

# A Study on the Effects of Lexical Processing Strategies in Incidental Vocabulary Acquisition While Reading

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## Abstract

Research on vocabulary acquisition in SLA has revealed that a large proportion of vocabulary is acquired without overt intention. This paper analyzes the relevance of different lexical processing strategies for incidental vocabulary acquisition while reading involving 56 native Chinese speakers who are studying English at a local university in China. The lexical processing strategies which the participants adopted to analyze unknown words are discussed based on the cognitive processes involved, namely implicit/explicit cognitive processes and top-down/bottom-up cognitive processes. According to the introspective data collected during a think-aloud protocol as well as the results of a subsequent vocabulary retention test, we examine the acquisition effects of different strategies. The results indicate that students can learn vocabulary incidentally through implicit processing, though it has a significantly lower acquisition rate than that of the explicit processing strategies. With regard to the dichotomy of top-down and bottom-up cognitive processes, the bottom-up processing strategy demonstrates better acquisition effects than the top-down strategy. Finally, a multilevel cognitive model of factors that contribute to incidental vocabulary acquisition is developed in an attempt to provide theoretical and practical implications to L2 vocabulary teaching and learning in China.

**Keywords:** incidental vocabulary acquisition, lexical processing strategies, explicit cognitive process, implicit cognitive process, top-down cognitive process, bottom-up cognitive process, acquisition effects, cognitive factors

## 1. Introduction

One of the key challenges to second language (Note 1) acquisition, regardless of learning stages, is acquiring and expanding vocabulary knowledge. While it has been argued that students can learn about 30 words per hour by using a vocabulary list directly (Ellis, 1994), this is unlikely to be the most common means of acquiring lexical items for advanced learners (Hulstijn, 2013; Fraser, 1999; Paribakht & Wesche, 1999; Wode, 1999). There is evidence available from various L2 contexts that vocabulary can be learned from reading as well as other forms of input. Therefore, it is often assumed that a substantial portion, if not all, of one's second language vocabulary is acquired incidentally, as a result of other forms of cognitive activity that involve comprehension (Gass, 1999).

In a very general context, incidental vocabulary acquisition is defined as picking up lexical knowledge unintentionally, as the learner is not aware of an upcoming retention test (Hulstijn, 2013). However, this type of purpose-oriented definition does not provide any information concerning the underlying mechanisms of incidental vocabulary acquisition. In light of this, it is worthwhile to examine in more detail the processes involved in incidental vocabulary acquisition as a consequence of another activity, such as the reading comprehension task discussed in the current study.

## 2. Lexical Processing Strategies

### 2.1 Classifications of Lexical Processing Strategies

The different strategies that a person employs to acquire, store, and use language effectively are known as language learning strategies (O'Malley & Chamot, 1990). Lexical processing strategy is a type of language learning strategy that learners use when attempting to process unfamiliar words. While trying to process unfamiliar words, learners engage in many mental activities. A lexical processing strategy is usually defined as one of the following strategic options a student can use when faced with an unfamiliar word (Fraser, 1999): (1)

ignoring the unfamiliar word, (2) consulting a dictionary or another person, or (3) inferring its meaning. Moreover, the strategy of inferring a word's meaning can be further divided according to the clues upon which the inference is based. The learner can infer a word's meaning either based on (a) non-linguistic factors provided by the context/ background knowledge or based upon (b) linguistic factors provided by their previous knowledge of the native or target language (O'Malley & Chamot, 1990). Based on Fraser's classification of lexical processing strategies, the researcher classified the strategies according to two dichotomies (i.e., implicit/explicit processing strategies and top-down/bottom-up processing strategies).

Depending on whether a learner analyzes an unknown word in a conscious way or not, the cognitive process can be classified into two categories, namely explicit lexical processing and implicit lexical processing. Implicit processing refers to the unconscious and unintentional way in which learners analyze linguistic input (Hulstijn, 2005), whereas explicit processing is the learners' consciously analysis of the linguistic input. The following figure illustrates how lexical processing strategies are classified according to explicit and implicit cognitive processes.

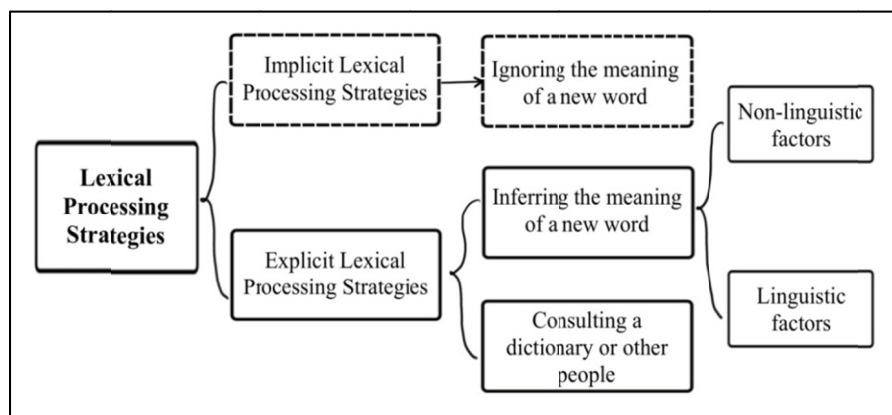


Figure 1. Classification of lexical processing strategies based on explicit and implicit cognitive processes

From Figure 1, it can be seen that, apart from the strategy of ignoring the meaning of a new word, all other lexical processing strategies belong to the explicit lexical processing strategies and require the participation of the learners' consciousness.

Taking the specific approach of cognitive processes into account, the lexical processing strategies can be divided into two general categories: top-down and bottom-up approaches. O'Malley and Chamot (1990) demonstrated that in the cognitive process of bottom-up vocabulary processing, the learners start by digesting the properties of a single lexical item, eventually progressing to comprehending the entire text. The top-down lexical approach is characterized by the fact that learners begin by attempting to determine the meaning of an entire text, before moving on to determining a single word's meaning (O'Malley & Chamot, 1990, p. 129). Based on these two approaches to lexical processing, Figure 2 illustrates the classification of lexical processing strategies.

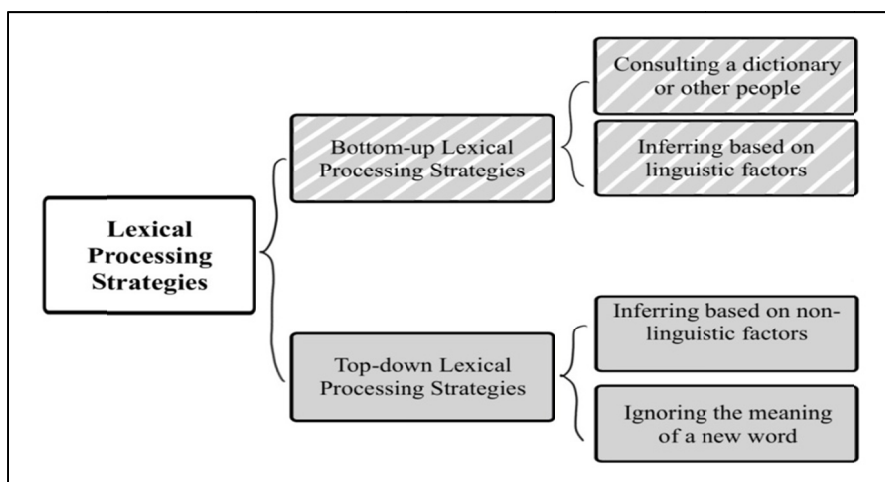


Figure 2. Classification of lexical processing strategies based on top-down and bottom-up cognitive processes

According to Figure 2, different lexical processing strategies can be divided into two categories based on the cognitive approaches involved. The bottom-up vocabulary processing strategies include two components: consulting a dictionary or other individuals and inferring a word's meaning from its linguistic characteristics. Inferring the meaning of a word based on nonlinguistic factors and ignoring the meaning of a new word belong to the top-down vocabulary processing strategies.

## 2.2 Cognitive Factors Influencing Lexical Processing Strategies

In the process of language acquisition, the first step for a second language learner is to convert the linguistic input into the intake. The learner's attention is crucial to this process. It is not possible to process and extract information if the learner does not notice the linguistic features of the input. Schmidt (2001) held the view that "learning is a by-product of the processing of a learner's noticing" (p. 29). He argued that noticing is the learners' conscious attention to features of the available linguistic input and that they are influenced by six factors: occurrence frequency, perceptual salience, instruction method, tasks requirements, learners' expectations, and processing capacity (Schmidt, 2001).

When one encounters and notices an unfamiliar lexical item, the integration of important features of this item into the mental lexicon is greatly affected by the depth of processing. According to Craik and Lockhart (1972), the degree of mental processing determines how much of the targeted information is retained in the mind. Retention is a result of cognitive processing. Memory retention will be enhanced to a greater extent when there is a deep level of cognitive processing (Zhang & Wu, 2001).

The concept of 'involvement load' was introduced by Laufer and Hulstijn (2001) as a combination of one motivational dimension (need) coupled with two cognitive dimensions (search and evaluation). The hypothesis (Laufer & Hulstijn, 2001) stated that the involvement load can be quantified with the sum index of its components: need, search, and evaluation. In their opinion, Laufer and Hulstijn (2001) believed that vocabulary acquisition is affected by the involvement load of the learners; under the same conditions, the greater the learners' involvement load invested to the task, the greater the impact of the task in promoting vocabulary acquisition, and the greater the effect of vocabulary retention.

The cognitive factors mentioned above could influence incidental vocabulary acquisition in the following way, as demonstrated below:

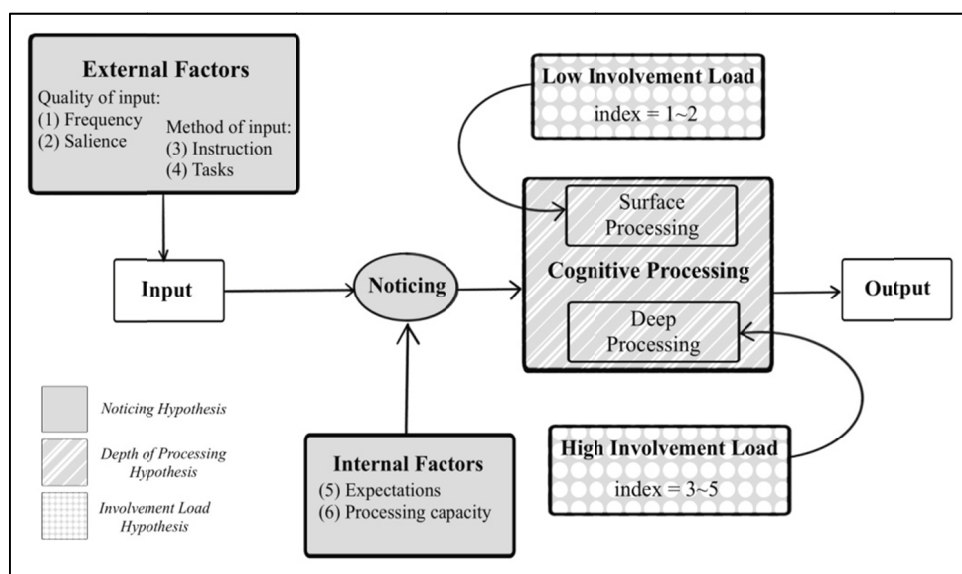


Figure 3. Cognitive process of incidental vocabulary acquisition

### 3. Method

#### 3.1 Research Questions

This study has aimed to examine Chinese EFL learners' incidental vocabulary acquisition during reading comprehension tasks and to compare the relative importance of different types of cognitive processes in incidental vocabulary acquisition. In this study, we examined the frequency of different lexical processing strategies employed by Chinese EFL learners during the reading comprehension task, as well as their impacts on vocabulary retention. On the basis of this, the study further explored the explicit/implicit cognitive processes and the bottom-up/top-down cognitive processes that are involved in incidental vocabulary acquisition during reading. With the aim of achieving the research purposes, the present study has attempted to answer the following research questions:

- (1) What are the lexical processing strategies adopted by college students in China when confronted with unknown lexical items during reading tasks, and how frequently are they used?
- (2) What are the effects of these lexical processing strategies with regards to vocabulary retention?
- (3) How do explicit and implicit cognitive processes differ from one another according to the learning effects?
- (4) In terms of learning effects, how do bottom-up and top-down cognitive processes differ?

#### 3.2 Participants

The current study involved 56 college students from a local Chinese university. The participants were all sophomore students and none of them majored in English. There were 22 Journalism majors, 19 Chinese majors, and the rest of them were Engineering majors. Twenty-nine of the participants were female, while the remainders were male. The average age of the participants was 19.7 years. The participants were registered for the researcher's *College English* course, which is a liberal education course offered to all undergraduate students of non-English majors. In this course, students will develop their overall language skills, with a particular focus on reading and writing.

There were no participants who had studied or been preparing to study in native English-speaking countries. By the time this research was conducted, all of the participants had been learning English as a foreign language for at least eight years. They enrolled in the course based on their placement test results when they entered the college, and they had taken the course for two semesters at the same level of proficiency in English. Additionally, all participants had just passed the *College English Test Band 4* (CET-4), indicating that they were intermediate-level English learners. The test results indicated that the lowest score was 504, the average was 512, and the standard deviation was 3.05. Accordingly, it could be assumed that the participants' English proficiency was similar.

According to the *Requirements of College English Teaching* issued by the Ministry of Education of the PRC in

2007 and the participants' performance in CET-4, the participants' English level reached B1 (independent users at a lower intermediate level), suggesting that the overall vocabulary level of the participants in this study was around 4,000 to 4,500 words. The following table summarizes the overall information concerning the participants.

Table 1. Summary of the participants

Items	Descriptions
Total number	56
Gender	Female: 29, Male: 27
Major	Journalism: 22, Chinese: 19, Engineering: 15
Average age	19.7
Experience of study-abroad	None
English proficiency	B1 (Independent users at a lower intermediate level)
Vocabulary level	4000–4500 words

In the current study, all the tasks were carried out by the same group of students. We did this so that we could maintain the consistency of data collection and ensure reliable data analyses to some extent.

### 3.3 Procedure

#### 3.3.1 Unknown Vocabulary Extraction

The researcher examined the reading texts using the vocabulary description tool, *VocabProfilers*, in the Compleat Lexical Tutor corpus (<https://www.lex tutor.ca>), to ensure that the selected reading texts contained new vocabulary for the participants. The online corpus displayed the words contained in the two reading texts which are distributed in the top 12,000 common words (K-1–K-12) according to the BNC and COCA corpora.

In the following step, the researcher presented all the content words from K-3 to K-12 (words distributed between 2,000 and 12,000 common words according to the online corpus) in the texts to all the participants and asked them to mark the words they did not understand from the word list. Participants were required to check the box next to each unknown word on the list. Additionally, they were instructed to mark the unknown words based on their first impression, without using any learning strategies. The extraction task was to be completed within 15 minutes by all participants.

#### 3.3.2 Reading for Comprehension

Participants were asked to complete a reading comprehension task three days after completing the new words extraction task. Two passages were included in the reading comprehension task. The first passage was an excerpt from a literary work (*A Rose for Emily* by William Faulkner) and the second was an expository science article (*The Story of Silk*) selected from *Cambridge IELTS 11 Test 3*. This task required participants to read the texts at a normal reading speed and answer ten multiple-choice questions related to the content of the texts (five questions for each text). The participants were given dictionaries, and it was made clear that they could consult a dictionary as needed. None of them was aware that there would be a test for the unfamiliar words after reading for comprehension in order to maximize the likelihood of incidental vocabulary acquisition. There was a time limit of 45 minutes for this task.

#### 3.3.3 Think-aloud Protocol

After reading for comprehension, a think-aloud task was administered. In general, the think-aloud protocol can be divided into three stages as described below.

Initially, the researchers explained why they were participating in the think-aloud protocol in order to ensure that the participants understood the purpose of the procedure. After this, the participants were introduced to different lexical processing strategies based on the classification model adopted in this study and on the specific information gathered during an interview in the pilot study. Specific examples were provided to participants to ensure that they understood these concepts. Finally, based on the unknown words on their list, each participant was instructed to report the specific lexical processing strategies they used when coping with each unknown word and the reasons for doing so. Oral reports were conducted individually for each participant via online or face-to-face interviews with the researcher and a research assistant. As a means of reducing participants' anxiety, we conducted the interview in their native language (Mandarin Chinese). If necessary, the researcher might ask participants to interpret or summarize certain paragraphs including new words. Notes were taken throughout the

interview concerning specific strategies. During the notes-taking process, the researcher asked questions such as, “What do you think of the passages,” “Why do you pause,” “Do you have a problem here,” when they seemed confused or paused. We audio-recorded the interview process with each participant for transcription and data analysis later.

### 3.3.4 Vocabulary Retention Test

A week after the think-aloud protocol, the participants were asked to take the vocabulary retention test in order to evaluate the effect of incidental vocabulary acquisition. The test was conducted in the form of a five-scale vocabulary knowledge test based on the vocabulary knowledge scale (VKS) developed by Wesche and Paribakht (1996). Participants were asked to self-assess their vocabulary knowledge based on the following five categories:

I: I haven’t seen this word before.

II: I have seen this word before, but I don’t know its meaning.

III: I have seen this word before, and maybe it means \_\_\_\_\_ (synonym/translation).

IV: I know this word. It means \_\_\_\_\_ (synonym/translation).

V: I can make a sentence with this word, e.g., \_\_\_\_\_ (if you answer this question, please also answer question IV).

### 3.4 Analyses

After collecting the data gathered from the unknown vocabulary extraction task, the researcher identified the unknown words that had been marked by each participant in order to determine the difference between them in terms of the number of new words. Moreover, a specific new word list for each participant was developed for further analysis.

Based on the data gathered via the reading comprehension task, a score for each participant’s reading comprehension was generated based on the number of correct answers they provided in response to questions testing their understanding of the reading texts. The total score was based on ten points, with 1 point assigned to each comprehension question.

During the think-aloud task, the researcher and the research assistant took notes regarding the participants’ use of lexical processing strategies. The researcher transcribed all important recordings into texts after each subject had completed the think-aloud task. Using the transcribed texts and the notes, the researcher developed statistics and classifications regarding the lexical processing strategies employed by the participants during the reading process.

The new word retention test was conducted by means of a self-test report. The self-test report was developed based on the vocabulary knowledge scale (VKS) of Wesche and Paribakht (1996) and the score grade scale outlined in the same paper. We customized the word retention test for each participant as the corresponding new words were different for each student.

In accordance with the VKS of Wesche and Paribakht (1996) and the grading scale that they outline in the same paper, the former is divided into five categories based on the participants’ familiarity with the new vocabulary, and the latter into five levels. Therefore, the vocabulary knowledge scale can be I, II, III, IV, or V depending on the participant’s familiarity with a new word. If the answers are correct for categories III to V, the participants will receive the appropriate score; if the answers are incorrect, they will be reduced to categories II to IV and receive only 2 to 4 points. The following table explains the specific meaning of scores.

Table 2. Meaning of Scores Based on Wesche and Paribakht’s (1996) VKS

Categories	Scores	Meaning
I	1	The word is not familiar at all.
II	2	The form is familiar, but the meaning is unknown.
III	3	A probable or related meaning is given.
IV	4	The meaning is known in terms of semantic appropriateness.
V	5	The meaning is known in terms of semantic appropriateness and grammatical accuracy in a sentence.

Researchers classified the retention effect of new words into two groups in order to distinguish the levels of acquisition of the new words by the participants. The words with scores of 1 and 2 were classified as [- acquired], while those with scores of 3, 4, and 5 were classified as [+ acquired]. Based on the binary acquisition state, we were able to determine the ultimate retention for each word. Consequently, this study was able to investigate the relationship between the processing strategies and the vocabulary retention effects.

It was evident that each participant provided a different set of data based on their situation, and each unknown word was learned by each participant differently. In view of the fact that the data collected in this study have an interdependent structure, the traditional statistical model is not appropriate. As a result, the data collected was analyzed using a generalized linear mixed-effect model. Using this model, one can take into account the correlation between the vocabulary, the study participants, and the lexical processing strategies as well as the variables of non-normal distributions.

## 4. Results

### 4.1 Types and Frequencies of the Strategies

Participants' high accuracy rate of the reading comprehension questions indicated that they had an overall understanding of the reading texts. That is to say, participants had overcome the obstacles of their unknown words to some extent during the process of reading. According to their think-aloud protocol, they reported that they had used a variety of lexical processing strategies to find out the meaning of the words they do not know.

The researcher conducted descriptive statistics pertaining to the specific types and frequency of lexical processing strategies employed by participants. There were generally four types of lexical processing strategies used by participants during the process of reading comprehension, as indicated by their oral reports. Figure 4 presents a comparison of the frequencies of the processing strategies used by the participants during the reading comprehension task.

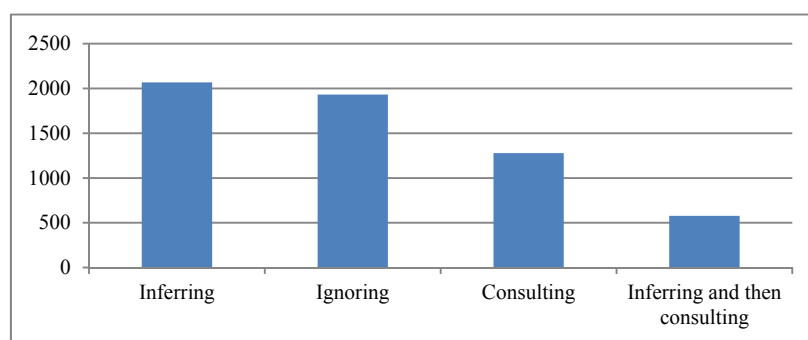


Figure 4. Types and frequencies of lexical processing strategies used by the subjects

We can see from Figure 4 that the most frequently used lexical processing strategy in this study was 'inferring the meaning of a word', which accounts for 35.3% of all lexical processing strategies, or 2,068 times overall. The second most frequently used lexical processing strategy was 'ignore the meaning of the word' (1,933 times). It accounted for 33% of the total number of lexical processing strategies used in this study. There were 1,279 instances of 'consulting a dictionary or asking for assistance', which accounted for 21.8% of the total number of vocabulary processing strategies. It was found that 'inferring the meaning and then consulting a dictionary' was the least frequently used lexical processing method, which was used 577 times in total by the participants. Combining the 'inferring' and 'consulting' strategies, this strategy comprised 9.9% of the total number of lexical processing strategies employed by participants.

#### 4.1.1 Frequencies of Implicit and Explicit Lexical Processing Strategies

The researcher categorized the lexical processing strategies used by the participants according to the criteria of explicit and implicit processing strategies based on the above statistics. In Table 3, we summarize the frequencies and proportions of implicit and explicit lexical processing strategies used in the present study.

Table 3. Frequencies of Implicit and Explicit Lexical Processing Strategies

		<b>Implicit</b>	<b>Explicit</b>		
	Total number	Ignoring	Inferring	Consulting	Inferring and then consulting
<b>Frequency</b>	5,857	1,933	2,068	1,279	577
<b>Percentage</b>	100%	33.0%	35.3%	21.8%	9.9%
<b>Percentage (total)</b>	100%	33%	67%		

From Table 3, it is clear that the proportion and frequency of explicit lexical processing strategies are significantly higher than implicit lexical processing strategies. This suggests that most of the words they identified as unknown vocabulary were processed consciously during the reading comprehension task.

#### 4.1.2 Frequencies of Top-down and Bottom-up Lexical Processing Strategies

Regarding the approach of cognitive process, the researcher classified the lexical processing strategies used by the subjects into top-down and bottom-up strategies. Since the ‘inferring and then consulting’ strategy is also initiated with the ‘inferring’ strategy, the researcher studied the strategy of ‘inferring and then consulting a dictionary’ together with the ‘inferring’ strategy. Table 4 summarizes the frequency and proportion of top-down and bottom-up lexical processing strategies.

Table 4. Frequencies of top-down and bottom-up lexical processing strategies

		<b>Top-down</b>		<b>Bottom-up</b>	
	Total number	Ignoring	Inferring based on non-linguistic factors	Inferring based on linguistic factors	Consulting
<b>Frequency</b>	5,857	1,933	1,284	1,361	1,279
<b>Percentage</b>	100%	33.0%	21.9%	23.3%	21.8%
<b>Percentage (total)</b>	100%	54.9%		45.1%	

Table 4 indicated that the frequency and proportion of top-down lexical processing strategies were slightly higher than those of bottom-up lexical processing strategies. It became evident that the participants processed more words when reading for comprehension, from the overall meaning of the context to the specific meaning of each new word.

#### 4.2 Effects of the Strategies

In order to analyze the effects of the participants’ lexical processing strategies, statistical analysis was conducted on data collected from the think-aloud task and the vocabulary retention test. A total of 5,857 pairs of lexical processing strategies and unknown words were identified. The use of the ‘ignoring’ strategy was reported 1,933 times; the use of the ‘inferring’ strategy was reported 2,068 times; the use of the ‘consulting’ strategy was reported 1,279 times; the use of the ‘inferring and then consulting’ strategy was reported 577 times. To get more specific information concerning the acquisition rate of each strategy, please refer to Table 5 below.

Table 5. Frequencies and retention effects of four major lexical processing strategies

		<b>Ignoring</b>	<b>Inferring</b>	<b>Consulting</b>	<b>Inferring and then consulting</b>
		<b>N (%)</b>	<b>N (%)</b>	<b>N (%)</b>	<b>N (%)</b>
	Frequency	1,933 (100)	2,068 (100)	1,279 (100)	577 (100)
[- acquired]	Score = 1	717 (37.1)	64 (3.1)	189 (14.8)	8 (1.4)
	Score = 2	801 (41.4)	412 (19.9)	567 (44.3)	67 (11.6)
[+ acquired]	Score = 3	212 (11.0)	421 (20.4)	215 (16.8)	95 (16.5)
	Score = 4	145 (7.5)	809 (39.1)	91 (7.1)	135 (23.4)
	Score = 5	58 (3.0)	362 (17.5)	217 (17.0)	272 (47.1)

The sub-categories of the inference strategy have been analyzed in terms of linguistic and non-linguistic factors. As far as linguistic factors were concerned, they included intra-lingual and inter-lingual cues, while non-linguistic factors included contextual and background information. In total, the inference strategies were used 2,645 times, including 2,068 instances of ‘inferring the meaning of a new word’ and 577 instances of ‘inferring the meaning and then consulting a dictionary’. Below are the specific frequencies and acquisition rates



for each sub-strategy at different scores levels.

Table 6. Frequencies and retention effects of the sub-categories of inference strategy

		Linguistic Factors		Non-linguistic Factors	
		Intra-lingual cues N (%)	Inter-lingual cues N (%)	Contextual information N (%)	Background information N (%)
Frequency		1,122 (100)	239 (100)	1,207 (100)	77 (100)
[- acquired]	Score = 1	18 (1.6)	16 (6.7)	26 (2.2)	12 (15.6)
	Score = 2	84 (7.5)	19 (7.9)	352 (29.2)	24 (31.1)
[+ acquired]	Score = 3	203 (18.1)	52 (21.8)	247 (20.5)	14 (18.2)
	Score = 4	483 (43.0)	101 (42.3)	341 (28.2)	19 (24.7)
	Score = 5	334 (29.8)	51 (21.3)	241 (19.9)	8 (10.4)

In light of the descriptive statistics listed in the previous section, it became evident that different lexical processing strategies would result in a different level of vocabulary retention. Taking the impact of different unknown lexical items on data processing into account, this study examined the relationship between different lexical processing strategies and vocabulary acquisition effects through a generalized linear mixed-effects model with RStudio for Windows.

Regarding the process of modeling, we modeled ‘vocabulary retention effect’ as a binary variable, namely acquired (= 1) and non-acquired (= 0); ‘strategy’ was entered as a fixed effect; ‘participant’ and ‘vocabulary’ were entered as random effects. According to a likelihood-ratio chi-square test, lexical processing strategies significantly influenced vocabulary retention ( $\chi^2(3) = 1693.9$ ,  $p < .001$ ). The figure below illustrates the modeled effects of different lexical processing strategies.

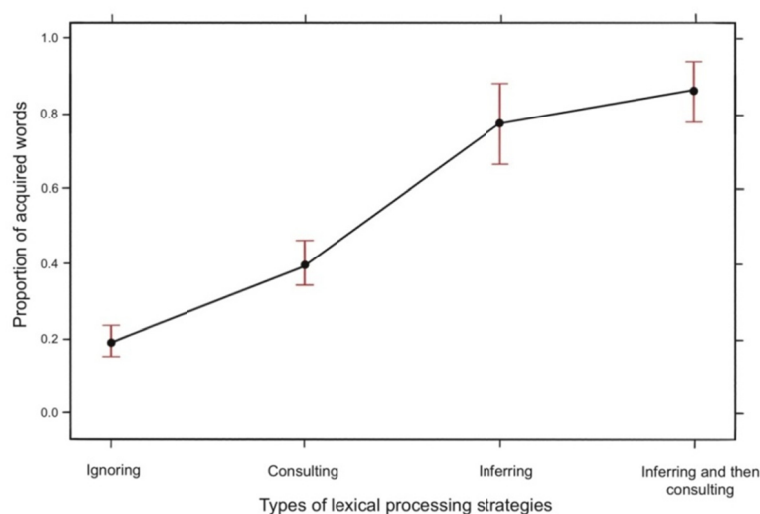


Figure 5. Modeled effect of four types of lexical processing strategies

The figure above presents the back-transformed proportion values as well as the respective confidence intervals to enable a direct comparison of the acquisition effects. The model indicates that 19.3% of vocabulary acquisition was accomplished by ignoring the meaning of a new word. In other words, the percentage of vocabulary acquisition following the application of the implicit lexical processing strategy was 19.3%. It is clear that the percentage of vocabulary acquisition following the use of explicit lexical processing strategies is greater than that following the use of implicit processing strategies. A higher percentage of vocabulary acquisition was achieved using the ‘consulting’ strategy than with the ‘ignoring’ strategy, which accounted for 39.1%. The ‘inferring’ strategy was successful in gaining 77.8% of the unknown vocabulary, which was significantly higher than the two strategies mentioned above. Among the four types of lexical processing strategies, the percentage of

vocabulary acquired by the ‘inferring and then consulting’ strategy was the highest at 86.1%.

In Figure 5, we see a distinct difference between the confidence intervals for the implicit processing strategy (i.e., the ‘ignoring’ strategy) and the other three explicit lexical processing strategies. Compared to the other three explicit lexical processing strategies, the confidence interval for the ‘ignoring’ strategy was much smaller. This implies that the use of the ‘ignoring’ strategy has been least affected by other factors. The difference between the confidence intervals of the other three explicit lexical processing strategies was also clear with the ‘inferring’ strategy having the largest confidence interval, and the ‘inferring and consulting’ strategy having the second largest.

Based on the types of factors that were involved in the process of inference, differences were observed in the percentages of acquisition in the previous section. This might account for the wide confidence intervals of the two inference strategies. To test whether different inference clues would result in different effects of vocabulary retention, the vocabulary retention effect of inference strategies was further divided by the nature of the factors involved. We, therefore, conducted an additional generalized linear mixed-effects analysis.

In terms of the process of modeling, the inference strategies were divided into two categories, including ‘inferring from non-linguistic factors’ and ‘inferring from linguistic factors’. We modeled the vocabulary retention effect as a binary variable in the same way as we did in our previous analysis; the ‘sub-strategy’ was entered as a fixed effect, and ‘participant’ and ‘vocabulary’ were entered as random effects. Another likelihood-ratio chi-square test manifested that the sub-strategy use affected retention significantly ( $\chi^2(1) = 203.7$ ,  $p < .001$ ). Figure 6 depicts the modeled effects of different types of factors that are involved in inferences.

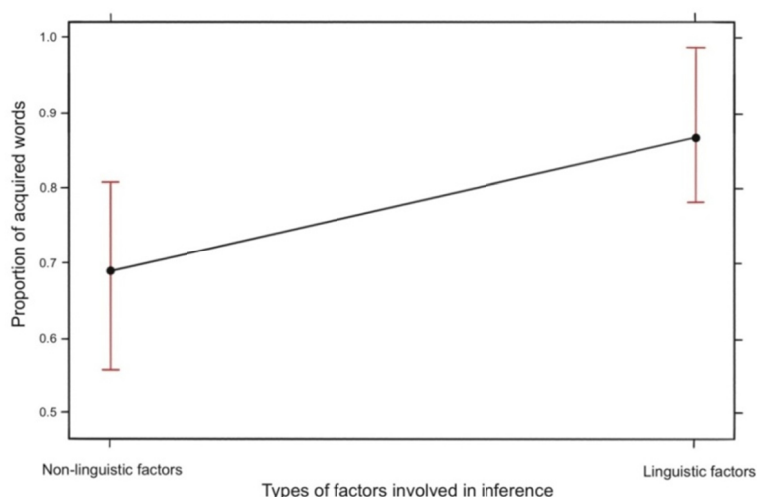


Figure 6. Modeled effect of two types of factors involved in inference processing strategy

As shown in Figure 6, the inference strategies involving linguistic factors achieved a significantly greater acquisition effect (87.3%) than those strategies that did not involve linguistic factors (68.7%). According to the model, although both of the confidence intervals of the two types of factors are wide, the one pertaining to non-linguistic factors is wider. Perhaps this is because of the small sample size in the present study, the individual variations of the subjects, and the differences in the unknown words each participant identified. In the current experiment, the language-based inference was a less frequent but more efficient strategy for vocabulary retention than inferences based on contextual information or prior knowledge.

## 5. Discussion

### 5.1 Implicit and Explicit Processing

#### 5.1.1 Implicit Processing of Unknown Vocabulary

In this study, implicit lexical processing referred to the use of the ‘ignoring’ lexical processing strategy. This study revealed that even when learners used the ‘ignoring’ strategy for word processing, they were still able to

recall some of the meaning of the word. By using this evidence, it can be confirmed that (1) implicit cognitive processes occur in incidental vocabulary acquisition and (2) implicit cognitive processes are effective in incidental vocabulary acquisition.

According to the results of this study, the subjects did not engage in explicit lexical processing for all unfamiliar words during the process of reading comprehension. Based on the notes of the think-aloud task, a large portion of the vocabulary was neglected by the subjects during the reading process, although some of the neglected words were identified as unknown words by the subjects when the new words were extracted. They did not provide oral reports regarding their processing methods of these words since they were able to infer the meaning of the vocabulary through implicit cognitive processes. This study could assume that the subjects were immersed in the mental activity of comprehension as they processed the unknown vocabulary. By virtue of the context provided by the reading task, the subjects processed the meaning of these words unconsciously.

After analyzing the data from this study, the researcher concluded that implicit cognitive processes are adequate for generating preliminary meanings for lexical items. In the subsequent vocabulary retention test, the subjects were able to recall the initial meanings of the new words after the implicit cognitive process. It is important to note, however, that this does not mean that the subjects have mastery of the words after the implicit cognitive processing has been conducted. Generally, after repeated exposure to the same unknown words through implicit processing, the subjects may provide the appropriate meaning of the unknown words when they are finally exposed to them, based on the context provided in the reading texts.

Generally speaking, the results of this study indicated that it is not always necessary to engage in a conscious learning process at a semantic or conceptual level, nor to pay explicit attention to the form-meaning connections, during the acquisition of word meanings.

#### 5.1.2 Explicit Processing of Unknown Vocabulary

There is no doubt that explicit lexical processing strategies have produced better learning results in the current study than implicit strategy. Figure 5 illustrates that the explicit lexical processing strategies led to a higher proportion of vocabulary acquisition than the implicit lexical acquisition strategy. Despite being the least effective explicit lexical processing strategy, the ‘consulting’ strategy resulted in about twice as many acquired words as the implicit vocabulary processing strategy when measured by retention rate.

During the reading comprehension task, incidental acquired vocabulary was increased through the use of explicit lexical processing strategies. Learning a second language often requires explicit processing of some key words’ meaning, by constructing hypothetical lexical meanings and determining whether those meanings are consistent with the specific text being read (Laufer & Hulstijn, 2001).

As discussed in the second part, there are three cognitive factors that play an important role in the process of incidental vocabulary acquisition. These factors include noticing, involvement load, and processing depth. Taking these cognitive factors into account, the benefits of explicit lexical processing can be explained. As a start, all three explicit processing strategies bring the target words to conscious awareness. In addition, in order to fulfill the comprehension task, the subjects need to know the meaning of certain key words, and therefore, they must guess the meaning or search for the meaning of the target words. Need, search, and evaluation are the components of involvement load. Finally, based on their involvement loads, the target words are analyzed either via surface or deep processing.

In terms of vocabulary retention, it may seem surprising that the ‘consulting’ strategy performed worse than the ‘inferring’ strategy. Considering the influence of cognitive factors, we are able to explain this phenomenon. The process of consulting a dictionary or asking someone for the meaning of a new word did not need much effort from the subjects to analyze the unfamiliar words by themselves. One of the challenges for the subjects was to identify the most appropriate meaning option for the unknown words in the text they were reading. In addition, the subjects often annotated the meaning of the target words in the margins after consulting a dictionary, which would likely reduce the need for the subjects to remember the vocabulary independently. It has been assumed in related studies that the use of reference books by L2 learners does not require a significant cognitive effort on their part to locate, retrieve, and reconstruct mental knowledge independently (Gong, 2009; Huang, Hu, & Wang, 2017).

#### 5.2 Top-down and Bottom-up Processing

##### 5.2.1 Top-down Processing of Unknown Vocabulary

It has been discussed previously that the top-down processing of lexical items begins with the overall meaning of the texts and progresses to the specific words. Based on the current study, the top-down lexical processing

strategy was composed of two strategies: the ‘ignoring’ strategy and the inference strategy based on non-linguistic factors. Considering their frequency of use, both strategies are used frequently, and the top-down processing strategies outnumbered the bottom-up strategies in the present study. These two strategies, however, performed much worse in terms of the incidental acquisition rate than the bottom-up processing strategies.

Due to its implicit and unconscious nature, the ‘ignoring’ strategy obviously had the poorest retention effect, as discussed in the previous section. Then why did the linguistic factor inference outperform the non-linguistic factor inference in terms of vocabulary retention? The answer may be related to the approach of the cognitive process. An inference strategy based on non-linguistic factors belongs to the top-down cognitive process, which involves students understanding the context first and then using the contextual clues to infer the meaning of the words. A considerable amount of cognitive effort is required from the subject during this process. The meaning of a word that is generated through factors other than linguistic knowledge is not automatically saved but is embedded in the context. Therefore, a word’s meaning that is inferred from nonlinguistic factors can be readily recalled in similar situations. Nevertheless, it is possible for meaning inferred from nonlinguistic cues to be lost if the context is lacking. It should be noted that the primary focus of non-linguistic inference is on meaning, and most of the words inferred through non-linguistic inference strategies are unrelated to the particular form of a word. Due to this, although the participants invested a considerable amount of cognitive effort in making non-linguistic inferences, they were unable to achieve the best retention results. Mondria and Boer (1991) also observed that rich contexts can facilitate the ability of learners to make inferences, while simultaneously reducing their memory of the vocabulary.

### 5.2.2 Bottom-up Processing of Unknown Vocabulary

Contrary to top-down processing, the bottom-up processing of a lexical item begins with the particular form and meaning of the target word and moves on to the overall context of the word. From the standpoint of English pedagogy, this method of cognitive process is closely related to the traditional method of language teaching, which is an approach that has received a great deal of criticism from scholars and educators alike. In terms of lexical processing in the present study, the bottom-up lexical processing strategy had a very good performance in terms of vocabulary acquisition. The bottom-up lexical processing strategy in this study consisted of the ‘consulting’ strategy as well as the inference strategy based on linguistic factors. As a result of the high frequency of the ‘ignoring’ strategy, the total number of bottom-up strategies was lower than that of top-down strategies. However, inferences based on linguistic factors were more common than inferences based on non-linguistic factors. Compared to their top-down counterparts, both bottom-up processing strategies performed better in terms of incidental acquisition rates.

The bottom-up cognitive process enables students to be aware of the form of the target word at the very beginning, which in turn leads to the creation of a mental lexicon of form-meaning combinations. As a consequence, the resulting form-meaning combinations are more stable and are more likely to result in subjects recalling the specific meaning of the new word. Thus, when the meaning of a word is deduced via the linguistic factor, the student is able to infer it again using his or her knowledge of linguistics when the word is removed from its original context. It is, by contrast, impossible for the non-linguistic factors to perform the same step of inference outside of the context of the original text. Therefore, the linguistic factor inference strategy used in this study was the most effective in terms of vocabulary retention, although it was not the most frequently employed one.

Another reason may be related to the mainstream method of language teaching in China. In spite of the negative impact that the traditional method may have on the learning of a second language, it is still widely used in China as an effective method of language teaching, and students are accustomed to this method. Li (2006) suggested that the notion of gradual evolution from smaller and basic elements to complex structures is an internalized feature of Chinese philosophy and thought. It is true that most Chinese education (including first language literacy) follows a bottom-up approach (Jin, 2010; Peng, 1997). Some Chinese educators even advocated an obvious bottom-up sequence as the most effective way to teach Chinese literacy: 字, 词, 句, 段, and 篇 (word, phrase, sentence, paragraph, and text). As a matter of fact, most Chinese literacy textbooks follow this order. Consequently, it is not surprising that Chinese learners preferred and performed better with the bottom-up approach to cognition.

### 5.3 Multilayered Model of Cognitive Factors Facilitating Incidental Vocabulary Acquisition

In relation to the results and discussions regarding the different types of lexical processing strategies, it is possible to construct a multilevel model based on the cognitive factors that influence incidental vocabulary acquisition during the process of learning a second language. Because the subjects participating in this study

were experienced L2 learners (college students), a hierarchical model of incidental vocabulary acquisition was only developed for this level of learners. A diagram showing this specific model is presented in Figure 7.

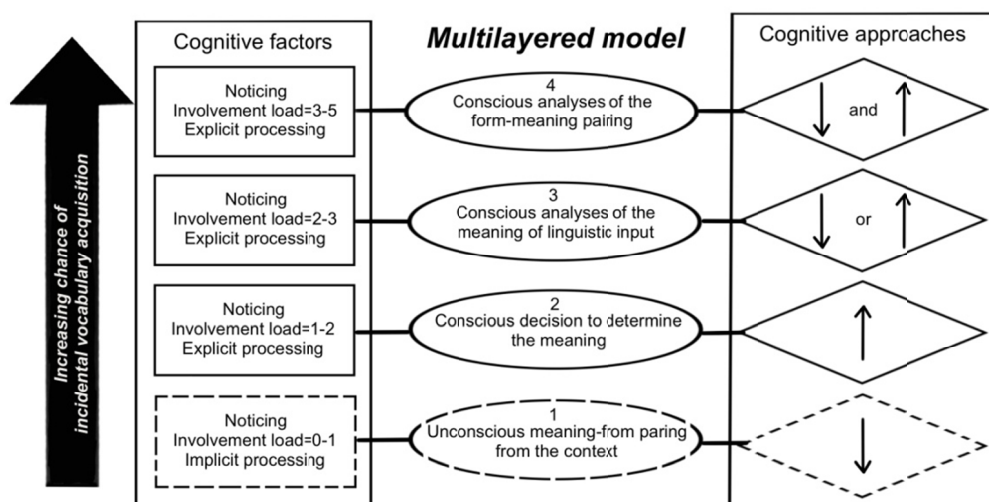


Figure 7. Multilayered cognitive model of incidental vocabulary acquisition

Initially, the implicit and top-down cognitive processes serve as a preliminary level of incidental vocabulary acquisition when reading. According to the results discussed above, college-level (experienced) L2 learners could learn the meanings of some unfamiliar words implicitly from their context and combine them with a corresponding lexical form in their brain. In reality, the process of implicitly acquiring the meaning of words from context may be a long and gradual process. An L2 learner may grasp the meaning of a word as they encounter it repeatedly and process it unconsciously while interpreting the overall meaning of a reading text. A meaning-form pair will then be constructed in their mental lexicon by combining the implicitly obtained meaning and a specific form. Only 'noticing' plays an unconscious role in incidental learning at this level, as there is no explicit processing involved.

At the second level, explicit surface cognitive processing is performed. The explicit cognitive process is activated by the learners' consciously deciding to find out the specific meaning of an unknown word. When reading for comprehension, an L2 learner notices the form of a word and identifies it as an unknown word. Having a need for overall comprehension, he/she consciously decides to seek out the meaning of an unknown word. The second level of process is an explicit bottom-up way of learning through strategies like 'consulting a dictionary or asking others', which is fundamentally different from implicitly inferring the meaning from its context. In addition to 'noticing', involvement load and depth of processing also play a role in incidental vocabulary acquisition, although they are quite superficial and do not require too much effort from the learners.

Explicit surface cognitive processing is performed at a deeper level, in the third layer. The learners should consciously engage in the process of analyzing and evaluating the linguistic input through inference in order to maintain a smooth reading process. It is possible to conduct this process either from the bottom-up or from the top-down approach. By increasing the evaluation requirements for learners, the involvement load for this explicit level of process rises in comparison to the previous level. To distinguish a 'consulting' strategy from an 'inferring' strategy, one has to determine whether the input is analyzed and evaluated by the learners independently. This suggests that the cognitive demands to linguistic input evaluation can also facilitate the explicit cognitive process.

The last layer is explicit deep cognitive processing. This level of process involves the explicit processing of linguistic input by the L2 learners through pairing of word forms and meanings precisely. It is an important level in the cognitive process. Usually, this process is performed both in the top-down and the bottom-up approach. In general, the learners' demands to the meaning of the target words are quite high at this level. Having inferred the meaning of an unknown word from the context, L2 learners also may encounter some difficulties or gaps in comprehension as they proceed. In order to confirm their speculation, they may refer to a dictionary to determine

a word's meaning for sure. Finally, they are able to establish a comparatively clear mental lexicon of form-meaning combinations. Obviously, the fourth level of the acquisition process involves the highest involvement load and the most rigorous cognitive processing, and therefore, usually results in the most effective acquisition results.

In the present study, a multilevel cognitive model was developed to facilitate incidental vocabulary acquisition, which supported Craik's (2002) assumption that "higher levels of vocabulary acquisition are associated with the more meaningful processing of linguistic input" (p. 316). As a consequence, the more closely the four layers mentioned above are combined, the more likely it is that L2 learners can construct their mental lexicon.

In this sense, incidental vocabulary acquisition is a combination of implicit and explicit cognitive processes with respect to consciousness involved. As well, it is a combination of top-down and bottom-up cognitive processes, depending on the cognitive approach applied. Alternatively, the incidental vocabulary acquisition process is incorporated into a complex structure consisting of a variety of cognitive processes with a continuous facilitating effect.

## 6. Conclusion

In this study, lexical items acquired incidentally through reading for comprehension were investigated. It has been shown that incidental vocabulary acquisition can result from both implicit and explicit cognitive processes. It should be noted that although implicit processes are limited, their effects are not negligible, since statistical modeling reveals that learners retain the meaning of unknown words in 19 percent of cases in which they are not explicitly handling a formerly unknown lexical term. In light of the fact that reading comprehension is a very common activity, especially for advanced learners, it would be logical to assume that vocabulary can also be expanded through implicit processing. It appears, however, that explicit methods, such as 'consulting a dictionary', 'inferring the meaning based on different knowledge', or the combination of these two approaches, are more effective for learning.

On the dichotomy between top-down and bottom-up cognitive processes, the bottom-up strategy exhibited significantly better acquisition effects than the top-down strategy. A top-down cognitive approach does not automatically preserve the meaning of a word; it is largely dependent on the context in which it is used. Consequently, the meaning of a word derived from a top-down cognitive process is likely to fade together with its immediate context. However, bottom-up processing seems to provide a strong anchor for newly added lexical items, because it is based on direct associations involving form and meaning.

These results were placed within a hierarchical model of processing which, starting from a situation in which there are limited chances for implicit acquiring an unknown word, assumes that four aspects foster the incidental acquisition of an initially unfamiliar lexical item: (1) whether a preliminary meaning-form pairing was involved in the implicit cognitive processing, (2) whether the target word's meaning was consciously determined via surface processing, (3) whether the linguistic input was evaluated by the learners independently through a deeper surface-level of processing, and (4) whether the analysis of the linguistic input involved the precise pairing of the form and meaning of the unknown word at a deep processing level.

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## Notes

Note 1. In this research paper, second language, foreign language, and L2 are used interchangeably.

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