

Study on the Effect of Structural Priming on Chinese EFL Learners' Language Production

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Abstract—Structural priming refers to the phenomenon that people tend to reuse the structure which is previously heard, read or written when a sentence is produced. It's believed that it is the structural priming that makes the sentence structure function and that priming leads to the activation of the structure. Different from previous studies, the present study aimed to investigate the effects of structural priming on language production for relative clauses from the perspectives of pauses, latency and correctness, and to examine effects brought by different patterns of priming. After reviewing the previous studies, subjects were determined who shared the same first language background and were at the same stage in second language learning. Then, experimental materials were carefully chosen. Based on these materials, an experiment was conducted, which included three stages: pre-test, priming and post-test. Priming patterns were categorized as listening and speaking, reading and writing. By analyzing the statistics, it's found that the performance between pre-priming and post-priming was significantly different. Structural priming could improve the performance in language production and exert positive effects on language production for Chinese EFL learners. Moreover, the performance based on listening and speaking priming was significantly different from that based on reading and writing priming. Different patterns of priming produced different effects. It's hoped that the study could provide some implications for the improvement of second language teaching and further suggestions for future researches in this field.

Index Terms—structural priming, priming patterns, priming effects, EFL learners

I. INTRODUCTION

In the past few decades, a new form of repetition has arisen. Structural priming refers to the phenomenon that people tend to reuse the structure which is previously heard, read or written. In a classic experimental study, Bock (1986) found that speakers were inclined to repeat the similar sentence structure during language production. It revealed that the sentence structure of participants' previous experience affected their subsequent utterances (Bock, 1989; Bock & Loebell, 1990). Ever since, this phenomenon has been the subject of empirical study. As in other fields in cognitive psychology, the tendency to reuse the aspects of knowledge affected by the repetition can be used to judge the nature of that knowledge. The tendency to repeat certain aspects of sentence structure helps researchers discern some typical characteristics when people construct in language production.

Structural priming is identified with many different structures. Structural priming for spoken and written language production has been shown as the following types of structures in English: active vs. passive, prepositional vs. double object dative, and optional complementizer production (Bock, 1989; Ferreira, 2003; Pickering & Branigan, 1998; Pickering, Branigan, & McLean, 2002). Among these researchers, Bock is the pioneer in this area studying transitive structure and dative structure. While for priming structures like RC attachment and Noun-phrase relative clause, Branigan et al. (2000), Cleland and Pickering (2003) are leading researchers.

The repetition of sentence structures is a popular phenomenon in language use. The phenomenon of reoccurrence of previously experienced sentence structures can be found in spoken and written language production, which is shown at all levels of linguistic structure, from phonological factors through the consideration of phrases and sentences to the organization of the target language (DuBois, 1986; Schenkein, 1980; Tannen, 1987). It happens in children (Kempen, 1977) as well as in adults. No matter in the controlled experimental investigations or in our daily communication, structural priming occurs both in children and adults (Estival, 1985; Weiner & Labov, 1983; Bock, 1986, 1990; Pickering & Branigan, 1998; Smith & Wheeldon, 2001). In a word, structural repetition is pervasive.

In addition, researchers are also interested in the study of bilingual structural priming, considering whether second languages are learned differently than first or native languages and when and how bilinguals switch between languages in conversation (Myers-Scotton, 1997). To our relief, researchers have recently realized that structural priming provides a method for assessing structural representations and processes in bilinguals. True cases are found in languages such as: Dutch, German and Spanish. Schoonbaert et al. (2007) found priming between Dutch L1 speakers and English L2 learners. Dutch L1 were more likely to use an English prepositional-object structure after hearing an English prepositional-object structure than an English double-object structure in language production. Later, priming was found in English complex noun phrases (such as *the baby that is thin*) with Dutch L1 speakers (Bernolet, Hartsuiker, & Pickering, 2007). And the phenomenon of priming was also found between German L1 and English L2 in a picture description task for datives (Loebell & Bock, 2003), in which participants first repeated a priming sentence and then

described a picture in the other language. The result showed that English datives were produced more likely after priming of German dative sentences and vice-versa. Similar effects for dative sentences between Spanish and English were also found by using sentence recall (Meijer & Fox Tree, 2003).

Relative clauses are subordinate clauses that modify nouns, or pronouns, or noun phrases. For example, the phrase *The man who was sitting over there* contains the noun *man*, which is modified by the relative clause *who was sitting over there*; in sentence *He to whom I have written*, the phrase contains the pronoun *he* which is modified by the relative clause *to whom I have written*; in sentence *The bird in the tree, which is about to fly*, the complete phrase is the noun phrase.

In addition, according to the Spreading Activation Model (Pickering & Branigan, 1998), priming is the result of both combinatory nodes and lemma nodes under residual activation. On this basis, the experiment on the priming of complex noun phrases in language production was conducted (Cleland & Pickering, 2003). In the experiment, a confederate described a picture of a colored object using a noun-relative clause structure *the sheep that's red*. The result showed that there was an evident priming effect for noun-relative clause as the participants repeated the structure just used by the confederate. During the priming process, one influential factor is a lexical boost, when the noun in the priming sentence is the same as the one in target sentence, the tendency to repeat the structure is stronger; the other is semantic relatedness between the priming and target which enhance priming. Thus, priming effect will be strong with the same noun such as *sheep-sheep* rather than *knife-sheep*, and *the sheep that is red* being more likely after *the goat that is red* than after *the knife that is red* (Pickering, 2008). Indeed, the lexical boost and semantic relatedness can fully explain the semantic boost in target language processing, in which production of the target *the sheep that is red* leads to activation of the lemma *goat*. As the link between the lemma *goat* and the *N, RC* node keeps some activation from priming, the activation of *N, RC* node is strengthened (Schoonbaert et al., 2007).

Looking back into the previous studies conducted by numerous researchers, on the one hand, it is found that most experiments about structural priming center around dative structure, transitive structure and few experiments about noun-relative clause. Meanwhile, these studies are mostly about priming effect on L1 learners and between English and foreign languages such as German, French and Spanish. Few studies research about priming effect on Chinese EFL learners. On the other hand, previous studies are mostly conducted through a way that participants hear or read a certain sentence structure, then are asked to describe a given picture to see whether they follow the structure of the priming sentence. Therefore, this study takes a somewhat different measure of investigating structural priming, different patterns of structural priming are employed to see the effects.

II. METHODOLOGY

A. Research Questions

The present study employs an experimental approach to investigate the effects of structural priming on language production among Chinese EFL learners and is intended to address the following research questions:

1. What is the effect of structural priming on target utterances?
2. Does priming effect differ with different priming patterns?

The first question aims to find effects of structural priming on language production, and how the former can influence the latter. It argues that under the influence of structural priming, whether the performance can be promoted with regard to aspects like: response time, fluency and errors. The second question aims to compare the different effects of priming after different priming patterns.

B. Subjects

The participants are fifty-six College English learners from the School of Public Administration, Nantong University, with an age ranging from 19-21 years old. These students are assigned to Class B among College English learners. Moreover, they all have received formal English education in their third year from primary school. They have studied English for about twelve years. Therefore, these students are equipped with enough knowledge about English and it is well believed that they are competent to do a good job in the experiment.

C. Design and Materials

The experiment involves three stages. Firstly, participants are required to describe a series of pictures which are respectively designed for the typical use of relative clauses. Participants' utterances are recorded. Secondly, the priming activity is taken. Participants are divided into two groups receiving different patterns of priming. The first group is asked to listen to sentences one by one and repeat them; the second group is asked to finish the gap filling task. Finally, participants finish another task of picture description and their utterances are also recorded for later analysis. An example of the activity is shown in Figure 1.

Stage 1
Picture Description

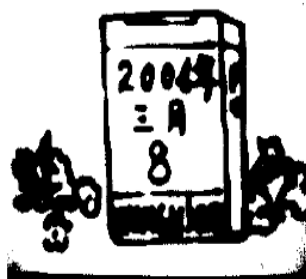


Reference words: which, that, who, whom,
whose, when, where and why

Stage 2
Priming

Group1 (listening and repeating)	Group2 (gap filling)
a. A shop should keep a stock of those goods which sell best. b. She studied hard at school when she was young, which contributes to her success in her career.	a. A shop should keep a stock of those goods sell best. b. She studied hard at school when she was young, contributes to her success in her career.

Stage 3
Picture Description



Reference words: which, that, who, whom,
whose, when, where and why

Figure 1. Activity Designed for Relative Clauses

For the relative clauses, with the given relative pronouns and relative adverbials, participants are expected to produce sentences like *An apple that seems fresh* or *There is an apple on the table which is fresh* instead of sentences like *There is an apple on the table* or *There is an apple on the table and it is fresh*.

D. Procedure

The experiment took place in a language lab with necessary equipment; the participants were told by the researcher that they would take part in an activity. Of course, they were not told what would be expected of this activity, which in a sense ensured the objectiveness of this study. Before the experiment, they were told to choose their own seats at random and turn on their computers. The researcher opened the recording system and got everything ready for recording. When everything was perfectly done, the activity started.

In this experiment, the first stage proceeded like this. Firstly, the participants were given a piece of paper (Named Paper No.1) on which there were five pictures designed for the relative clause. The paper was handed out one by one by their teacher to make sure that every participant received it. Then the researcher gave the instruction that they were given ten seconds to take an overall look at them and they should respond immediately on hearing the onset bell and they should try their best to create utterances which make sense. When participants began to describe these pictures, the recording system was also set to record their utterances, which was done without their notice. Secondly, when they had finished the description task, the participants were randomly divided into two groups. For the first group, as the researcher was reading 10 sentences (sentences of relative clause) to the students one by one, they were told to listen to them as attentively as they could and try their best to repeat those sentences. For the second group, they were given another piece of paper (Named Paper No.2) handed out by the researcher. The paper was designed for the purpose of structural priming through gap filling. Thirdly, after priming activity, both of the two groups were given another piece of paper (Named Paper No.3) with five pictures on it. The paper given to the two groups was the same. Then the researcher gave the same instruction as that given in the previous picture description. Participants' target utterances were also recorded.

E. Data Collection

The audio material was transcribed and the target utterances from picture description were scored for structural forms for data collection.

In the experiment, sentences were scored as wh- and that relative clauses which should contain a noun, or pronoun, or noun phrase followed by a subordinate clause functioning as modification (e.g., I often write to my brother who have been abroad for two years.). If the utterances contained other structures, these sentences were regarded as others in

analysis. In addition, parameters about the performance were also considered. They included fluency, latency and error rate, which were respectively scored on the condition that how many pauses were made during utterance, how much time consumed before utterance and how many mistakes concerning grammatical rules were made during utterance. Moreover, priming effects under the influence of two different patterns of priming were also measured.

III. RESULTS AND DISCUSSIONS

A. Results

In the experiment, 280 sentences were yielded before the priming activity, and 280 sentences were produced after the priming activity. These two groups of statistics were compared based on three parameters: pauses, latency and errors. In addition, the priming effect on target sentences uttered after priming pattern one (140) was compared with the effect on target sentences uttered after priming pattern two. Paired-Samples T Test was employed to determine whether the effect of priming activity was significant and Independent-Samples T Test was employed to measure which pattern shows stronger influence.

1. Structural Priming in Different Groups

TABLE 1
PAIRED-SAMPLES T TEST OF THE EFFECT ON RELATIVE CLAUSES

Priming condition	Pauses			Latency			Errors		
	T	df	Sig. (2-tailed)	T	df	Sig. (2-tailed)	T	df	Sig. (2-tailed)
No Priming vs. Priming Pattern One	15.000	28	.000	8.007	28	.000	6.431	28	.000
No Priming vs. Priming Pattern Two	10.190	28	.000	11.082	28	.000	10.003	28	.000

*P<0.05

Table 1 shows two groups of statistics. Whether in the group of priming pattern one or in the group of priming pattern two, participants' language production was significantly improved with the results gained with no structural priming ($t(56) = 15.000, 8.007, 6.431, 10.190, 11.082$ and $10.003, p < 0.05$). The result demonstrated participants' fewer pauses and errors, and less time when producing language. Based on the data, it's found that structural priming are effective on relative clauses.

2. Structural Priming of Different Patterns

TABLE 2
GROUP STATISTICS OF DIFFERENT EFFECTS ON RELATIVE CLAUSES

Pattern	Pauses			Latency			Errors		
	N	Mean	Std. Deviation	N	Mean	Std. Deviation	N	Mean	Std. Deviation
One	28	.9643	.74447	28	1.4643	.57620	28	1.0357	.74447
Two	28	.5714	.63413	28	.8571	.59094	28	.6429	.62148

TABLE 3
INDEPENDENT-SAMPLES T TEST

Priming Pattern	Pauses			Latency			Errors		
	T	df	Sig. (2-tailed)	T	df	Sig. (2-tailed)	T	df	Sig. (2-tailed)
One vs. Two	2.126	56	.038	3.892	56	.000	2.144	56	.037

*P<0.05

Table 2 & 3 demonstrate that language production primed by the second pattern in the experimental was significantly different from that primed by the first pattern ($t(56) = 2.126, 3.892$ and $2.144, p < 0.05$). By analyzing the two groups of statistics, it is found that the average score by pattern one (0.9643, 1.4643 and 1.0357) is significantly higher than the score by pattern two (0.5714, 0.8571 and 0.6429). To sum up, participants of priming pattern one have a higher mean of total mark in the analysis done on relative clauses, which indicates the stronger effect brought by priming pattern two.

B. Discussions

1. Significant Effects of Structural Priming

TABLE 4
THE PERFORMANCE IN TARGET UTTERANCES

Condition	Relative Clauses		
	Pauses (ts)	Latency (ms)	Error Rate (%)
No Priming	1080	22	20
Priming	430	11	7
Difference	650	11	13

Note. ts=times
ms= minutes
%= percentage

In the experiment, it is demonstrated that performance after priming is significantly superior to that after no priming. Firstly, target utterances have fewer pauses (respectively by 430, 1080) than utterances uttered after no priming. Apparently, participants' fluency in utterances is guaranteed. Secondly, less time is consumed before utterance (respectively by 11, 22), which also contributes to the fluency in the target utterances. Thirdly, error rate in target utterances is significantly reduced (respectively by 7, 20), which significantly improves the accuracy. Clearly, such a result provides the evidence compatible with the hypothesis that structural priming benefits participants by reducing the processing costs during structure generation (Bock, 1986; Levelt & Kelter, 1982).

The result has a number of implications for language production. It is evident that the result demonstrates that structural priming reduces the time of sentence structure production, which provides confirmation of the *effort reduction* theory advanced by Levelt and Kelter (1982), and Bock (1986). According to the theory, the function of structural persistence which is brought by structural priming is to reduce the processing costs of the language producer and so to promote the fluency and rapidity of utterance. Generally speaking, the reduced time which is 11ms in total might not seem like a tiny reduction in processing costs. However, it should be remembered that the figure represents the effort saved for only the first phrase of an utterance prior to utterance onset. Therefore, it is necessary to look at speakers' performance after onset. The number of pauses may reflect the time taken to articulate a sentence. Thus, we cannot rule out the possibility that structural persistence enables further reductions in the number of pauses beyond the initial phrase after utterance onset. The number of mistakes is another criterion to measure speakers' performance. Influenced by priming sentences, structural persistence enables enormous reductions in mistakes, which ensures the quality of target utterances. Generally, the current study provides evidence in line with the view that structural persistence can provide significant reduction in processing efforts and thus supports the hypothesis made in the study that structural priming exerts positive effects on language production.

2. Priming Effects of Different Priming Patterns

TABLE 5
PERFORMANCE OF DIFFERENT PRIMING PATTERNS

Pattern	Relative Clauses		
	Pauses (ts)	Latency (ms)	Error Rate (%)
One	269	6.8	0.87
Two	160	4.0	0.62
Difference	109	2.0	0.25

Note. ts=times
ms= minutes
%= percentage

From Table 5, it is evident that in the experiment conducted on relative clauses, the effect brought by priming pattern one is weaker than that brought by priming pattern two. Thus, what is behind the phenomenon that can contribute to the different effects?

It is known to all that the most basic of all human needs is the need to understand and be understood and the best way to understand people is to listen to them (Ralph, 1999), which implies the significance of listening and can be used to verify the findings in the study. Just as the best way to understand a person is by listening, the best way to master a structure is by listening. However, for the priming effects on relative clauses, priming pattern two exhibits stronger effect than priming pattern one. When the two groups of participants for the two patterns of priming were interviewed about their reaction in the priming activity, the group with listening and speaking priming responded that when they were listening to the given sentences, they felt quite puzzled because they had no pre-notice of the structure intended for description. As is known to all, the relative clause is a difficult part in grammar and difficult for learners to master, as it has different relative pronouns (that, which, who, whom, whose) and relative adverbials (when, where, why). Each is differently used based on the noun, pronoun and noun phrase before them. Thus, just listening to the priming sentence for once is not enough for them to get all the information, not less to repeat every part in the sentence. For the group with gap filling as priming activity, they responded that each gap was designed for the sensitiveness of the relative clause, before they made the decision about which relative pronouns or relative adverbials to choose, they had carefully read the whole sentence which helped a lot in later tasks. From participants' responses, it is reasonable to explain why the second group performed better.

IV. CONCLUSION

A. Findings of the Study

In the study of structural priming, many researchers have done a lot to investigate the effects of structural priming. Apart from the researches done on structural priming with L1 learners (Bock, 1986), more and more researches focus on L2 learners in order to identify the priming effect on L2 language learners (Leeman, 2003; Ayoun, 2001; Iwashita, 2003; McDonough, 2006), of which not many studies are centered on Chinese L2 learners. Thus, this study is devoted to explore the structural priming effect on Chinese EFL learners.

The major findings of the study are presented according to the research questions. As to the first research question, Chinese EFL learners' performance in target utterances is significantly enhanced by structural priming, which indicates

that structural priming functions in EFL learners. Moreover, the phenomenon of structural priming really exists in EFL learners' language production and target structures tend to follow priming structures. With regard to the second research question, effects of different priming patterns are examined. The results show that in relative clauses, participants who had received reading and writing priming performed better than those who had received listening and speaking priming. The result can be attributed to the different properties of the two priming patterns.

B. Limitations of the Study

In this study, the findings concerning the effects of structural priming on language production are reported. However, some limitations are inevitably constrained by objective conditions.

Firstly, only 56 participate in the experiments, and all of them are just from the same university. The size of samples is limited. Whether the results can be generalized to a larger scale depends on further research.


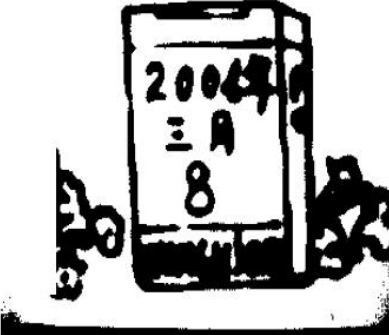


Secondly, types of participants involved in this study are limited. They are all Chinese EFL learners. The study can be further conducted between L1 learners and L2 learners to compare the similarities and differences.

Thirdly, there are some uncertain factors in the experiment. Great efforts are made to ensure the validity, but participants' involvement may be different due to such factors as memory, enthusiasm, concentration, etc., which more or less influence the results.

C. Summary

Structural priming, as a method to look into the mechanism of language processing, has been of considerable interest in psycholinguistic area. In general, it has effect on target utterances. It is believed that structural priming can cast light on structural representation and processing and the mechanisms underlying the language production. Moreover, it can allow us to get a thorough understanding of the development of EFL learners' structure representation. This thesis provides a different perspective in the research and is hoped to provide reference for practical English language teaching.

APPENDIX A. PICTURES FOR RELATIVE CLAUSES

	Before	After	
1	 <p>red apples</p>	 <p>Mothers' Day</p>	
2	 <p>my hometown</p>	 <p>I spent 4 years in this university.</p>	

3



Her songs are very popular among youngsters.



My friend introduced him to me.

4



overlook



It's going to rain.

5



The boy is a stranger to the old man.



A gift from my father.

Reference words: which, that, who, whom, whose, when, where and why

Reference words: which, that, who, whom, whose, when, where and why

APPENDIX B. PRIMING SENTENCES

Group1(listening and repeating)	Group2(gap filling)
a. A shop should keep a stock of those goods which sell best. b. She studied hard at school when she was young, which contributes to her success in her career.	a. A shop should keep a stock of those goods _____sell best. b. She studied hard at school when she was young, _____ contributes to her success in her career.
a. The letter that came this morning is from my father. b. I've got a bottle of beer, but I haven't got anything that I can open it with.	a. The letter _____ came this morning is from my father. b. I've got a bottle of beer, but I haven't got anything _____ I can open it with.
a. The student who answered the question was Joan. b. I know the man whom you described.	a. The student _____ answered the question was Joan. b. I know the man _____ you described.
a. I'd like a room whose window overlooks the sea. b. I fell in love with the girl whose brother was my best friend.	a. I'd like a room _____ window overlooks the sea. b. I fell in love with the girl _____ brother was my best friend.

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