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The Influence of Semantic Relationship on Semantic Priming Effect

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Abstract

Factors that influence semantic priming effects have captured the attention of many scholars. Previous studies on factors influencing semantic priming effects have made great progress, but there are still some inadequacies. Although it is commonly agreed that semantic priming occurs in semantic-related word pairs, the influence of different lexical semantic relationship types has rarely been investigated. The present study tried to investigate the difference of semantic priming effect between Chinese learners' native and second language, as well as the influence of lexical relationships on semantic priming. Two experiments were carried out by adopting a lexical decision task. Results showed that: 1) The magnitude of semantic priming was not consistent between the native language and the second language by the variables of error rate and reaction time. 2) Generally, synonyms and antonyms have a significant influence on semantic priming effect in the two languages, but there was no significant difference between the two types of relationship. Hyponym exerted different influence on semantic priming effect between native and second languages. In the native language, the hyponym pairs had the largest impact on semantic priming, while in the second language, the semantic relationship of hyponym did not have any impact on semantic priming.

Keywords

Semantic Relatedness, Semantic Type, Semantic Priming Effects

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1. Introduction

Semantic priming refers to the phenomenon that people can get an advantage in processing a stimulus if they are presented a semantically related stimulus soon before. Semantic priming is affected by many factors, such as semantic relationship, word frequency, word length, types of tasks. Among these factors, the most important one is the semantic relationship [26], [38].

Large quantities of research about semantic priming have been carried out in English. In fact, the models proposed to explain this phenomenon are also based on English. Whether these theories can also be applied to other languages arouses researchers' interest and they want to prove it. However, few studies specifically concentrate on the extensive application of the priming models in different languages except the priming effect in English. Perea & Rosa [28] discovered a significant priming effect in native speakers of Spanish. The effect also existed in Spanish/Basque bilinguals [29]. Frenck-Mestre [8] chose bilinguals as the subject of the experiments and found priming effect in both native and second language.

Although large quantities of studies about semantic priming effects have been carried out in native speakers, it is necessary to further explore this phenomenon in L2 learners or bilinguals. Moreover, priming studies in native speakers of Chinese or Chinese English bilinguals are quite few. Although the form of lexicons may be somewhat different across different languages, the representation of lexical semantics is supposed to be basically shared between languages. Therefore, comparison of priming effects between native language and

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second language has been conducted to enrich the findings.

The present study intends to carry out semantic priming experiments in Chinese native speakers to examine the existence of priming effect in Chinese language. Specifically, the priming effect of different lexical semantic relationship is studied to explore the influence of it on semantic priming effect. Word pairs with the relationship of synonym, antonym and hyponym are chosen as materials in the experiments. Through the experiments in this study, the popular models and theories about semantic priming effect can be tested to see if they are language nonselective.

2. Semantic Priming

Semantic priming has been a heated topic in cognitive science for several generations. As it reflects the processing of words and meaning in mind, many researchers have proposed mechanisms to explain the phenomenon. Therefore, a large quantity of models and theories relevant to the access and retrieval of word and word meaning have been proposed. The phenomenon of semantic priming is not only theoretically important but also applies to the empirical research of many other topics.

As the mechanism of semantic priming is gradually understood by people, it came to be a tool to investigate other aspects of cognitive issues. Semantic priming appears in many cognitive tasks such as lexical decision, pronunciation, semantic categorization tasks etc. By applying these tasks, researchers have carried out empirical experiments on topics such as semantic representation in bilinguals [31], [29], [1], comparison of the processing of native and second language [8], [2], the influence of native language on processing the second language [40].

2.1. The Mechanisms of Semantic Priming

2.1.1. Spreading Activation Models

The spreading activation theory was first proposed by Quillian [32], who tried to simulate human's processing of meaning in the computer. Later Collins and Loftus [6] extended the theory and applied it to the explanation of some experimental findings. The spreading activation models were also proposed by Anderson [3], [21]. Although these models differ in some ways, they share some assumptions. According to the model, the concepts are represented as nodes in semantic network, and the distance of two nodes is determined by the relatedness of the two concepts. If two concepts are more semantically-related, the distance of nodes between them is shorter. The properties of the concept are represented as links, which connect these nodes together according to their semantic relations. So the links also symbolize different types of relation between these nodes. Quillian [32] originally proposed five different kinds of links: superordinate and subordinate links, modifier links, disjunctive sets of links, conjunctive sets of links, and a residual class of links.

The spreading activation models have provided a good explanation to the semantic priming effect. During the experiment of semantic priming, a prime is presented to the participant and is immediately followed by a target. Participants have to decide whether the target is a word or a nonword. When the prime is presented, the concept of it is activated and the activation is transmitted from the node of the prime to the nearby nodes through links. The closer the node of the target is to the prime's node, the quicker the activation reaches the target's node, and the quicker the target is activated. For example, the activation of the concept node doctor will spread to the nearby node nurse, thus facilitating the understanding of the latter.

2.1.2. Compound-cue Theory

Based on the theoretical framework of Gillund & Shiffrin [9], Ratcliff & McKoon [34] developed the compound-cue theory. The theory assumes that the prime word and the target word would form a compound-cue in the short term memory which can access the long term memory. The semantic priming effect is due to the familiarity of compound-cues which is determined by the relatedness of the cues. If the prime word and the target word are more related with each other, the compound-cue they form will be more familiar. For example, lion and tiger are more related word pairs than table and tiger. Therefore, the familiarity of the cue they form is higher than the familiarity of the cue containing table and tiger [23]. As the semantic priming effect depends on the familiarity of compound cues, the reason why some cues are responded quicker while some cues are responded slower can be explained.

Compound-cue theory has been criticized for its uncertainty to explain cues in the standard semantic priming paradigm, such as lexical decision [27]. If the cues are just visual representations and their meaning does not get accessed, there is no sense in regarding semantic related word pairs as compound cues. Ratcliff [33] suggested another view to interpret cues. He believed that cues contain not only orthographic features but also semantic features, and these features change and develop over time. The various changes of semantic features in cues depend on many factors, such as task, the stimuli, and the duration time of processing. Taking the factor of task for example, in a sequential lexical decision task in which both the prime and the target should be reacted, the prime is fully processed, including its various features. In a lexical decision task in which only the target is to be responded, the prime may not be fully processed, so the cues include only visual features.

2.1.3. Distributed Memory Model

The distributed memory model was proposed under the framework of Connectionism which came to be popular since 1940s. Masson [18], Seidenberg & McClelland [37], Becker & Moscovitch [5] proposed several versions of distributed memory models. According to distributed network models, semantic network is made from numerous interconnected units. Concepts are represented by patterns of activation across these units. Similar concepts are represented by similar patterns of activation. When given a stimulus, some units get activated and form an initial pattern of activation. This pattern of activation develops as other connected units are activated through weights between these units, and finally reaches a stable pattern of activation. Different stimuli cause different stable patterns of activation, which are determined by diverse weights across units.

McNamara [23] divided all the distributed network models proposed into two categories based on different explanations to the priming effect. One category is called "proximity models", which attribute the priming effect to the closeness of primes and targets in the semantic network [18], [30]. The models support the idea that concepts are represented by patterns of activation and that related concepts have similar patterns of activation. During the priming process, the target word is activated after the prime word. As related target word and prime word share more similar patterns of activation than unrelated target word ones, and the processing of target word is based on the existing activation of the prime word, thus the target word gets an advantage when it is preceded by a related word, leading to the priming effect. The other category is called "Learning models". It also assumes that concepts are represented by patterns of activation and that related concepts have similar patterns of activation. However, the explanation of semantic priming is different. "Learning models" assume that semantic priming results from incremental learning. Every time a stimulus is given to the semantic network, the weights in the network can be changed. So, the network "learns" from the process each time and is more probably to give the same reaction to the same stimulus.

2.2. Factors Influencing Semantic Priming

2.2.1. Word Frequency

Word frequency is an important factor for semantic priming in that it can affect the response rate in experiments. Generally, the response for words with high frequency is faster than words with low frequency. This phenomenon is called frequency effect. To avoid the influence of frequency effect, the factor of word frequency should be controlled in the design of experiments. High frequency words should be chosen as they are easier and faster to process.

2.2.2. Semantic Relationship

According to Hutchison [14], types of relationship between primes and targets include synonyms (*afraid and scared*), antonyms (*day and night*), natural category (*sheep and goat*), artificial category *(table and chair*), perceptual only (*pizza and saucer*), superordinate only (*dog and animal*), perceptual property (*canary and yellow*), functional property (*broom and sweep*), script relation (orchard and apple), instrument (*bloom and floor*), forward phrasal associate (*baby boy*), backward phrasal associate (*boy baby*), associated properties (*deep and dark*). The semantic relationship between primes and targets can be merely associatively related (e.g. *sugar and sweet*), pure semantically related (e.g. *dog and rabbit*), and both associatively related and semantically related (e.g. *doctor and nurse*).

Many experiments with the semantic priming paradigm in the early studies did not separate associative priming from pure semantic priming. This leads to a question as to whether the priming is resulted from association strength, or semantic relatedness, or both. From meta–analysis, Lucas [16] concluded that there is strong evidence of pure semantic priming effect but no evidence of priming based purely on association. By reviewing relevant studies, Hutchison [14] came to a somewhat different conclusion from that of Lucas, claiming that automatic priming is due to both association strength and feature overlap. The conclusion is consistent with claims of both associative and semantic contributions to priming [4, 25, 26, 41].

2.2.3. Tasks Used in the Semantic Priming Research

The semantic priming research generally includes three types of tasks: lexical decision task, pronunciation (naming) task and semantic categorization task. Each of them also has some variants of tasks respectively. The lexical decision task includes three kinds: standard lexical decision task, masked lexical decision task and continuous lexical decision task. In the standard lexical decision task, participants are required to decide whether the target is a real word. The masked lexical decision task is carried out by adding a mask before the prime or after it or both. By adding a mask, participants are less likely to see the primes clearly so as to increase the automaticity of priming. In the continuous lexical decision task, participants should respond to both primes and targets. The second one is a pronunciation (naming) task in which participants are asked to pronounce the target word. There is standard pronunciation and pronunciation with a visually degraded target. A semantic categorization task has also been used in semantic priming research. In semantic categorization tasks, participants usually see the prime word in a computer screen and are asked to decide if the target word is a member of a specific semantic category.

Different results have been obtained by using different tasks in semantic priming research. Although the lexical decision task was commonly thought to produce the largest priming effect, there existed exceptions. For example, in the experiments made by Grainger & Frenck-Mestre [10], the semantic effect was stronger in semantic categorization task than in lexical decision task. This phenomenon could be attributed to the different access to the conceptual information of prime words [36]. The semantic priming effects arise because of the meaning overlap or associative relatedness, so the processing involves the retrieval of the meaning of prime and target words in which enough retrieval means greater priming effects. In a lexical decision task, the decision on whether the prime is a real word or not may only base on the word form but seldom on word meaning. While in a semantic categorization task, to decide whether a word belongs to a certain category requires the involvement of word meaning [17], [38].

2.3. Aims of the Present Research

Since Meyer and and Schvaneveldt [24], large quantities of studies have probed the issue of semantic priming effect in every condition. Various types of lexical semantic relations have been proposed and classified. They are chosen as materials in many studies. Using a lexical decision task, Frenck-Mestre & Prince [7] found significant priming effect for related word pairs such as synonyms, antonyms and collocations in second language learners. Perea & Rosa [28] examined Spanish synonyms, antonyms and category coordinates and found significant priming effect for these types in the experiments. The effect of type of semantic relationship was significant in both experiments. Among these relations, synonyms and antonyms make up a great part of lexical semantic relationship. Hyponyms is also an important kind of semantic relationship. These three types of lexical relationship worth further studying to unveil the impact of different lexical relations on semantic priming.

The present study intends to investigate the influence of synonyms, antonyms and hyponyms on semantic priming effect. Whether there exists priming effect in the Chinese language is investigated. And the results of priming effects in native Chinese are to be compared with that in second language priming to see the difference. In the past, the studies of priming usually concentrated on other languages, especially English, and the priming effect in Chinese language has seldom been explored. Therefore, the existence of priming effect in a new language would supplement the current research and further test the related theories. The present study tries to investigate the following questions: Whether the semantic priming effect for the three types of lexical relationship will arise in Chinese learners' native and second language? What's the difference of semantic priming effect between Chinese learners' native and second language? How do the lexical relationships influence semantic priming?

3. Methodology

In order to solve the problems in this study, two experiments were conducted with the psychological software E-Prime 2.0. In addition, the software data collected from the experiments were analyzed via the E-prime 2.0 and SPSS 13.0.

3.1. Subjects

A total number of 35 students from Hunan University were included in the research. All of them are graduate students majoring in English teaching, English linguistics or English literature. They have passed TEM8 at college, so they have a high proficiency of English.

3.2. Materials

To fully explore the semantic network in memory, materials included word pairs of various lexical relationship. Specifically, word pairs of antonym, synonym and hyponym relations have been chosen to compose the experimental materials. In the first experiment, all prime and target words were in English. There were 60 related word pairs and 60 unrelated word pairs. The 60 related word pairs were composed of 20 synonym pairs, 20 antonym pairs and 20 hyponym pairs. In addition, a total number of 60 pairs of word-nonword were included. The relatedness proportion, which refers to the proportion of related word pairs in all word-word pairs, was 0.5. The nonword ratio, which refers to the proportion of nonword targets in all unrelated targets, was also 0.5. The second experiment is in Chinese. Sixty related word pairs were also composed of 20 Chinese synonym pairs, 20 Chinese antonym pairs and 20 Chinese hyponym pairs. All the synonyms and antonyms were chosen from the dictionaries. Similarly, sixty unrelated Chinese word pairs were served as the control group, and 60 word-nonword pairs were constructed. Subjects were familiar with All words in materials.

The English nonword was made by changing one or two letters of the real English words. For example, by replacing the letter "a" for "i", the real word "damage" is changed to the nonword "damige". Vowels were replaced by vowels and consonants were replaced by consonants so as to guarantee that the nonwords were pronounceable. The Chinese nonword was formed by combining any two Chinese characters together, but the combining word does not exist in Chinese language or makes any sense.

3.3. Procedures

The software E-Prime 2.0 was adopted for recording participants' performance. All stimuli were presented in a random order in the center of the computer screen. The texts were in black while the background is white.

Before formal experiments, participants were told to read the instructions of the task, and they did some practice before the start of experiments. The practice included 4 pairs of related words, 4 pairs of unrelated words and 8 pairs of word-nonword. In the formal experiments, each participant was given a total of 360 trials: 180 trials in native language and 180 in second language. There is a short break between the Chinese experiment and the English experiment. It is suggested [23] that SOA should better be 200ms to produce the automatic priming. Thus prime words were presented on the computer screen for 150ms, followed by a blank lasting for 50ms. Then targets words appeared on the screen. Participants had to respond to the targets within 1000ms or the targets would disappear and continued the next trial. Participants were required to decide on the target words as quickly and accurately as possible. Before each prime word, a symbol "+" would appear in the middle of the computer screen to remind participants of the beginning of each trial.

The instructions of the two experiments are in Chinese. The translation is as follows: Two words will appear successively in the center of the screen. The first word is a real word while the second one is either a real word or a word which does not exist. You are required to make a decision on the second word. If it is a real word, please press the "D" key; if it is a nonword, please press the "k" key. Before the first word appears, there will be a sign "+" in the center of the screen to show the beginning of each trial. Please do it quickly and accurately.

3.4. Data Analysis

While participants were doing the experiments in front of the computer, their responses were recorded at the same time. The statistics of accuracy and reaction time are particularly important to the study. Only the data of related and unrelated word pairs would be compared. The mean reaction time for both related and unrelated word pairs would be calculated. The data of participants whose error rates exceed 20% were cancelled. In this way, the data only included 31 participants in the experiment of native language and 27 participants in the experiment of second language. When calculating the reaction time for each type of related words, the data which was incorrect or which was not responded were removed.

The statistics collected from the two experiments were analyzed by SPSS 13.0. ANOVA test was used to analyze the factors of relatedness and the semantic relationship. As study tried to investigate the influence of different types of semantic relationship on semantic priming, the type of semantic relationship would be the independent factor, and the error rate and the reaction time would be the dependent factors. The significance level was set to $p<.05$.

4. Major Results

4.1. Factor of Relatedness on Semantic Priming in Both Chinese and English

In Chinese experiment, sixty pairs of semantically related words and sixty pairs of semantically unrelated words were selected as the experimental material. Participants' responses to these word pairs were shown on table 1. Statistics show that participants make fewer errors in responding to the related word pairs than to the unrelated word pairs (1.45% vs 4.78%). In addition, the reaction time of related word pairs is also smaller, 50.97ms faster than that of unrelated word pairs.

Table 1. Factor of relatedness on semantic priming in the Chinese experiment.

relatedness	error rate (%)	RT (ms)
unrelated	4.78%	616.79
related	1.45%	565.82

The result of One-way ANOVA revealed that relatedness has a significant influence on the error rate ($F=34.50$, $p=.00<.05$), as targets preceded by related words were responded more accurately than those preceded by unrelated words. The effect is also significant on the mean reaction time ($F=201.95$, $p=.00<.05$), as the semantically relatedness word pairs were responded faster than semantically unrelated word pairs.

In the English experiment, there were also sixty pairs of semantically related words and sixty pairs of semantically unrelated words. Participants' responses to these word pairs were shown on table 2. Statistics show that participants make fewer errors in responding to the related word pairs than to the unrelated word pairs (7.59% vs 12.84%). In addition, the reaction time of related word pairs is also smaller, 32.48ms faster than that of unrelated word pairs.

Table 2. Factor of relatedness on semantic priming in the English experiment.

relatedness	error rate (%)	RT (ms)
unrelated	12.84%	663.79
related	7.59%	631.31

The result of One-way ANOVA revealed that relatedness has a significant influence on the error rate ($F=24.48$, $p=.00<.05$) and on the mean reaction time ($F=49.61$, $p=.00<.05$), as the semantically relatedness word pairs were responded faster and accurately than semantically unrelated word pairs.

4.2. Influence of Lexical Semantic Relationship on Semantic Priming

Three types of lexical relationship in native language, including synonym, antonym and hyponym, were composed of the semantically related group. To investigate the influence of lexical semantic relationship, the error rate and reaction time of each type was calculated. Table 3 shows the result.

Table 3. Semantic relationship on semantic priming in the Chinese experiment.

type	ER (%)	RT (ms)
synonym	1.45%	565.79
antonym	1.77%	577.63
hyponym	1.13%	554.09
unrelated	4.78%	616.79

Generally, few mistakes were made in the experiment of native language. Unrelated word pairs were more likely to be wrongly responded, with the error rate of 4.78%. For synonym and antonym word pairs, the error rate was only 1.45% and 1.77% respectively. Participants show least errors for hyponym word pairs. For the reaction time, unrelated word pairs take the most time to react with the mean reaction time of 616.79ms. Hyponym word pairs take the least time to react with the mean reaction time of 554.09ms.

The one-way ANOVA data shows a significant effect of semantic relationship type on error rate ($F=11.64$, $p=.00<.05$) and on reaction time ($F=72.38$, $p=.00<.05$). For error rate, all three types of semantic relationship have a significant difference from unrelated word pairs on affecting semantic priming. However, within these three types of relationship, there isn't any significant difference between any two types. For reaction time, unrelated word pairs also show significant difference from the three types of semantic relationship. In addition, there is a significant difference between antonym and hyponym word pairs.

Table 4. Semantic relationship on semantic priming in second language experiment.

type	ER (%)	RT (ms)
synonym	5.19%	618.14
antonym	4.63%	616.44
hyponym	12.96%	659.34
unrelated	12.84%	663.79

In the second language experiment, the error rates of hyponym and unrelated word pairs increase greatly, reaching to 12.96% and 12.84% respectively. The error rate for hyponym word pairs is even a little larger than the unrelated word pairs. For the reaction time, the reaction time for synonym pairs and antonym pairs is nearly the same while they are much smaller than hyponym pairs. The reaction time of hyponym pairs is only 4.45ms smaller than that of unrelated word pairs (659.34 vs 663.79). One-way ANOVA test was carried out with semantic relationship type as the independent factor and the error rate and reaction time as the dependent factors. Statistics show that the semantic relationship type has a significant influence on both error rate ($F=16.86$, $p=.00<.05$) and reaction time ($F=28.89$, $p=.00<.05$).

According to the data of error rate, significant influence of lexical semantic relationship was found for synonyms ($p=.00<.05$) and antonyms ($p=.00<.05$) but not for hyponyms ($p=0.93>.05$), which proves both synonym and antonym word pairs show a significant semantic priming effect. However, hyponym word pairs exert no semantic priming effect. The result is the same for the data of reaction time. significant influence of lexical semantic relationship was also found for synonyms ($p=.00<.05$) and antonyms ($p=.00<.05$) but not for hyponyms ($p=0.50>.05$).

As for the influence of different types on semantic priming effect, both the error rate and the reaction time are significantly different between synonym and hyponym pairs as well as antonym and hyponym pairs. Both the error rate and the reaction time is much smaller for the synonym and antonym word pairs than for the hyponym word pairs. However, there is little difference between synonym and antonym word pairs in both error rate and reaction time. Although both of them exert significant priming effect, the response time of the two types is nearly equivalent.

4.3. Comparison of the Two Experiments

In the present study, two experiments have been carried out to investigate the influence of lexical semantic type on semantic priming effect. The error rate of native language is much smaller than that of English language in all types of semantic relationship. It can be noted that for three types of semantic relationship, all the error rate is less than 1%, which means nearly no mistakes were made in native language. The situation is similar in the variable of the reaction time. For all three types of semantic relationship, the reaction time is much smaller for native language than for English language.

In the native language, hyponym word pairs were responded the fastest while in the English language, antonym word pairs were responded the fastest. Hyponyms had the strongest impact on semantic priming, followed by synonyms and then antonyms. In the second language, hyponyms had no impact on semantic priming and contrary to the results in the native language, the influence on semantic priming was a little larger for antonyms than for synonyms. However, the difference between synonyms and antonyms was not significant in both languages.

Table 5. Comparisons of the error rate in two languages.

	related			unrelated
	Synonym	antonym	hyponym	
Native language	1.45% (3.33)	1.77% (3.01)	1.13% (3.65)	4.78%
English language	5.19% (7.65)	4.63% (8.21)	12.96% (-0.12)	12.84%

Table 6. Comparisons of the reaction time in two languages.

	related			unrelated
	Synonym	antonym	hyponym	
Native language	565.79 (51.00)	577.63 (39.16)	554.09 (62.70)	616.79
English language	618.14 (45.65)	616.44 (47.35)	659.34 (4.45)	663.79

As for the size of priming effect in the two languages, for the error rate, the priming effect was smaller in the native language than in the second language (9.99% vs 15.74%). However, for the reaction time, the priming effect was larger in the native language than in the second language (152.86ms vs 97.45ms). Generally, the priming effect was even larger in second language.

5. Major Findings and General Discussion

The study tried to explore the influence of the semantic relationship on semantic priming effect in both Chinese and English languages. Specifically, the relationship of synonym, antonym and hyponym were investigated. The results in chapter 4 answered three research questions in this study.

The first research question was whether the semantic priming effect will arise in Chinese learners' native and second language. The statistics from the present study obviously support the existence of priming effect in both languages. For native language, the error rate of related word pairs was significantly lower than that of unrelated word pairs while the reaction time was significantly smaller, which proved the existence of priming effect when a target was preceded by a related prime, which was the same for the second language.

The second research question was about the difference of semantic priming effect between Chinese learners' native and second language. Although the error rate and reaction time were much smaller in the native language compared with the second language, the size of priming effect was not consistent. For the error rate, the magnitude of priming effect was smaller in the native language than in the second language (9.99% vs 15.74%). However, for the reaction time, the size of priming effect was larger in the native language than in the second language (152.86ms vs 97.45ms). Generally, the priming effect was even larger in second language.

The third question was how the lexical relationships influence semantic priming. The present study included three types of lexical semantic relationship which were synonym, antonym and hyponym. These semantic relationships, especially hyponym exerted different influence on semantic priming effect between native and second languages. In the native language, the three types of semantic relationship all had significant influence on semantic priming effect. The hyponym pairs had the largest impact on semantic priming while the antonym pairs had the smallest impact. Within these types, there was no significant difference between synonyms and antonyms on affecting semantic priming. The significant difference only existed between antonyms and hyponyms. In the second language, only synonym and antonym pairs had significant impact on the priming effect. The priming effect of antonym pairs was only a little larger than that of synonym pairs, but the difference did not reach significance. Different from the result in the native language, the semantic relationship of hyponym did not have any impact on semantic priming, as its error rate was even bigger than that of unrelated word pairs and its reaction time approximates to that of unrelated word pairs.

The fact that semantic priming effect also existed in the Chinese language well supported the popular models about lexical representation such as spreading activation theory [32], [6] and distributed models [18], [37], [5]. According to the spreading activation theory [32], [6], semantic network was composed of nodes representing different concepts and links representing different relationships between concepts. The distance between any nodes was determined by the semantic similarity between the concepts. If two concepts share more features, they are more related with other, and they are closer to each other in the semantic network. When a concept is activated, the activation can spread along the semantic network. If two concepts are related, it is faster to spread the activation from one to another as the distance between them is shorter. That can explain why related word pairs were responded faster than unrelated word pairs. Compared with unrelated pairs, related word pairs, no matter what type of relation between the two words, obviously get an advantage in the semantic network. As some of the word pairs often appeared together, it was more likely that their semantic nodes stayed near each other. That is, it is easy and quick to think of a word after the situation of another. Semantic priming effect thus occurs because of quicker spreading though short distance of nodes.

The compound-cue theory [19], [35] is another theory to explain semantic priming effects, but the theory does not necessarily apply to the experimental results of the study. This theory emphasizes on the combination of the prime and the target as a compound cue in short-term memory to search for the mental lexicon in long-term memory. The rate of searching depends on the participants' familiarity with the compound cue. If participants are familiar with the compound cue, the searching process is quicker, thus leading to less reaction time.

If the participants are unfamiliar with the compound cue, it demands more time for searching, thus slowing down the reaction time for decision. A compound cue is often formed by co-occurred word pairs. However, synonym and antonym pairs do not form compound cues in most cases, and hyponym word pairs form even less compound cues. The compound-cue theory provides good explanations for those word pairs which always appear simultaneously, but it needs developing to explain the priming effect for more semantic-related word pairs. As Lucas [16] remarked, "the compound-cue model does not provide a complete or satisfying account of semantic priming without association."

Finally, the distributed memory theory of Masson [18] seemed a better way to explain the results of semantically related word pairs, because it did not focus on the direct link between primes and targets. Distributed Memory emphasized on the common semantic features between words. Thus there was more room for words of shared feature. Semantic priming effects did not come from the spread of activation, nor from the familiarity with compound cues, but from the similarity of processing units with the similar characteristics between word pairs. In terms of semantic categories of many kinds of overlapping words, this theoretical mechanism gives a stronger explanation for them. For example, synonymy word pair "*aim*" and "*goal*", because these two words exist many similar semantic features, when the prime word "*aim*" appears, the processing unit representing features of "*aim*" is activated until stable. Because most of semantic features of "*aim*" are activated, when target word "*goal*" appears, subjects would be more rapid and accurate.

How did lexical semantic types influence semantic priming effect? Semantic priming was found for synonyms and antonyms in both native and second languages. However, there was no significant difference between synonyms and antonyms in this effect, which was consistent with the previous research. However, some studies did find significant difference between the two types. Similar to their studies, the reaction time for synonyms was also larger than that of antonyms, but the difference was quite small in the present study.

According to the experiments in the research, the semantic priming effect for hyponyms was quite different from that of synonyms and antonyms. For hyponyms, they did not show any semantic priming effect in second language. The reaction to hyponym pairs was just similar to that of unrelated word pairs. Therefore, it can be inferred that there are few connections between hyponym pairs in participants' second language. Hyponyms were just like unrelated words for second language learners. According to some studies, the priming effect for hyponyms did appear in categorization tasks. Therefore, the tasks chosen may result in the disappearance of priming effect. The requirement of categorization tasks was very different from that of lexical decision tasks. In categorization tasks, participants were asked to determine whether the targets belonged to the category of primes, which means that the access to semantic information was supposed to happen during the process. In comparison, the processing of the meaning of primes is uncertain in the lexical decision task. So, the task used can be a reason for the disappearance of priming in lexical decision task.

Another reason why semantic priming for hyponyms in second language did not occur could be attributed to strategic processes. It was speculated that there was inhibition during the processing of superordinate words which could happen in strategic processes. According to the expectancy theory [5], [3], when a prime was presented, the semantic information of the prime was detected by lexical memory, and words related to the prime would be searched and activated. Before the presentation of the target, a semantic set was already set up, composing the activated words that related to the prime. If the target happened to be one of the related words in semantic set, the reaction would be faster. If not, the reaction time would be shorter. Likewise, superordinate words were presented and searched for semantic set. If the target was not one of the semantic set, the priming of it can be inhibited.

In spite of the careful choice of the materials and the strict selection of subjects, there are still some limitations in the study. Firstly, the number of subjects who participated in the experiments was only 35. After removing the data of those participants whose error rate exceeded 20%, there only remained data of 32 participants in Chinese experiment and 27 in English experiment. As the requirement for the subjects was strict for many students, we only include these students in the experiments. In addition, the gender of participants was not considered. Most of the subjects were girls. To make the results more convincing, more participants should be included, and stricter principles should be applied to choose subjects.

Secondly, much effort was made to control the priming conditions in order to guarantee automatic priming, such as the selection of lexical decision tasks, the short SOAs etc. However, the SOAs may not be short enough because some participants claimed that they could sense the relationship between primes and targets. Consequently, the automatic process of primes couldn't be guaranteed, and participants may use strategies during the priming. To make the process more automatic, a masked priming paradigm and shorter SOAs can be considered.

More research on the semantic priming effect of Chinese language is suggested to be carried out. The reason is that current models on semantic priming are applicable for English, but do not completely accommodate the results of Chinese language. The theories and models need developing and more evidence from across languages is needed. Moreover, more types of semantic relationship are suggested to be studied to examine their influence on semantic priming. The present study only included three types of semantic relationship which are synonym, antonym and hyponym. More new findings about semantic priming may hide in other types of word relations.

6. Conclusion

The present study intends to carry out semantic priming experiments in Chinese native speakers to examine the existence of priming effect in Chinese language and to investigate the difference of semantic priming effect between Chinese learners' native and second language by adopting a lexical decision task. Specifically, the priming effect of different lexical semantic relationship is studied to explore the influence of it on semantic priming effect including the relationship of synonym, antonym and hyponym.

Conclusion can be drawn from the experimental results. First, the semantic priming effect exist in Chinese language and the second language. Second, the magnitude of semantic priming was not consistent between the native language and the second language by the variables of error rate and reaction time. Generally, the priming effect is even larger in second language. Third, in terms of the way lexical relationships influence semantic priming, synonyms and antonyms have a significant influence on semantic priming effect in the two languages, but there was no significant difference between the two types of relationship. In addition, hyponym exerted different influence on semantic priming effect between native and second languages. In the native language, the hyponym pairs had the largest impact on semantic priming, while in the second language, the semantic relationship of hyponym did not have any impact on semantic priming.

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Appendix

Table A1. English material in Lexical Decision Task.

semantic relationship					
synonym		**antonym**		**hyponym**	
purchase	buy	empty	full	sport	football
error	mistake	open	shut	subject	math
autumn	fall	young	old	color	red
pain	ache	white	black	season	winter
ship	boat	love	hate	fruit	apple
suit	fit	life	death	food	noodle
advise	suggest	long	short	animal	sheep
aim	goal	wet	dry	disease	cancer
allow	permit	hot	cold	weather	rain
teach	instruct	win	lose	furniture	bed
finish	complete	clever	stupid	organ	heart
correct	right	healthy	ill	job	teacher
expect	hope	dirty	clean	country	America
location	place	above	below	vegetable	cabbage
answer	reply	soft	hard	meat	pork
author	writer	glory	shame	flower	rose
form	shape	accept	refuse	bird	parrot
gentle	soft	admit	deny	tool	hammer
gift	present	dark	bright	insect	spider
speak	talk	strong	weak	music	jazz

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