was non-significant as shown in Table 65.

Table 66 Multiple Comparisons between Priming Structures for Native English Speakers

Multiple Comparisons						
Dependent Variable: N+RC						
LSD						
(I) Priming	(J) Priming	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Adj+N	N+RC(DN)	-.17	.652	.801	-1.53	1.19
	N+RC(SN)	-1.33	.652	.054	-2.69	.03
	Simple Sentence	-.67	.652	.319	-2.03	.69
N+RC(DN)	Adj+N	.17	.652	.801	-1.19	1.53
	N+RC(SN)	-1.17	.652	.089	-2.53	.19
	Simple Sentence	-.50	.652	.452	-1.86	.86
N+RC(SN)	Adj+N	1.33	.652	.054	-.03	2.69
	N+RC(DN)	1.17	.652	.089	-.19	2.53
	Simple Sentence	.67	.652	.319	-.69	2.03
Simple Sentence	Adj+N	.67	.652	.319	-.69	2.03
	N+RC(DN)	.50	.652	.452	-.86	1.86
	N+RC(SN)	-.67	.652	.319	-2.03	.69

Based on observed means.  
The error term is Mean Square(Error) = 1.275.

The above table shows “Multiple Comparisons between Priming Structures for Native English Speakers”, the priming effects between different priming structures was not significant ( $p > 0.05$ ), which means that the priming effects for native English speakers were not significant.

## CHAPTER 5

### DISCUSSION AND CONCLUSION

This chapter mainly focuses on discussion and conclusions in four sections: 5.1 reports the results and discussion of Hypothesis One; 5.2 concerns the results and discussion of Hypothesis Two; 5.3 concentrates on new findings of the current study and discussion; and 5.4 concluded the study.

#### **5.1 Results and discussion of Hypothesis One**

According to the findings in Chapter IV (Table 47 and Figure 16), L1 Chinese learners produced more “N + RC” when the priming structure was “N + RC (DN)”, and the priming effect was significant ( $P < 0.05$ ) (Table 55). Therefore, the results confirmed Hypothesis One, which states that “L1 Chinese learners produce more “N + RC” phrases when they are primed by the “N + RC” structure, and the priming effect is significant.”

The results were in line with S. Bernolet et al. (2007). In experiment two of their study, the participants were L1 Dutch speakers whose L2 was English. When primed by English “N + RC (DN)”, the participants produced more “N + RC” (14.9%) than after having been primed by English “Adj + N” (0.7%), and the priming effect was significant ( $p < 0.001$ ).

The results were also in accordance with Cleland and Pickering (2003), in which the participants were 16 students attending the University of Edinburgh, and the results showed that the priming effect was 19% when the priming structure was “N + RC (DN)”, and it was significant ( $p < 0.005$ ).

Also, Liesbeth M van Beijsterveldt and Janet G van Hell (2009) found that when having been primed by “N + RC (DN)”, the 7- and 8-year-old L1 Dutch children produced more “N + RC” 43 (16%) than after having been primed by “Adj + N” 2 (2%). The priming effect was significant ( $p < 0.001$ ). The 11- and 12-year-old L1 Dutch children produced 28 (10%) and 1 (0) “N + RC” when the priming structure was “N + RC (DN)” and “Adj + N”, respectively. The priming effect was significant ( $p < 0.001$ )(Liesbeth M van Beijsterveldt & Janet G van Hell, 2009).

This could be interpreted in terms of the effect of structural priming and short-term memory. According to structural priming, the priming effects were ascribed to abstract structure rather than anything else. Structural priming could work mainly because of the way the syntactic information was represented and organized in the mind. According to Pickering and Branigan (1998) and Cleland and Pickering (2003), lemmas are linked to specific combinatorial nodes for specific syntactic structures. When a specific structure is activated, the lemmas are activated as well as the links are activated (Cleland & Pickering, 2003; Pickering & Branigan, 1998).

Structural priming also involves memory searching. It could work because of short-term memory. If there was no short-term memory, then structural priming could not work since people might forget the sentences or phrases that they have heard or used previously. According to the short-term memory effects, when people use a particular sentence structure, the words and structure would be activated, and last for a short period. Then these people would reuse the same structure and related words that have the same properties (De Smedt, 1990; Dell et al., 1997).

With respect to the English “N + RC” as the focus of the present study, when “N” and “RC” were activated, the link between them was active, and L1 Chinese learners would reuse the same structure.

## 5.2 Results and discussion of Hypothesis Two

In accordance with the findings in Chapter IV, after the L1 Chinese learners had been primed by “N + RC (SN)”, the production of “N + RC” was enhanced more than when they were primed by “N + RC (DN)”, and this enhancement was significant ( $P=0.000$ ). The results were consistent with Hypothesis Two — “When the priming “N + RC” and the target share the same noun, L1 Chinese learners produce more “N + RC” phrases, and the priming effect is enhanced.”

The results were in line with Cleland (2003), in which the priming structure was “N + RC (SN)”, the participants’ production of “N + RC” was more than when the priming structure was “N + RC (DN)”, and the priming effect was significant ( $p < 0.001$ ) (Cleland, 2003).

The present study was also consistent with the findings of Sarah Bernolet et al. (2007). In their experiment one, after the L1 Dutch speakers had been primed by the Dutch “N + RC (SN)”, the production of “N + RC” was enhanced more than when the priming structure was “N + RC (DN)”, and the enhancement was significant ( $p > 0.001$ ) (Sarah Bernolet et al., 2007).

The findings were also in accordance with Liesbeth M van Beijsterveldt and Janet G van Hell (2009). In experiment one of their studies, the 7- and 8-year-old Dutch children produced more “N + RC” when the priming structure was “N + RC

(SN)” than when they were primed by “N + RC (DN)”, and the priming effect was significant ( $p < 0.005$ ) (Liesbeth M van Beijsterveldt & Janet G van Hell, 2009).

Based on lexical residual activation Pickering and Branigan (1998), lemma is linked to the combinatorial nodes, which are activated when the articulator uses a syntactic structure. Repetition of the content words can facilitate structural priming due to residual activation of the combinatorial and lemma nodes and the links between them. Specifically, when the priming structure and the target structure shared the same content word, the enhanced priming effect results from residual activation of the lemma node, and the link between the lemma node and the combinatorial node (Pickering & Branigan, 1998). In the structure “N + RC”, the lemma node is “N”, which could be linked to “Adj” and “RC”. When “N + RC” was activated, the combinatorial node was activated, and after that activation, there was still some residual activation. When the priming and the target structure shared the same “N”, the “N + RC” would be enhanced. Then the speaker would probably reuse it, and the priming effect would be enhanced.

The results were different from those in experiment two of S. Bernolet et al. (2007), in which the L1 Dutch participants who were bilingual in English produced more “N + RC”, when primed by the English “N + RC (SN)” than when primed by the English “N + RC (DN)”, but the enhancement was not significant ( $p < 0.10 > 0.05$ ). Although “N + RC” exists in both Dutch and English, the word order in the “RC” is not the same. For example, “the shark that *is red*” in English is “de haai die *rood is*”(the shark that red is) in Dutch (S. Bernolet et al., 2007). Word order plays an important role in structural priming (S. Bernolet et al., 2007). When the priming



and the target structure shared the same word order, the priming effect would be obvious, but if there was some difference, the priming effect would be less apparent (Sarah Bernolet et al., 2007). When the participants produced English “N + RC” they would be affected by the L1 Dutch “N + RC”, since there were some differences between the word order of the Dutch and English “RC”. Moreover, the lexical residual activation was short-termed. Because of these two factors, the priming effect would be declined. So, after the learners had been primed by the affection of L1 Dutch “N + RC”, the production of the English “N + RC” although enhanced, was not significant.

The results from the current study, therefore, supported lexical residual activation and were in line with Cleland (2003), Sarah Bernolet et al. (2007) and Liesbeth M van Beijsterveldt and Janet G van Hell (2009), Pickering and Branigan (1998), Branigan et al. (2000), Corley and Scheepers (2002) and Cleland and Pickering (2006) in that the repetition of the content words could enhance the priming effects.

### **5.3 Unexpected findings of the current study and discussion**

This section reports on unexpected findings of the current study and discussion in three subsections: 5.3.1 concentrates on findings when the priming structure was “Simple Sentence”; 5.3.2 focuses on the priming effects between L1 Chinese learners and native English speakers; 5.3.3 deals with L1 Chinese learners’ trend of production.

#### **5.3.1 Findings when the priming structure was “Simple Sentence”**

As reported in 4.1.4, when the priming structure was “Simple Sentence”, the top three productions of L1 Chinese learners were “Adj + N”, “N + RC” and “Simple

Sentence”. The numbers and proportions were 268 (50.87%), 173 (36.77%) and 71 (13.45%), respectively.

The results were different from what they should have been according to structural priming, short-term memory and lexical residual activation (See 2.1.1, 2.1.2 and 2.1.3). Based on these theories, the results should be that, after having been primed by “Simple Sentence”, the L1 Chinese learners should have produced “Simple Sentence”, “Adj + N” and “N + RC” as the top three productions. However, according to Cleland (2003), “Adj + N” was shorter and syntactically simpler than the other two, and the order should be “Adj + N”, “Simple Sentence” and “N + RC”.

The results therefore supported the “Accumulate (or Experience) Effects”(Chang et al., 2006; Pickering et al., 2013) and “Implicit learning”(Bock & Griffin, 2000).

According to Pickering et al. (2013), language learners comprehend and produce more structures that they have encountered was mainly because of the accumulation effects. This is because when the participants have heard a structure, the node and the links of that structure are activated. The more times the node and the links are activated, the more experiences of that structure are accumulated, and the participants will be more likely to reuse the same structure (Pickering et al., 2013).

Regarding the present study, in each L1 Chinese group, the learners received all the four types of priming, which were “Adj + N”, “N + RC (DN)”, “N + RC (SN)” and the “Simple Sentence”. Obviously, the activation of “N + RC” appeared more frequently than the other two types, which means that the accumulation of this link was higher than with the other two. This was why the participants produced more “N

+ RC” than the “Simple Sentence” after having been primed by the “Simple Sentence”.

Bock and Griffin (2000) found that structural priming persists over trials that are fairly long (Bock & Griffin, 2000). Moreover, they found that there were no significant declines of priming (Bock & Griffin, 2000). Their findings were consistent with structural priming in terms of experience-dependence which was implicit learning (Bock & Griffin, 2000).

With respect to the current study, for each group of the L1 Chinese learners, they received an equal number of priming structural types, which were “Adj + N”, “N + RC (DN)”, “N + RC (SN)” and “Simple Sentence”. For each group, after the priming of “N + RC (DN)”, there were several space-holder sentences or pictures. Then, after having been primed by the “Simple Sentence”, they produced more “N + RC”, this was because after several interval trials, the priming effects of “N + RC” continued to be effective. This was in line with Bock and Griffin (2000), when the process of the task is shown in Figure 26.

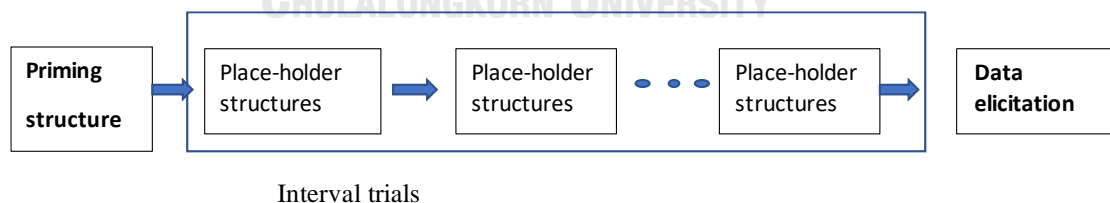


Figure 26 The Process of the Experiment in Bock and Griffin (2000)

The process of the current experiment is demonstrated in Figure 27:

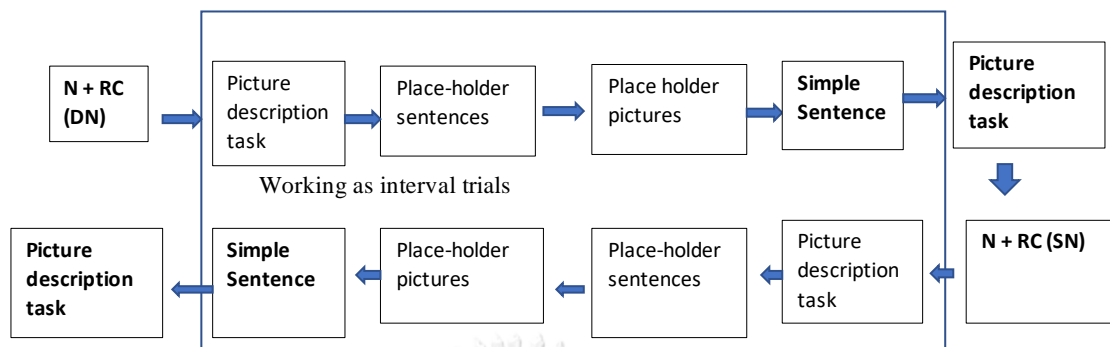


Figure 27 The Process of the Experiment in the Current Study

After several interval trials, the priming effects of “N + RC”, no matter with the same noun or different nouns, continued to work. Furthermore, the function of the “Simple Sentence” was part of the interval trials. Therefore, the results supported Bock and Griffin (2000).

It was also in accordance with Bock and Kroch (1989), Bock (1989), Bock and Loebell (1990), Hartsuiker and Kolk (1998), Boyland and Anderson (1998), and Bock (1986), as well as Levelt (1993). All these previous studies also found that structural priming persisted over several interval trials. What is more, Boyland and Anderson (1998) found that priming could be effective in spite of a 20 mins delay after multiple repetition of a priming form (Boyland & Anderson, 1998).

The present study together with the previous studies concerning the time course of structural priming demonstrated that structural priming is not only a short-term activation, but it is also a kind of implicit learning (Bock & Griffin, 2000).

It seems that the results were also affected by the priming sequence. The priming sequence for group one, group two and group three are as follows:

Group one: "Adj + N"- picture description task - Place holder sentence - place holder picture – N + RC (DN) – picture description task – place holder sentence – place holder picture – N + RC (SN) -picture description task – place holder sentence – place holder picture – Simple Sentence – picture description task – place holder sentence – place holder picture – "Adj + N"- picture description task ...

Group two: N + RC (DN) – picture description task – place holder sentence – place holder picture – N + RC (SN) -picture description task – place holder sentence – place holder picture – Simple Sentence – picture description task – place holder sentence – place holder picture – "Adj + N"- picture description task- place holder sentence – place holder picture- N + RC (DN) – picture description task ...

Group three: N + RC (SN) -picture description task – place holder sentence – place holder picture – Simple Sentence – picture description task – place holder sentence – place holder picture – "Adj + N"- picture description task- place holder sentence – place holder picture- N + RC (DN) – picture description task

Regardless of the group, the priming sentence "Simple Sentence" consistently lagged behind other priming sentences. In Group one, "Simple Sentence" came after "Adj + N," "N + RC (DN)," and "N + RC (SN)." In Group two, it followed "N + RC (DN)" and "N + RC (SN)." In Group three, it came after "N + RC (SN)." This suggests that the priming effect of the preceding structure can influence the priming effect of "Simple Sentence," indicating that structural priming could last for a long time. The current study found that the previous "N + RC" priming effect endured over

time, resulting in continued high production of "N + RC" even after the priming of "Simple Sentence."

It is important to note that previous studies have indicated that the immediate priming effect is stronger than the effect observed after several intervals. However, in the current study, the participants produced more "N + RC" structures than "Simple Sentence" structures following the priming of "Simple Sentence". This can be explained by the "inverse preference effect" and explicit learning. For the L1 Chinese learners, "Simple Sentence" is more commonly used compared to the English "N + RC" structure. When the L1 Chinese learners were primed with the English "N + RC" structure, and considering that the priming effect of "N + RC" can last for a long time, they produced more "N + RC" structures than "Simple Sentence" structures. Further studies are needed to investigate whether priming "Simple Sentence" before other structures leads to increased production of "Simple Sentence" in L2 Chinese learners, as this particular sequence was not examined in the present study.

### **5.3.2 L1 Chinese learners' VS Native English speakers' performance**

The results in Chapter IV showed that the priming effects of "N + RC" was significant no matter whether the priming and the target shared the same head noun or not. When they shared the same head noun, the priming effect was enhanced, and the enhancement was significant. With respect to the native English speakers, the priming effect was non-significant irrespective of whether they shared the same head-noun or different head-nouns.

The reason was that language proficiency level could affect priming effect (Liesbeth M van Beijsterveldt & Janet G van Hell, 2009), and lower or intermediate

level English learners were more reliable on lemma and node, as well as the links that had been activated (Liesbeth M van Beijsterveldt & Janet G van Hell, 2009). The participants were intermediate English proficiency level L1 Chinese learners, whose English was still developing, and they were more influenced by the lemma, node and links that had been activated. Moreover, because there was no “N + RC” in Chinese, they would more likely rely on imitating of the previous structures they had heard (Liesbeth M van Beijsterveldt & Janet G van Hell, 2009). Considering the English native speakers, since “Adj + N” was syntactically simpler than “N + RC”, especially when the “Adj” was a simple word, they would more likely use “Adj + N” than “N + RC” (Cleland, 2003).

The results could also be explained by the inverse preference effect (Hartsuiker, 1999; Hartsuiker & Kolk, 1998; Hartsuiker & Westenberg, 2000; Scheepers, 2003), that is the rarer the structure was, the more productions the participants would produce when they were primed by the structure. As there was no “N + RC” in Chinese. This structure was unfamiliar for the L1 Chinese learners, So, they would be more likely to use the “N + RC” structure that they had heard recently.

The results were different from previous studies (S. Bernolet et al., 2007; Cleland, 2003; L. M. van Beijsterveldt & J. G. van Hell, 2009).

In Cleland (2003), for native English speakers, irrespective of whether the priming and target structure shared the same head noun or not, the priming effect was significant. When they shared the same noun, the priming effect was enhanced, and the enhancement was significant. The differences could be ascribed to the task effect. In Cleland (2003), the task which tested both the participants’ comprehension and

production included a confederate. During the process of the experiment, the participants and the confederate constantly switched between comprehension and production, and were clearly able to use what they had comprehended to guide what they produced (Pickering & Ferreira, 2008), which was called alignment. In other words, the participants were more likely to make the structures of what they comprehended and what they produced to be the same. In the present study, the participants were only tested on their production, and thus there was no alignment effect.

S. Bernolet et al. (2007) found that for the L1 Dutch speakers whose L2 was English, when they were primed by the English “N + RC(DN)”, the production of “N + RC” increased compared with when they were primed by other structures, and the priming effect was significant ( $p < 0.001$ ). However, when the priming structure was “N + RC (SN)”, there was no significant increasing priming effect ( $p > 0.10$ ).

The reason why there was a significant increasing priming effect for the L1 Chinese learners but not for L1 Dutch speakers after having been primed by English “N + RC (SN)” was most probably because of the inverse preference effect (Hartsuiker, 1999; Hartsuiker & Kolk, 1998; Hartsuiker & Westenberg, 2000; Scheepers, 2003), since there was no “N + RC” in Chinese, the L1 Chinese learners were more likely to use it. With respect to the L1 Dutch speakers, although “N + RC” existed in Dutch, they were found to disfavor this structure. This affected their L2 English in that they tended to produce less “N + RC” (Sarah Bernolet et al., 2007).



### 5.3.3 L1 Chinese learners' trend of production

The L1 Chinese learners' trend of production was as follow: Figure 17 in Chapter IV showed the distribution of production during the priming procedure when the L1 Chinese learners were primed by the English "N+ RC" and the priming and the target shared different nouns (See 4.1.2). From the second trial, the production of "Adj + N" declined, while at the same time the production of "N + RC" and "N + 'prep phrase'" increased. From trial 4, the production of "N + 'prep phrase'" declined, while the production of "N + RC" rose until the end of the task.

Figure 19 in Chapter IV showed the distribution of production during the priming procedure when the L1 Chinese learners were primed by the English "N+ RC" and the priming and the target shared the same noun. We can see that when the production of "N + RC" rose, the production of "N + 'prep phrase'" declined (See 4.1.3).

Figure 21 showed that the line shapes for the production of "N + RC" and "N + 'prep phrase'" were similar. The only difference was that the line of "N + RC" was higher than that of "N + 'prep phrase'" (See 4.1.4).

These trends demonstrated that there were some relationships between the production of "N + RC" and "N + 'prep phrase'". One common feature of the two structures was that the word order was similar: they were both "N + ...". Both structures could express similar content, for example, "a girl with black hair" ("N + prep phrase") VS "a girl whose hair is black" ("N + RC"). According to Bernolet et al. (2007), word order played an important part in structural priming. Word-order

repetition was needed for the construction of integrated syntactic representations. (S. Bernolet et al., 2007).

With respect to the present study, when the L1 Chinese learners were primed by the English “N + RC”, the order of the structure was activated, maybe they did not understand the following RC, but they did realize that the order of the structure should be “N + ...”. They then produced both “N + RC” and “N + ‘prep phrase’”, since the priming structure was “N + RC”, they produced more “N + RC” than “N + ‘prep phrase’”. When they were still in the confused stage, the trend of the production of both structures should be similar (Figure 21 and Figure 17). When they were clear about the two structures, the trend would be opposite (Figure 19 and Figure 17). The results demonstrated that the L1 Chinese learners’ acquisition of the English “N + RC” relies on lexicon and word order. More specifically, first they acquired the “N” and the word order of the structure, then they acquired the whole structure, i.e., “N + RC”.

#### **5.3.4 L1 Chinese learners’ and native English speakers’ mental representation of “N + RC”**

Subsections 5.3.2 and 5.3.3 revealed contrasting mental representations of the English "N + RC" structure between the native English speakers and the L1 Chinese speakers. The native English speakers exhibited automatic mental representation of English syntax (Bock, 1986), which leads to effortless and automatic processing and production of sentences and phrases. This may explain the lack of a significant priming effect observed for the native English speakers in the current study, as they tended to instinctively select simpler and more commonly used sentence structures over the complex "N + RC" construction.

The L1 Chinese learners were in the process of acquiring the English "N + RC" structure, and their acquisition is referred to as interlanguage, which is a dynamic system. Subsection 5.3.3's experiment and analysis revealed that the L1 Chinese learners' acquisition of the English "N + RC" progresses through stages, including the acquisition of the "N" and word order within the structure, as well as the "N + RC" stage. The experiment demonstrated that, as learners advance through the experimental process, their production of standard English "N + RC" increases, indicating the impact of accumulated input and language exposure on their language performance. This also elucidates why the L1 Chinese learners exhibited a higher frequency of "N + RC" after the corresponding priming.

#### **5.4 Conclusions**

This section reports the conclusions of the present study in three subsections: 5.4.1 focuses on the general conclusions of the current study; 5.4.2 is mainly concerned with the implications of the present study; and 5.4.3 concentrates on the limitations of the study and recommendations for future research.

##### **5.4.1 General conclusions**

The present study was conducted to investigate the effects of structural priming and lexical activation on the acquisition of the English "N + RC" structure by L1 Chinese learners.

Two hypotheses were formulated:

1) L1 Chinese learners produce more "N +RC" phrases when they are primed by the "N +RC" structure, and the priming effect is significant.

2) When the priming “N +RC” and the target share the same noun, L1 Chinese learners produce more “N +RC” phrases, and the priming effect is enhanced.

The results confirmed the hypotheses.

Moreover, the study found that structural priming can still work after several interval trials, and it was not only a kind of immediate activation but also a kind of implicit learning. The current experiment also found that there were different structural priming and lexical residual activation effects for L1 speakers and L2 speakers, and this could be ascribed to language proficiency levels, the different structures between L1 and L2, and the inverse preference effect.

#### **5.4.2 Implications of the present study**

This sub-section reports on the implications of the present study in two aspects: 1) The theoretical implications for structural priming and lexical residual activation, and 2) The pedagogical meanings for SLA (second language acquisition).

Considering the theoretical implications for structural priming and lexical residual activation, the present study supported the previous studies concerning structural priming (Sarah Berolet et al., 2007; Cleland, 2003; Liesbeth M van Beijsterveldt & Janet G van Hell, 2009), and filled the gap of lexical residual activation in the field of the acquisition of English L2. Previous studies showed that structural priming and lexical residual activation have functions in L1 acquisition, and the priming effect was significant (Sarah Berolet et al., 2007; Cleland, 2003; Liesbeth M van Beijsterveldt & Janet G van Hell, 2009). With respect to SLA, structural priming can still work, and when the priming and target structures shared different head nouns, the priming effect was significant (Sarah Berolet et al., 2007).

However, when the priming and target structures shared the same noun, the priming effect was enhanced, but such enhancement was not significant (Sarah Bernolet et al., 2007). The current study showed that irrespective of whether the priming and target structures shared the same noun or not, the priming effect was significant, and when the priming and the target structures shared the same noun, the priming effect was enhanced, and the enhancement was significant.

Regarding the pedagogical implications for SLA, making full use of structural priming and lexical residual activation in teaching and learning could enhance L2 learners' acquisition of sentence and phrase structures of the target languages. The present study has demonstrated that structural priming and lexical residual activation could enhance L1 Chinese learners' acquisition of the English "N + RC" structure, and the enhancement was significant ( $p < 0.05$ ). The empirical findings could also be expanded to L1 Chinese learners' acquisition of other English constructions, such as "Passive Construction", "Dative Constructions" and "Accusative Verb Constructions". It is also suitable for other L2 learners who are learning English or other languages. Applying structural priming and lexical residual activation in teaching materials and activities would facilitate the learners' acquisition of the focused linguistic features. For example, teachers could design practice materials for reading or writing that provide example sentences of a structure and then give students a picture or some words to use in creating a new sentence. Additionally, they could design example sentences and target sentences including the same content words. Application of SP and LRA could facilitate the students' acquisition of the targeted constructions.

### **5.4.3 Limitations of the current study and recommendations for future research**

Limitations of the current study and recommendations for future research are as follows.

First of all, the present study did not consider age and gender factors for structural priming and lexical residual activation; thus, future studies might explore if these factors play a role.

In addition, in the present study's data collection process, interviews were not included. Future research could use interviews to obtain some insightful data from the participants.



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**APPENDICES**

จุฬาลงกรณ์มหาวิทยาลัย  
**CHULALONGKORN UNIVERSITY**

## APPENDIX I

Table 1 Tests of Between-Subjects Effects for L1 Chinese Learners

<b>Tests of Between-Subjects Effects</b>						
Dependent Variable: N+RC						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3712.389 <sup>a</sup>	5	742.478	37.844	.000	.741
Intercept	10706.722	1	10706.722	545.718	.000	.892
<b>Priming type</b>	<b>3644.944</b>	<b>3</b>	<b>1214.981</b>	<b>61.927</b>	<b>.000</b>	<b>.738</b>
<b>Group</b>	<b>67.444</b>	<b>2</b>	<b>33.722</b>	<b>1.719</b>	<b>.187</b>	<b>.050</b>
Error	1294.889	66	19.620			
Total	15714.000	72				
Corrected Total	5007.278	71				

a. R Squared = .741 (Adjusted R Squared = .722)

Table 2 Tests of Between-Subjects Effects for Native English speakers

<b>Tests of Between-Subjects Effects</b>						
Dependent Variable: N+RC						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	6.458 <sup>a</sup>	3	2.153	1.688	.202	.202
Intercept	7.042	1	7.042	5.523	.029	.216
<b>Priming type</b>	<b>6.458</b>	<b>3</b>	<b>2.153</b>	<b>1.688</b>	<b>.202</b>	<b>.202</b>
Error	25.500	20	1.275			
Total	39.000	24				
Corrected Total	31.958	23				

a. R Squared = .202 (Adjusted R Squared = .082)

## APPENDIX II Background Information Questionnaire

### Privacy statement

The information of this questionnaire is used for research purposes, and any information that could be identified with you will remain confidential.

### Instructions

There are two parts of this questionnaire,

#### Part I General information

#### Part II Educational information concerning English learning

Please give your general information in part I, and give your educational information concerning English learning by circling the appropriate English letters and give short answers if necessary.

#### Part I general information

Name: \_\_\_\_\_ Gender: \_\_\_\_\_

Age: \_\_\_\_\_ Nationality: \_\_\_\_\_

Faculty: \_\_\_\_\_ First language: \_\_\_\_\_

#### Part II Educational information concerning English learning

1. How long have you been learning English?
  - A. Less than 6 years
  - B. 6---8 years
  - C. more than 8 years
2. Have you ever been learning English overseas?
  - A. Yes Where and how long? \_\_\_\_\_
  - B. No.

*Thank you for your participation and cooperation!*

### APPENDIX III Sentences and Phrases that Used in the Experiment

#### 1. Priming “Noun + Relative Clause” phrases

No.	“Noun + Relative Clause”
1	A square that is blue
2	A table that is white
3	A cup that is green
4	A telephone that is new
5	A tree that is small
6	A refrigerator that is pink
7	A TV set that is new
8	A flower that is yellow
9	A man who is tall
10	A baby who is ugly
11	A woman who is beautiful
12	A doctor who is handsome
13	A nurse who is fat
14	A teacher who is dressed in blue clothes
15	A student who is bad
16	A worker who is weak
17	A panda that is small
18	A dinosaur that is big
19	A squirrel that is grey



20	A fish that is yellow
21	A monkey that is black
22	A rabbit that is white
23	A bear that is thin
24	A cat that is fat

## 2. Priming “Adj + noun”

No.	Adj + noun
1	A blue cup
2	A red square
3	A new TV set
4	A yellow flower
5	A pink room
6	A small tree
7	A round table
8	A pink refrigerator
9	A tall man
10	A cute baby
11	A sick woman
12	A handsome doctor
13	A pretty nurse
14	An elegant teacher
15	A lovely student
16	A lively worker

17	A small panda
18	A big dinosaur
19	A grey squirrel
20	A yellow fish
21	A brown monkey
22	A lovely rabbit
23	A thin bear
24	A fat cat

### 3. Priming simple sentences

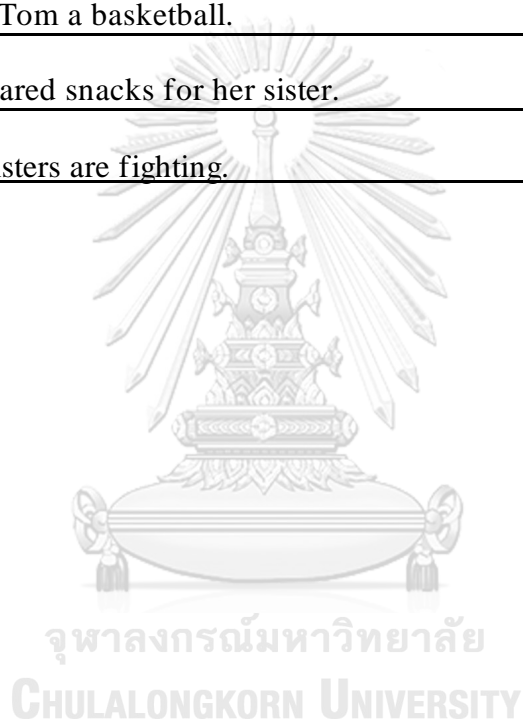
No.	Simple sentences
1	They have lived in Bangkok for several years.
2	Tina and Jane went to Tokyo last year.
3	Ellen will go to kindergarten next year.
4	We are going to make a decision tomorrow.
5	Where there is a will there is a way.
6	Beef is difficult to cook for me.
7	Don't change cellphone frequently.
8	I will never forget 2020.
9	Linda and Jasmine are working in Guiyang.
10	The students do not want to learn swimming.
11	Children always like to ask why.

12	My son likes reading books with me.
13	My husband has never read a book for my son.
14	My son likes playing games with my husband.
15	Anne received an email from her boyfriend.
16	Cindy gave a presentation on the conference.
17	Please come back home soon.
18	Mrs. Wu does not like inviting friends to home.
19	Our team consists of girls and boys.
20	Cindy was scared by the monster.
21	Name is after surname in China.
22	Jogging is not good for knee.
23	The file was destroyed by the boss.
24	Students should keep the classroom clean and tidy.

#### 4. Place-holder sentences





No.	A simple sentence
1	The winter is coming.
2	The earth goes around the sun.
3	Thirty plus twenty equals fifty.
4	Mum and Dad love each other.
5	Sixty minus thirty is thirty.
6	The girl received gifts yesterday.
7	China has a population of 1.4 billion.


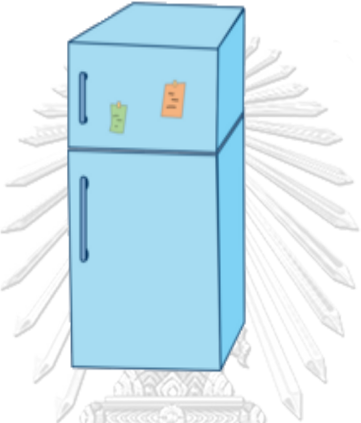


8	She made a mistake in the test.
9	Lily has been working as a reporter.
10	Mum has worked for the government for 25 years.
11	Sunshine, air and water are indispensable in our life.
12	My sister's dream is to be an accountant.
13	Jack likes physics and chemistry very much.
14	Dad gave Tom a basketball.
15	Lucy prepared snacks for her sister.
16	The two sisters are fighting.











### APPENDIX IV Pictures that Used in the Experiment

#### 1. Priming and target sharing the same noun



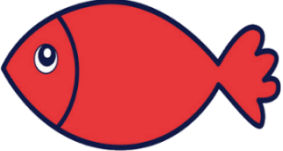
No.	Priming phrases	Pictures	Examples of expected phrases
1	A square that is blue		A square that is pink/big/small
2	A table that is white		A table that is square/green / small
3	A cup that is green		A cup that is yellow/cute/ small
4	A telephone that is new		A telephone that is old/pink/ lovely/ beautiful

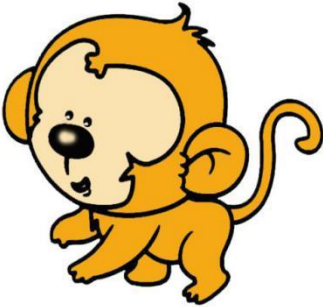
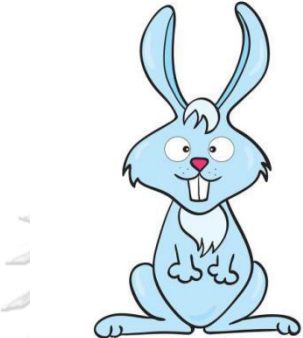


5	A tree that is small		A tree that is big/ green
6	A refrigerator that is pink		A refrigerator that is big/ blue/ closed/ old/ new
7	A TV set that is new		A TV set that is blue/ cute/ small /old
8	A flower that is yellow		A flower that is red/ small/ beautiful

9	A man who is tall		<p>A man who is fat / short / white</p> <p>A man who has a big belly</p>
10	A baby who is ugly		<p>A baby who is cute/ lovely/ fat/ adorable /beautiful</p>
11	A woman who is beautiful		<p>A woman who is thin/ slim/ tall/ ugly/ pretty</p>
12	A doctor who is handsome		<p>A doctor who is pretty/ lovely/ tall/ short/ slim</p>





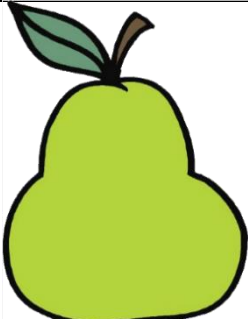
13	A nurse who is fat		A nurse who is thin/ slim/ lovely/ lively/ smiling
14	A teacher who is dressed in blue clothes		A teacher who is dressed in red and blue/ wears a glasses/ is smiling/is teaching
15	A student who is bad		A student who is a boy/ cute / lovely  A student who is dressed in yellow shirt/ blue pants/ red shoes
16	A worker who is weak		A worker who is male/ strong/ happy/ waving  A worker who wears a yellow hat/ has a big head












17	A panda that is small		A panda that is big/ fat/ lovely/ ugly/ strong
18	A dinosaur that is big		A dinosaur that is blue/ lovely/ cute/ small
19	A squirrel that is grey		A squirrel that is yellow/ cute/ lovely/lively
20	A fish that is yellow		A fish that is red/ cute / small





21	A monkey that is black		A monkey that is yellow/ cute/ lovely/lively
22	A rabbit that is white		A rabbit that is blue/ lovely/ cute  A rabbit that has two big teeth
23	A bear that is thin		A bear that is fat/ lovely/ cute/ brown
24	A cat that is fat		A cat that is blue/ cute/ lovely/ pretty


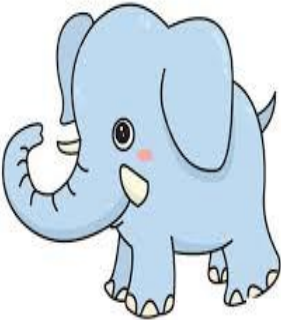

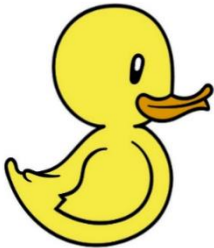
**2. Priming and target sentences and phrases have different nouns**



No.	Priming phrases	Pictures	Examples of expected phrases
1	A square that is blue		A star that is yellow/ small / beautiful / cute
2	A table that is white		A chair that is red/ small/ old/ new
3	A cup that is green		A spoon that is blue/ small/ lovely/ new
4	A telephone that is new		A mango that is yellow/ big/ small/ delicious
5	A tree that is small		A pear that is big/ small/ green / delicious

6	A refrigerator that is pink		A bag that is red / small /big/ beautiful / new
7	A TV set that is new		A car that is red/ old/new/ empty
8	A flower that is pink		A bus that is yellow/ blue/ small/ a toy
9	A man who is tall		A girl who is short/ lovely/ beautiful/ pretty A girl who is dressed in pink
10	A baby who is cute		A boy who is strong/ lovely/ handsome A boy who is dressed in blue/ has yellow hair



11	A woman who is beautiful		A chef who is cool/ fat/thin/ serious/ handsome/
12	A doctor who is handsome		A boy who is dirty/ happy/ laughing / lovely/naughty
13	A nurse who is fat		A policeman who is strong/ serious/handsome/ cool
14	A teacher who is elegant		A woman who is ugly/ not beautiful.  A woman who has a big mouth.

15	A student who is bad		a doctor who is handsome/ tall/ thin/ hard-working/ slim/ good
16	A worker who is weak		A firefighter who is handsome/ smiling/ lovely  A fire fighter who is dressed in red/ is holding a fire extinguisher
17	A panda that is small		A pig that is cute/ pink/ lovely/ lively/fat.
18	A dinosaur that is big		A sheep that is fat/ big/ old





19	A squirrel that is grey		<p>A frog that is green/ big/ small/fat</p> <p>A frog that has big eyes/a big head</p>
20	A fish that is yellow		<p>An elephant that is small/ blue/ fat/ cute / lovely</p>
21	A monkey that is black		<p>A dog that is brown/ fat/ cute/ lovely/ happy</p>
22	A rabbit that is white		<p>A duck that is yellow/ small/ unhappy</p>




23	A bear that is thin		A snail that is pink/ big / pretty/ cute/ lovely
24	A cat that is fat		A butterfly that is blue/ beautiful/ happy/ lovely

### 3. Priming phrases are “Adj + N”


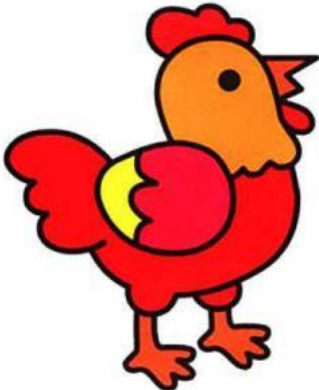


No.	Priming phrases	Pictures	Examples of expected phrases
1	A tall man		An old/short/ unhappy woman/lady
2	A cute baby		A handsome /thin/ slim/ happy man/boy








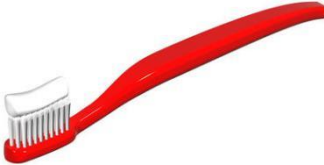
3	A sick woman		A happy /cute/ lovely/ yellow hair girl
4	A handsome doctor		An ugly/dirty/ fat man/ boy
5	A pretty nurse		A handsome/brown/ good/ bad man
6	An elegant teacher		A fat/ plump/ beautiful/ lovely woman/lady/ girl

7	A lovely student		A handsome/ elegant/ beautiful/ lovely/ boy/ man
8	A lively worker		A beautiful/ pretty / elegant/ woman/ lady/ girl
9	A small panda		A fat / blue/ cute/ lovely/ small fish
10	A big dinosaur		A beautiful/ pretty/ colorful/ elegant/ proud peacock

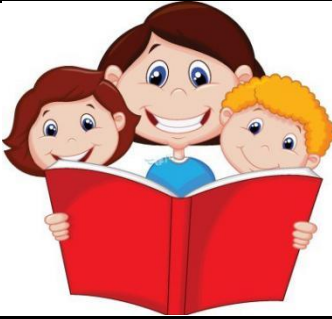
11	A grey squirrel		A blue/ fat/ elegant/ beautiful/ red nose swan
12	A yellow fish		A purple/ small/ cute/ lovely/ happy elephant
13	A brown monkey		A pink/ pretty/ beautiful/ lovely/ cute/ happy/ unhappy cat
14	A lovely rabbit		A small/fat/ cute/ yellow/ lovely chick


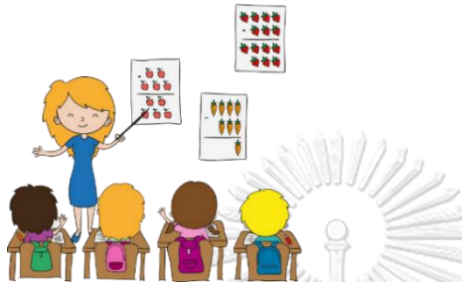



15	A thin bear		A yellow/ big/ small/ cute/ lovely/ happy/ bee
16	A fat cat		A red/ fat/ small/ cute/ lovely/ rooster
17	A blue cup		A pink/ small/ lovely/ beautiful/ comfortable sofa/ couch
18	A red square		A yellow/ small/ toy/ plane

19	a new TV set		A pink/ beautiful/ lovely/ small/ big hat
20	a yellow flower		A blue/ small/ big/ dirty/ comfortable T shirt
21	A pink room		A red/ cute/ lovely/ small/ beautiful sock
22	A small tree		A green/ small/ big/ delicious apple






23	A round table		A yellow/ big/ small/ beautiful umbrella
24	A pink refrigerator		A red/ small/ lovely toothbrush

#### 4. Place holder pictures





No.	Pictures	Examples of expected sentences
1		<p>They are reading/ reading a book.  Mum and children are reading/  reading a book.  Teacher and students are reading/  reading a book.</p>


2		<p>They/the family are having dinner.</p> <p>They/ the family are eating</p>
3		<p>They are having class.</p> <p>They are having math class.</p> <p>The teacher is teaching/ teaching math.</p>
4		<p>They are dancing.</p> <p>The man and the lady are dancing.</p> <p>Grandpa and grandma are dancing.</p>
5		<p>She/Mum is cooking.</p>
6		<p>They/ the children/ two boys and one girl are playing football.</p>



7		<p>They / two boys are playing basketball.</p>
8		<p>The doctor is checking the boy's mouth.</p> <p>The boy is visiting a/the doctor.</p>
9		<p>They/ two boys are fighting.</p>
10		<p>She is playing a computer game.</p> <p>She likes playing a computer game.</p>
11		<p>The cat is chasing the mouse.</p> <p>The mouse is being chased by the cat.</p>



12		<p>The animals are playing ball.</p> <p>A monkey, a dog, a duck, and a chick are playing ball.</p>
13		<p>They are jogging/ running.</p> <p>One boy and one girl are jogging/ running.</p>
14		<p>They bought a lot of presents.</p> <p>The family bought a lot of presents.</p> <p>The parents and their children bought a lot of presents.</p>
15		<p>The boss is scolding the man.</p> <p>2.The man is being scolded by the boss.</p>

16		<p>The man is giving his girlfriend a gift. The girl is receiving a gift from her boyfriend.</p>
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## VITA

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