Processing Unfamiliar Words: Strategies, Knowledge Sources, and the Relationship to Text and Word Comprehension

Wei Cai
University of Calgary

Benny P.H. Lee
Nanyang Technological University

Abstract

This study examines strategies (inferencing and ignoring) and knowledge sources (semantics, morphology, paralinguistics, etc.) that second language learners of English use to process unfamiliar words in listening comprehension and whether the use of strategies or knowledge sources relates to successful text comprehension or word comprehension. Data were collected using the procedures of immediate retrospection without recall support and of stimulated recall. Twenty participants with Chinese as their first language participated in the procedures. Both qualitative and quantitative analyses were made.

The results indicate that inferencing is the primary strategy that learners use to process unfamiliar words in listening and that it relates to successful text comprehension. Among the different knowledge sources that learners use, the most frequently used knowledge sources are semantic knowledge of words in the local co-text combined with background knowledge and semantic knowledge of the overall co-text. The finding that the use of most knowledge sources does not relate to the comprehension of the word suggests that no particular knowledge source is universally effective or ineffective and that what is crucial is to use the various knowledge sources flexibly.

Résumé

Cette étude examine les stratégies (la déduction et l'omission de mots) et les sources de connaissances (sémantique, morphologie, connaissance antérieure, etc.) utilisées par les étudiants d'anglais langue seconde (ALS) pour comprendre les mots inconnus à l'oral, et s'interroge sur les liens entre l'emploi des stratégies ou sources de connaissances et la bonne compréhension des textes et des mots. Les données ont été recueillies immédiatement après observation, sans rappel ni simulation ultérieure. Vingt locuteurs de langue maternelle chinoise ont participé à l'étude. Des approches qualitative et quantitative ont été utilisées.

Les résultats indiquent que la déduction est la stratégie de toute premi**è**re importance utilisée par les sujets pour comprendre les mots inconnus à l'oral, et ceci est lié à une bonne compréhension du texte. Parmi les sources de connaissances, celles qui sont les plus souvent utilisées par les étudiants sont la connaissance sémantique des mots du contexte immédiat alliée avec la connaissance de fond et la connaissance sémantique du texte global. Les résultats indiquent que l'emploi de la plupart des sources de connaissances n'a aucun rapport avec la compréhension des mots, suggérant ainsi qu' aucune source de connaissance en particulier n'est universellement efficace ou inefficace . Ce qui est crucial est l'emploi flexible de diverses sources de connaissances.

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Introduction

There has been a plethora of studies investigating vocabulary acquisition in second language (L2) reading comprehension (e.g., Haastrup, 1991; Haynes, 1993; Horst, 2005; Laufer, 2003). Evidence suggests that L2 learners are able to acquire vocabulary incidentally in reading and retain some of the vocabulary acquired in this way (Fraser, 1999; Laufer & Rozovski-Roitblat, 2011; Paribakht & Wesche, 1997). However, studies on how learners acquire vocabulary from listening are rare. The limited literature in this area does not provide much evidence of learners' ability to acquire meaning of new words in L2 listening, but when it does, it still does not inform our understanding of the mental processes learners use to acquire new vocabulary. The paucity of research on this topic may relate to the assumption that the employment of complicated strategies, such as inferencing, overwhelms the limited resources available for comprehension, as Ridgway (2000, p. 185) argues that there is simply "no cognitive space for employing such strategies in real-time listening". The purpose of this paper is to investigate the strategies and knowledge sources that L2 learners use to process unfamiliar words in listening and whether the use of these strategies or knowledge sources relates to success in text comprehension and word comprehension.

Strategies for Processing Unfamiliar Words in Reading Comprehension

Strategies for processing unfamiliar words have been explored extensively in reading comprehension (Bengeleil & Paribakht, 2004; Fraser, 1999; Haastrup, 1991; Hamada, 2009; Huckin & Bloch, 1993; Kaivanpanah & Alavi, 2008; Nassaji, 2003; Paribakht, 2005; Paribakht & Wesche, 1999). The abundance of research in this area may relate to the assumption that reading is the major way to acquire vocabulary after the first few thousands of words are learned (Paribakht, 2005). Consequently, several strategies for processing unknown words have also been identified in reading comprehension, such as the lexical ignoring strategy, the lexical inferencing strategy, and so on.[1] For instance, Fraser (1999) found that inferencing was the primary strategy that learners used to deal with unfamiliar words in reading comprehension, whereas the ignoring strategy was least used. In very few cases, learners reported that they did not notice the unfamiliar words. Not noticing unfamiliar words is referred to as 'no attention' in her study.

The extent to which learners use the inferencing strategy in a text may vary with different text factors, such as text coverage, "the percentage of running words in the text known by the readers" (Nation, 2006, p. 61). Achieving adequate comprehension of a text forms the basis for inferring the meaning of unknown words, particularly words without morphological clues. Existing studies reveal that a reasonable coverage of vocabulary is necessary for adequate reading comprehension. For instance, Laufer (1989) found a significant difference in comprehension between learners who knew 95% or more of lexical tokens than those who knew less. Laufer (1989) therefore argued that 95% text coverage

[1] In addition to these strategies, consulting (a dictionary or another individual) is also a strategy that L2 learners use to process unfamiliar words (Fraser, 1999). Given that consulting is not a cognitive strategy, it is not discussed in this paper. not discussed in this paper.

was required for adequate comprehension. Similarly, Hu and Nation (2000) found that 98% text coverage was necessary for sufficient comprehension. In a recent study, Schmitt, Jiang, and Grabe (2011, p. 26) found a "relatively linear relationship" between the percentage of known vocabulary and the level of reading comprehension although no vocabulary threshold was found at which reading comprehension was enhanced considerably. In another recent study, Laufer and Ravenhorst-Kalovski (2010) found that 8,000 word families yielded 98% text coverage and 4,000–5,000 word families resulted in 95% coverage. These studies reveal that a prerequisite for successful reading comprehension is knowing a high percentage of the words in the text. As deducing the meaning of unknown words (particularly for words without morphological clues) is largely based on comprehension of a text or individual sentences in the text, the results of this group of studies also suggest that a reasonable text coverage is needed for obtaining the meaning of unknown words in a text.

When the lexical inferencing strategy is used, learners make "informed guesses" of word meaning in the light of all available cues (Haastrup, 1991, p. 40). Existing studies reveal that L2 learners resort to a wide range of knowledge sources when they infer the meaning of unfamiliar words. The most comprehensive study on lexical inferencing was conducted by Haastrup (1991) in which she asked 62 pairs of Danish secondary school students to read a text and infer the meaning of unknown words while verbalizing their thoughts in pairs. She found that learners used contextual knowledge (co-text and knowledge of the world), intralingual knowledge (knowledge of the test word and syntax of the test word sentence) and interlingual knowledge (knowledge of languages other than the target language) to infer word meaning in reading comprehension. In a more recent study, Kaivanpanah and Alavi (2008) used think-aloud protocols to examine the lexical inferencing behaviors of Persian-speaking English learners. They found that learners used both linguistic and non-linguistic knowledge to infer the meaning of unfamiliar words and that learners used word-level cues, sentence level cues, and wider co-text beyond sentence level to infer word meaning in reading. Specifically, the knowledge sources that the learners used in their study included sentence level grammatical knowledge, word morphology and class, compound word constituents, sentence level semantic clues, discourse/text clues, homomymy/phonetic similarity and collocation.

Results of empirical studies indicate that the type of knowledge sources and the extent to which these knowledge sources are used by learners do indeed vary. For example, Paribakht (2005) investigated the effect of first language (L1) lexicalization on L2 lexical inferencing in reading comprehension by eliciting data from Farsi-speaking learners, using an introspective verbal report method. Her study revealed that the participants used linguistic knowledge at the word level (word association, collocation, morphology, and homonymy), sentence level (sentence meaning, sentence grammar, and punctuation), and discourse level (discourse meaning and formal schemata) to infer word meaning. In addition to L2 linguistic knowledge, her participants also used L1 word collocation and non-linguistic knowledge involving knowledge of the text for reading. In terms of the frequency of use of the knowledge sources, Paribakht (2005) found that sentence-level cues, in particular sentence meaning, constituted the primary cue that the participants used. The next higher-frequency knowledge sources were discourse-level cues and sentence grammar. Word-level cues, general world knowledge and L1-based cues were used to a lesser extent. The finding that sentence meaning is crucial lends support to Bengeleil and

Paribakht's (2004) study which suggests that learners would study the sentence containing the target word first before they resorted to the co-text beyond the target word sentence.

In another study, Nassaji (2003) used think-aloud protocols to collect data from 21 intermediate English as a Second Language (ESL) learners with five different L1 language backgrounds. Nassaji (2003, pp. 655–656) found that the most frequently used knowledge source for lexical inferencing in reading comprehension was world knowledge and that morphological knowledge constituted the second most heavily used knowledge source. Grammatical knowledge was moderately used. The least frequently used knowledge sources were discourse knowledge and L1 knowledge. Apparent differences can be found between Nassaji's (2003) and Paribakht's (2005) studies: discourse knowledge is among the least frequently used knowledge sources in the former, but constitutes a higher-frequency knowledge source in the latter; the high frequency of the use of world knowledge and morphological knowledge observed in Nassaji's study is also in contrast to Paribakht's study in which these two knowledge sources were used much less frequently. Nassaji's study seems to suggest that clues residing in one's background knowledge and word forms are more convenient to use than information residing within the text beyond the sentence level, which is apparently contradictory to Paribakht's study. An important finding of Nassaji's study is that success in inferring is not connected to the types of knowledge sources used. However, Hamada's (2009) study seems to suggest that word inferences depend on the knowledge sources activated for inferencing. In his study, Hamada studied five Japanese-speaking English learners' word inferencing performance in reading for four weeks. He found that learners' strategy use exhibited a shift from local strategies (word level strategies) to more global strategies (sentence or contextual level strategies) in the four-week period and that global strategies are linked with a higher success rate in word inference.

Haastrup (1991) found that the co-text was the most frequently used knowledge source.[2] However, Bensoussan and Laufer (1984) reported that when learners met an unknown word, they first generated a hypothesis about its meaning based on the word form, such as the morphological constituents of the word, cognates, and so on. The use of the context (by which they mean co-text in our terminology) was minimal and mainly as the learners' last resort. Huckin and Bloch (1993) also found that learners first studied the word form to infer the word meaning. Bensoussan and Laufer (1984) observed that learners often stuck to guesses based on the word form, ignoring clues in the co-text. Similarly, using a think-aloud procedure, Haynes (1993) found that when a hypothesis was formulated based on the word form, it tended to override learners' ability to use co-text. However, Huckin and Bloch (1993) reported that in most cases where learners inferred word meaning from the word form, they often checked the guesses against co-text, and this was usually successful.

Unlike Haastrup (1991), Bensoussan and Laufer (1984) and Huckin and Bloch (1993) seem to suggest that word form analysis is learners' preferred approach to handle unknown words. This finding perhaps relates to the observation that inferring from the

[2] In Haastrup's study, co-text (the linguistic context), which refers to the linguistic material accompanying the word whose meaning the reader is to infer, is to be distinguished from context, which is the general physical environment surrounding the word. Co-text is therefore just a part of the whole context. (See Yule, 1996 and Brown & Yule, 1983 for a discussion of this distinction.)

word form is characterized as a "fast, automatic, data-driven process in which the form of the unfamiliar word activates an L1 or L2 association in the learner's mental lexicon", whereas inferring word meaning with co-text is a "more deliberate and effortful process whereby meaning is created on the basis of language and situational cues from the text" (Fraser, 1999, pp. 231-232). Therefore, for a task requiring much cognitive resource and for learners with limited cognitive capacity, inferring word meaning from the word form is more appealing than inferring from the co-text.

The contradictory findings concerning the use of knowledge sources may be the result of differences in the elicitation tasks and participants' language proficiency levels. For instance, the elicitation tasks used in these studies differ greatly in the richness of clues in the co-text. In Haynes' (1993) study, all the target words are embedded in a rich co-text in that the words have either clues in the immediate sentence or clues in the integration of information throughout the passage. In contrast, Huckin and Bloch (1993) include in their study a proportion of target words without clues from the co-text. In addition, the language proficiency levels of the participants in these studies also vary greatly. For instance, the participants in Huckin and Bloch's (1993) study are students pursuing a Master degree, whereas in Haastrup's (1991) study, the participants are secondary school students.

To sum up, studies of lexical inferencing in reading comprehension show that L2 learners possess the ability to infer word meaning and the ability to use diverse knowledge sources to do so. However, differences have been found in previous studies on the extent to which learners use the knowledge sources. The generalizability of the findings from these studies to listening comprehension is unclear. In addition, the studies reviewed above show that there are issues which have yet to be addressed adequately even in reading comprehension. For instance, research is rare which takes both the inferencing strategy and ignoring strategy into consideration. Most studies focus solely on the inferencing strategy and hence provide an incomplete picture of how L2 learners treat unfamiliar words. Systematic research is also needed to examine the relationship between the use of strategies and text comprehension, and the relationship between the choice of knowledge sources and word comprehension.

Strategies for Processing Unfamiliar Words in Listening Comprehension

While much research has been done on unfamiliar word processing in reading comprehension, empirical studies specifically investigating this issue in listening comprehension are still limited. Not much is known about how L2 learners process unfamiliar words in listening comprehension. We are not clear whether, in most cases, they infer word meaning, ignore unfamiliar words, or not even notice the unfamiliar words in continuous speech due to cognitive overload.

In spite of the paucity of studies specifically examining unfamiliar word processing in listening, research on listening strategies in general (Goh, 1997, 1998, 2002; O'Malley, Chamot, & Kupper, 1989; Vandergrift, 1996, 1997, 2003) sheds some light on this issue. Graham and Macaro (2008) maintained that inferencing was unavoidable when listening to a difficult text and that effective inferencing resulted from the use of a cluster of strategies. In a longitudinal study of the effect of instruction of metacognitive strategies on L2 listening, Vandergrift and Tafaghodtari (2010) observed learners' increased ability to infer the meaning of unfamiliar lexical items. Goh (2002) found that L2 listeners used contextual clues, known content words, general world knowledge and linguistic knowledge of L2 to infer the meaning of unknown words. In another study, Vandergrift (2003, p. 495)

identified four types of inferencing based on the knowledge sources that L2 learners used: linguistic inferencing (inferencing based on "known words in an utterance"), voice inferencing (inferencing based on "tone of voice and/or paralinguistics"), extra-linguistic inferencing (inferencing based on "background sounds and relationships between speakers in an oral text, material in the response sheet or concrete situational referents"), and between-parts inferencing (inferencing by drawing on "information beyond the local sentence level").

Like reading comprehension, the proper use of the inferencing strategy in listening should be affected by text coverage as well. The limited body of research on the relationship between lexical coverage and listening comprehension reveals the necessary vocabulary knowledge needed to reach 95% and 98% coverage of spoken texts. Nation (2006) found that a 6,000-7,000 word-family vocabulary was needed for 98% coverage of spoken texts. Webb and Rogers (2009a) found that knowledge of 3,000-4,000 and 5,000-10,000 word families (plus proper nouns and marginal words) was required for 95% and 98% coverage of movies respectively. In another study, Webb and Rodgers (2009b) showed that knowledge of 2,000-4,000 and 5,000-9,000 word families (plus proper nouns and marginal words) was necessary for 95% and 98% coverage of television programs respectively. Based on this group of studies, we can assume that achieving a reasonable vocabulary size and text coverage is also needed for deducing word meaning correctly in listening.

There are several studies specifically focusing on lexical processing in listening (Cai & Lee, 2010; Cai & Wu, 2005; Lee & Cai, 2010). In Cai and Wu (2005), participants were asked to verbalize how they arrived at the meaning of unfamiliar words identified in advance. The result of this study revealed that co-text, local co-text in particular, was the most extensively used knowledge source, and this was followed by world knowledge. Morphology and word class related to the target words were also used to some extent. In terms of the use of combined knowledge sources, this study showed that the participants relied heavily on local co-text combined with world knowledge to infer word meaning. One weakness of this study is that the participants were forced to make a decision on the meaning of the unfamiliar words, which might otherwise go unnoticed or ignored in 'normal' listening when learners' focus is on general comprehension of oral input, rather than on specific unfamiliar words. Cai and Lee (2010) and Lee and Cai (2010) examined the effect of contextual clues and language proficiency on unfamiliar word processing in listening comprehension respectively and found that the use of strategies and knowledge sources was subject to the influence of contextual clues and learners' language proficiency levels. However, their studies did not examine the relationship between successful/unsuccessful text comprehension and the use of strategies, and the relationship between word comprehension and the use of knowledge sources.

In sum, existing studies do not address adequately unfamiliar word processing in listening comprehension. We are not clear the extent to which learners use inferencing and ignoring strategies in listening comprehension and whether the choice of the strategies relates to the comprehension of the text. A systematic study of the use of knowledge sources for inferring word meaning and its effect on the result of word comprehension is also needed. The current study aims to address these issues.

Methods

Research Questions

1. To what extent do L2 learners use inferencing and ignoring strategies to process unfamiliar words in listening comprehension? For completeness of account, this study also considers the instance of "no attention" where learners do not notice the unfamiliar words.
2. Does the choice of strategies relate to the comprehension of the text?
3. What knowledge sources do L2 learners use to infer word meaning in listening comprehension?
4. Does the choice of knowledge sources relate to the comprehension of the word?

Description of the Experiment

Participants.

Twenty Chinese students from a university in Beijing, China participated in this experiment. They were second-year English majors. Two English proficiency levels were distinguished among the 20 participants by means of the composite score of eight listening tests regularly administered by the English teaching program and the instructor's assessment of the participants' listening abilities. The ten high-proficiency participants were those with the highest mean scores of the eight listening tests and placed in the high-proficiency group by their instructors. The ten low-proficiency participants were the students with the lowest mean scores of the eight listening tests and placed in the low-proficiency group by their instructors.[3]

Listening materials.

In this experiment, participants were asked to listen to nine texts (see Appendix 1 for a sample text). The nine texts were based on popular science and mostly selected from *New Scientist*. Each text comprised four to five sentences and was approximately eighty words. Slight modifications were made, in particular some low-frequency words were replaced by high-frequency words. This is to ensure a high text coverage so that learners can achieve adequate comprehension of the sentences in the texts and the whole texts, forming the basis for inferring the meaning of the target words. To confirm the quality of the language after revision, two proficient native speakers of American English edited the language of the revised texts when necessary. A native speaker of American English provided the recording, with an average spoken word rate of 140 words per minute.

Each text contained one word to be inferred. Clues for inferring the word meaning can be found in the co-text, either in the target word sentence or beyond. To ensure that no subject had previous knowledge of the target words, we used novel words in place of the original words. These words retained the morphological features of the original words, whether inflectional or derivational. For instance, in one text, the target novel word "gomered" retained the inflectional ending "–ed" of the original word "covered"; in another text, the novel word "sloration" replaced "extinction", retaining the derivational suffix "–ion". A pre-test in the form of a cloze test was conducted on ten native speakers of English. The cloze test includes the nine experiment texts with the target words being replaced by

[3] A comparison of the performances between the high-proficiency and low-proficiency participants is reported in Lee and Cai (2010).

blanks. The participants were asked to fill in the blanks with words that semantically fit the text. The words given by the participants were either the original words or their synonyms.

Procedure.

Data were collected using verbal reporting methods in the form of the immediate retrospection procedure without and with recall support. As with other methods, the verbal reporting method has limitations. Major concerns of the use of this method relate to the completeness and accuracy of the verbal report in revealing the actual thought processes (For a full discussion of the verbal reporting method, see Ericsson & Simon, 1993). One way of enhancing the efficiency of the method is to minimize the delay between "the event reported and the reporting itself" (Gass & Mackey, 2000, p. 17). A different method is to provide participants with retrieval cues when they give the verbal report. This method is called the stimulated recall procedure. Verbal reporting in the forms of immediate retrospection without recall support and of stimulated recall is therefore used in this study. In operationalizing the method, care was taken to ensure that there was no interruption between the comprehension process and the verbal reporting process; retrieval cues (replaying parts of the recording) were given to the participants at the time of giving the report.

The experiment took the form of individual interviews. In each interview, participants listened to the texts, answered questions, and recalled the content of the texts. Having participants recall the content ensured that participants focused their attention on comprehending the text, rather than on the problem words. Participants were told from the outset that the goal of the listening task was to recall the content of the text. They were at liberty to use either English or Chinese to answer questions and recall text contents. The whole interview session was audio-recorded. In each interview, participants first received an introduction from the interviewer outlining the task which they were expected to do. A warm-up exercise similar to the actual experiment was provided to familiarize them with the experiment procedure. In the experiment, participants listened to each text twice. After listening to the text, the participants were asked to answer several questions. For the purpose of clarity, the questions are presented in Figure 1.

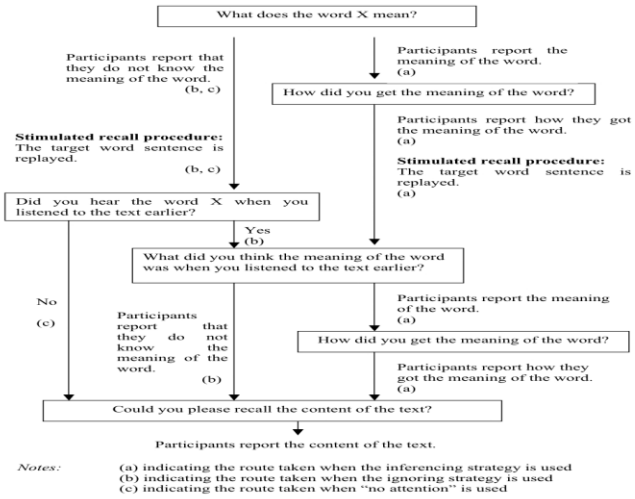

Figure 1 Questions asked during the experiment

As shown in Figure 1, the first question asked was 'What does the word X mean?' (X standing for the target word). If the participants reported that they did not know the meaning of the word, the stimulated recall procedure was initiated where the target word sentence was replayed. The participants were then asked the question: 'Did you hear the word when you listened to the text earlier?'. If their answer was no, they would proceed to recall the content of the text. This is marked as route (c) in Figure 1 and coded as 'no attention'. If their answer was yes, they would be asked 'What did you think the meaning of the word was when you listened to the text earlier?'. If they reported that they did not know the meaning of the word, they would be asked to go on to recall the content of the text. This is marked as route (b) and coded as the use of the lexical ignoring strategy, since in this instance, the participants did notice the word earlier but chose to ignore it. Route (a) was taken when participants reported their interpretation of the meaning of the word from the outset. Participants were then asked the question: 'How did you get the meaning of the word?', and so on. After the participants had answered the questions, they were asked to recall the content of the texts.

Analysis of the transcripts.

All the protocols were transcribed and coded for strategies for processing unfamiliar words and knowledge sources for inferring word meaning by the first author. To determine the intercoder reliability, a doctoral student in linguistics was also asked to code the data independently. We obtained an intercoder agreement of 95% for the use of strategies and of 93% for the use of knowledge sources. The inconsistencies were resolved by consulting another doctoral student in linguistics to reach 100% agreement among the three coders. The coding systems are described below.

Coding strategies for processing unfamiliar words. Definitions and examples of use of strategies are presented in Table 1. In all the protocols cited in the paper, 'I' stands for 'Interviewer', 'P' stands for 'Participant'.

Table 1
Definitions of strategies and examples of the use of strategies

Strategy	Example
The inferencing strategy: Participants report the meaning of the word and the knowledge sources for deriving the meaning.	(Before receiving the retrieval cue) I: What does the word "bosherate" mean? P1: Disappear. I: How did you get the meaning of the word when you listened to the text earlier? P1: According to the context. The following parts mention the world would slip into the bottom of the ocean and the carbon-based life would be in danger.
The ignoring strategy: Before receiving the retrieval cue, participants report that they did not know the meaning of the target word. After receiving the retrieval cue, they report that they heard the	(Before receiving the retrieval cue) I: What does the word "gomered" mean? P2: I don't know. (After receiving the retrieval cue) I: Did you hear the word when you listened to the text earlier?

word but did not derive its meaning earlier.	P2: Yes. I: What does the word "gomered" mean? P2: I don't know.
No attention: Before receiving the retrieval cue, participants report that they did not know the meaning of the target word. After receiving the retrieval cue, they report that they did not hear the word earlier.	(Before receiving the retrieval cue) I: What does the word "sigotive" mean? P3: I don't know. (After receiving the retrieval cue) I: Did you hear the word "sigotive" when you listened to the text earlier? P3: No.

Coding knowledge sources for lexical inferencing. Wherever the inferencing strategy was identified, the relevant transcripts were coded for the knowledge sources involved. There are existing taxonomies of knowledge sources for lexical inferencing in reading comprehension. The most comprehensive taxonomy is given by Haastrup (1991). The major problem with her taxonomy is that an attempt to use it fails to produce mutually exclusive categories. For a fuller discussion of the taxonomy, see Cai (2003). In another study, Dubin and Olshtain (1993, p. 183) delineate five components of textual support for unfamiliar words, including extra-textual knowledge ("the reader's general knowledge extending beyond the text"), thematic knowledge ("the reader's overall grasp of the content of this particular text"), Semantic I ("information extending over large discourse units in the text beyond the paragraph level"), Semantic II ("information available locally at the sentence or paragraph level") and syntactic ("relationships within the immediate sentence or paragraph"). Because this taxonomy is proposed for reading comprehension, it does not include knowledge sources specifically used in listening comprehension. In addition, this taxonomy does not identify different levels of knowledge sources. Given the limitations of previous taxonomies, a new taxonomy is developed for our purpose. The chief improvement of our taxonomy is that the constituent knowledge sources are delineated more tidily such that the overlapping knowledge sources of the various categories are minimized. Our taxonomy also identifies different levels of knowledge sources and incorporates some knowledge sources specifically adapted to the data collected in this study, i.e., the knowledge sources used in the listening modality (paralinguistics and phonology). The new taxonomy is presented in Table 2.

Table 2
A taxonomy of knowledge sources for lexical inferencing

Level 1	Level 2	Level 3	Level 4
Textual knowledge	Co-text	Local co-text	Semantics 1
			Paralinguistics
		Global co-text	Semantics 2 (specific words)
			Semantics 3 (overall co-text)
	Target word		Phonology
			Word class
			Morphology
Extra-textual knowledge			

In this taxonomy, four levels of knowledge sources are identified. Level 1 includes textual knowledge and extra-textual knowledge, which is the most general level and covers all the other three levels. At Level 2, textual knowledge is further divided into the co-text and target word. At Level 3, co-text is further divided into local co-text (referring to the target word sentence) and global co-text (referring to the text other than the target word sentence), and so on. At Level 4, we find the most basic knowledge sources: semantics in the local co-text (Semantics 1); paralinguistics (such as intonation and pitch); semantics of specific words in the global co-text (Semantics 2); semantics of the overall co-text (Semantics 3); the phonology, word class and morphology of the target word; and extra-textual knowledge. Given space constraints, this paper reports the use of the knowledge sources at Level 4 only. Definitions and examples of the use of the knowledge sources at Level 4 are presented in Table 3.

Table 3
Definitions of knowledge sources and examples of the use of knowledge sources

Knowledge source	Example
Semantics 1: Semantics of words in the target word sentence	(Before receiving the retrieval cue) I: What does the word "moop" mean? P2: Sleeplessness. I: How did you get the meaning of the word when you listened to the text earlier? P2: "That is sleeplessness" explains it. *Note:* "That is sleeplessness" appears in the target word sentence.
Paralinguistics: Rhythm, intonation, pitch, and others	(Before receiving the retrieval cue) I: What does the word "sigotive" mean? P5: Harmful. I: How did you get the meaning of the word when you listened to the text earlier? P5: …And I feel the man's tone, yes, the tone is low when he said coffee is always sigotive.
Semantics 2: Semantics of specific words in the text other than the target word sentence	(Before receiving the retrieval cue) I: What does the word "reboam" mean? P15: Part of the computer. I: How did you get the meaning of the word when you listened to the text earlier? P15: The text mentioned "chips in the computer". *Note*: "Chips in the computer" appears in the text other than the target word sentence.
Semantics 3: Semantics of the overall co-text	(Before receiving the retrieval cue) I: What does the word "bosherate" mean? P6: Become worse. I: How did you get the meaning of the word when you listened to the text earlier?

	P6: According to the context. The text talks about the bad results if we human beings don't have volcanoes. *Note*: The meaning is derived from the overall co-text, and not from any specific words found in the target word sentence or other sentences.
Phonology: The similarity of two phonological forms	(Before receiving the retrieval cue) I: What does the word "moop" mean? P17: Depressed. I: How did you get the meaning of the word when you listened to the text earlier? P17: I heard "trouble". I think "moop" should be related to "mood". Then "experience mood" must be "experienced depressed mood". *Note*: P17 connects "moop" with "mood".
Word class: The part of speech of the word	(Before receiving the retrieval cue) I: What does the word "reboam" mean? P11: Fan. I: How did you get the meaning of the word when you listened to the text earlier? P11: It's after "they", so it should be a verb …
Morphology: Prefix, stem or suffix	(Before receiving the retrieval cue) I: What does the word "reboam" mean? P12: Bang again. I: How did you get the meaning of the word when you listened to the text earlier? P12: "Re" is a prefix which means again. "Bang", is a word I know, like "hit"… *Note*: P12 hears "boam" wrongly as "bang".
Extra-textual knowledge: Background knowledge	(Before receiving the retrieval cue) I: What does the word "broamed" mean? P15: Sank. I: How did you get the meaning of the word when you listened to the text earlier? P15: It is so famous. I have seen the film. *Note:* The text is about the sinking of the Titanic.

Scoring lexical inferencing. The participants' lexical inferencing performance was scored based on a 0-3 scale (Nagy, Herman & Anderson, 1985, as cited in Read, 2000): An incorrect meaning was given 0 point; a distant partial meaning was credited with 1; 2 was rewarded for a very close partial meaning; and 3 for the correct meaning. 3 was given when participants provided the original words which the pseudo words replaced, the synonyms of the original words, or words provided by the native speakers of English participating in the pre-test on the contextual constraint of the target words.

Scoring text comprehension. Following Kintsch's (1974) method, the text was first analyzed in terms of its propositional content. After collecting the recall protocols, the propositions in the protocols were identified and matched with the propositions in the text. Each correct proposition in the protocols gained one point. The total number of correct propositions recalled for each text was the score for text comprehension.

While scoring the participants' recall, a lenient criterion for accuracy was followed. A subject was credited if a close paraphrase of the proposition was present. For example, credit was awarded for the paraphrase "always open their eyes" for "can't shut their eyes". Furthermore, incorrect or incomplete mention of proper name or time was also credited. For instance, "Tufts University in Florida" for "Tufts University in Maryland" received full credit; "April", "1912", "May 1936" for "April 1912" were all fully credited. Incomplete enumeration also received full credit. For example, the recall without thoroughly listing the three symptoms of "headaches, fatigue, and poor concentration" received full credit.

Results and Discussion

Research question 1: **To what extent do L2 learners use each of the strategies to process unfamiliar words in listening comprehension?**

A chi-square analysis was performed to determine whether there is a significant difference in the frequencies of the lexical inferencing strategy, the lexical ignoring strategy and "no attention". Table 4 reports results of frequency and chi-square analyses of the use of strategies.

Table 4
Frequency and chi-square statistics of use of strategies

Strategy	Token	Percentage
Inferencing	109	60.6
Ignoring	27	15.0
No attention	44	24.4
Total	180	100

$X^2 = 62.433$, df = 2, $p = .000$

The chi-square statistic for strategies is 62.433, df = 2, $p = .000$, indicating that there is a statistically significant difference in the frequencies of the lexical inferencing strategy, the lexical ignoring strategy, and 'no attention'. Table 4 reveals that inferencing is the most frequently used strategy, making up 60.6% of the 180 tokens. In contrast, the ignoring strategy and 'no attention' are used to a lesser extent; participants ignore the unfamiliar words in 15.0% of the instances and fail to notice the unfamiliar words in 24.4% of the instances.

The data above show that inferencing is the primary strategy that learners in this study use to process unfamiliar words, while the ignoring strategy is used to a lesser extent. This finding is consistent with that of Fraser (1999) who investigates strategies for processing unfamiliar words in reading comprehension. It confirms Vandergrift's (2003) observation that L2 learners are able to use the inferencing strategy in listening comprehension. It contradicts the assumption that employing complicated strategies, such as the lexical inferencing strategy, is practically unrealistic in listening comprehension

(e.g., Ridgway, 2000) and suggests that listening comprehension is as an active and creative process as reading comprehension.

Research question 2: Does the choice of strategies relate to the comprehension of the text?

The degree of text comprehension was determined by the number of correct propositions recalled for the text. Table 5 presents the descriptive and ANOVA statistics.

Table 5
Means, standard deviation and analysis of variance of text comprehension across strategies

Strategy	Mean	SD	F
Inferencing	12.3	6.7	14.258**
Ignoring	8.7	4.8	
No attention	6.7	5.2	

** $p \leqslant .001$

The ANOVA statistics show that there is a significant difference in text comprehension when using the three strategies. The Tukey's post hoc test was therefore performed. The data are presented in Table 6.

Table 6
Tukey's test of honestly significant difference in text comprehension across strategies

Strategy	Inferencing	Ignoring	No attention
Inferencing		3.5994*	5.5916*
Ignoring			1.9922
No attention			

* $p < .05$

The Tukey's post hoc test reveals significant differences in text comprehension between inferencing and ignoring and between inferencing and "no attention". The data show that the use of the inferencing strategy relates to better text comprehension than the use of the ignoring strategy and "no attention". However, no significant difference is found in text comprehension between the use of the ignoring strategy and "no attention".

In spite of the evidence that the use of the inferencing strategy relates to better text comprehension, we cannot establish the direction of the causal relation between them. Perhaps it is the use of the inferencing strategy which leads to better text comprehension, or perhaps it is better text comprehension which gives rise to more frequent use of the inferencing strategy. What we can conclude is that the inferencing strategy is connected to better text comprehension.

Research question 3: What knowledge sources do L2 learners use to infer word meaning in listening comprehension?

In coding the data, we found that learners used either a single knowledge source or a combination of knowledge sources in inferring the meaning of a particular word. Before the chi-square analysis was performed, we deleted all the knowledge sources or combined knowledge sources whose occurrences were below 5.

Table 7
Frequency and chi-square statistics of use of knowledge sources

Knowledge source	Token	Percentage
Semantics 1	9	9.8
Semantics 2	5	5.4
Semantics 3	22	23.9
Semantics 1 + extra-textual knowledge	33	35.9
Semantics 2 + extra-textual knowledge	10	10.9
Semantics 3 + extra-textual knowledge	5	5.4
Morphology + extra-textual knowledge	8	8.7
Total	92	100

$X^2 = 50.1304$, df =6, $p = .000$

Notes: Semantics 1: semantics in the local co-text
Semantics 2: semantics of specific words in the global co-text
Semantics 3: semantics of the overall co-text

The chi-square statistic for knowledge sources is 50.1304, df = 6, $p = .000$, indicating that there is a statistically significant difference in the frequencies of the use of the knowledge sources. Figure 2 illustrates the observed and expected values of the occurrences of the knowledge sources.

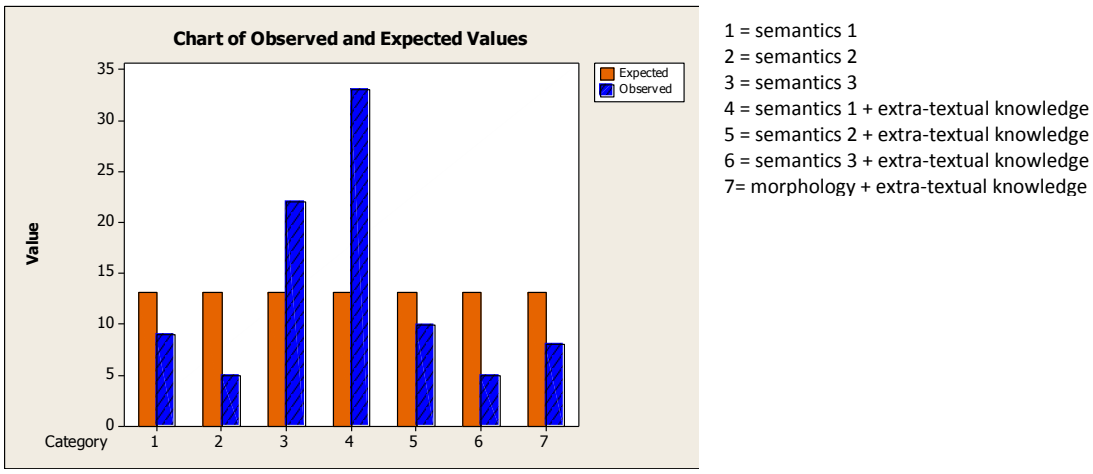

Figure 2 Observed and expected values of the occurrences of knowledge sources

Notes: Semantics 1: semantics in the local co-text
Semantics 2: semantics of specific words in the global co-text
Semantics 3: semantics of the overall co-text

As illustrated in Figure 2, Semantics 1 combined with extra-textual knowledge (35.9%) and Semantics 3 (23.9%) stand out in that their occurrences exceed the expected values of the frequencies of the knowledge sources. The rest of the knowledge sources are used to some extent, but below the expected value. We will therefore focus our discussion on these two knowledge sources.

In case of the use of Semantics 1 (semantics of words in the local co-text) combined with extra-textual knowledge (35.9%), the participants frequently pick out words in the target word sentence and relate these words to their background knowledge to make sense of the target word. This result is consistent with Haastrup (1991). However, it contradicts that of Bensoussan and Laufer (1984), and Huckin and Bloch (1993) who found that word form (such as morphology, cognate) was the primary knowledge source that learners relied on and that the use of co-text was minimal and mainly as the learner's last resort.

Protocol (1) is an example where a participant used semantic information in the local co-text (Semantics 1) and then related this information to his background knowledge to arrive at the interpretation of the target word "broamed". "Broamed" appears in the sentence "However, before the Titanic broamed, they played a considerable number of musical selections together, including the famous one, Autumn".

(1) (Before receiving the retrieval cue)
I: What does the word "broamed" mean?
P15: Sank.
I: How did you get the meaning of the word when you listened to the text earlier?
P15: It is so famous. I have seen the film.

When the participant heard the word "Titanic" (although not specified in the protocol example), the schema related to it was immediately activated. This example indicates how a subject benefits from successful decoding of words and efficient activation of background knowledge to arrive at an accurate interpretation of an unfamiliar word.

Semantics 3 (semantics of the overall co-text) is another high-frequency knowledge source (23.9%). Using Semantics 3 requires an integrated comprehension of the whole text. The mental process involved in using this knowledge source is more complicated naturally; listeners must first decode words in the text, and then connect the decoded words to form a meaningful representation of the text in the mind. Finally, they use this mental representation to infer the meaning of the word. In example (2), P6 used his overall general understanding of the entire co-text to deduce the meaning of "reboam". "Reboam" appears in the sentence "Instead, researchers at Tufts University in Maryland are studying the structure of butterfly wings to find out how they reboam heat".

(2) (Before receiving the retrieval cue)
I: What does the word "reboam" mean?
P6: Get rid of.
I: How did you get the meaning of the word when you listened to the text earlier?
P6: The whole text discusses how to keep computer cool. Researchers are investigating how to get rid of extra heat of computers.

In this example, the participant based his inferencing of the meaning of "reboam" on an integrated understanding of the text. The participant accurately decoded words in the text, and then connected the decoded words into a meaningful representation of the text. Finally, he used the mental representation to infer the meaning of "reboam".

To sum up, the participants are able to use different knowledge sources to infer word meaning in listening comprehension. The knowledge sources they rely on most

heavily are semantics in the local co-text combined with extra-textual knowledge, and semantics of the overall co-text.

Research question 4: Does the choice of knowledge sources relate to the comprehension of the word?

Word comprehension was determined by the inferencing scores ranging from 0 to 3. To examine the relationship between the use of knowledge sources and the comprehension of words, an ANOVA analysis of the inferencing scores across the knowledge sources was performed. Because some of the reported frequencies of a given knowledge source or combination of knowledge sources were low (<5), only knowledge sources with reported frequencies of ≥ 5 were included in the ANOVA analyses. Table 8 presents results on word inferencing scores across knowledge sources.

Table 8
Means, standard deviation and analysis of variance of word comprehension across knowledge sources

Knowledge source	Mean	SD	F
Semantics 1	2.22	1.09	13.892**
Semantics 2	1.80	1.64	
Semantics 3	2.50	1.01	
Semantics 1 + extra-textual knowledge	2.70	.85	
Semantics 2 + extra-textual knowledge	.60	1.26	
Semantics 3 + extra-textual knowledge	3.00	.00	
Morphology + extra-textual knowledge	.00	.00	

** $p \leqslant .001$

Notes: Semantics 1: semantics in the local co-text
Semantics 2: semantics of specific words in the global co-text
Semantics 3: semantics of the overall co-text

The data reveal that there is a significant difference in the inferencing scores when using the different knowledge sources. The Tukey's post hoc test was therefore performed. The results are reported in Table 9.

Table 9
Tukey's test of honestly significant difference in word comprehension across knowledge sources

Knowledge source	Semantics 2	Semantics 3	Semantics 1 + extra-textual knowledge	Semantics 2 + extra-textual knowledge	Semantics 3 + extra-textual knowledge	Morphology + extra-textual knowledge

Semantics 1	.42	-.28	-.47	1.62*	-.78	2.22*
Semantics 2		-.70	-.90	1.20	-1.20	1.80
Semantics 3			-.20	1.90*	-.50	2.50*
Semantics 1 + extra-textual knowledge				2.10*	-.30	2.70*
Semantics 2 + extra-textual knowledge					-2.40*	.60
Semantics 3 + extra-textual knowledge						3.00*

* $p < .05$

Notes: Semantics 1: semantics in the local co-text
Semantics 2: semantics of specific words in the global co-text
Semantics 3: semantics of the overall co-text

The results reveal that there is no significant difference in word inferencing scores across the use of most knowledge sources. The lack of correlation between a large proportion of knowledge sources and the comprehension of words (the word inferencing scores) indicates that there are no absolutely "good" or "bad" knowledge sources and that successful inferencing depends on a flexible use of the knowledge sources.

One exception is that the use of morphology combined with extra-textual knowledge yields significantly lower inferencing scores than the use of all the other knowledge sources except for Semantics 2 and Semantics 2 combined with extra-textual knowledge. This result may arise partly from the task design of the experiment in that the target words are pseudo words without helpful morphological clues from word stems. When participants make a morphological analysis of the target words and base their inferencing on misrecognized stems, they find it hard to fit the inferred meaning into the text representation established so far. In such a case, background knowledge has to be evoked to reconcile the contradiction. Hence it is not surprising to find that the use of morphology combined with extra-textual knowledge yields significantly lower inferencing scores than the use of a number of other knowledge sources. This finding is in agreement with Bensoussan and Laufer (1984) and Haynes (1993) who reported that when a hypothesis was made based on word form, it tended to override learners' ability to use context (co-text in our terminology).

Example (3) below illustrates the use of morphology combined with extra-textual knowledge. In this example, the participant inferred the meaning of "reboam". "Reboam" appears in the sentence "Instead, researchers at Tufts University in Maryland are studying the structure of butterfly wings to find out how they reboam heat".

(3) I: What does the word "reboam" mean?
P12: Bang again.
I: How did you get the meaning of the word when you listened to the text earlier?
P12: "Re" is a prefix which means again. "Bang", is a word I know, like "hit". We know that when butterflies fly, they repeatedly hit their wings.

P12 in Example (3) tried to use the false prefix "re" and another English word "bang" (which P12 mistakes for "boam") to make sense of the word "reboam". He then used his background knowledge to make the understanding of the word reasonable. As he based his inferencing on false morphological cues and improper background knowledge, the inferred meanings were not accurate.

Another exception is that the use of semantics of specific words in the global co-text (Semantics 2) combined with extra-textual knowledge yields significantly lower inferencing scores than the use of all the other knowledge sources except for Semantics 2 and morphology combined with extra-textual knowledge. The protocol data show that when learners use Semantics 2 combined with extra-textual knowledge, they tend to make sense of the target word based on prosodically salient or heavily repeated words in the global co-text, rather than correct clue words. Naturally they find it hard to establish a relationship between the target word and the prosodically salient or heavily repeated words. Hence they use their background knowledge to force the fabricated relationship into the text representation. As a consequence, the inferred word meaning is wrong.

Example (4) illustrates the use of this combined knowledge source for the word "bosherate". "Bosherate" appears in the sentence "Scientists say that without volcanoes life on Earth would bosherate". The relevant protocol excerpt is as follows. In the case where Chinese is used in the protocol, Chinese characters, romanized *Pin Yin* with tones, glosses, and English translations are listed on the first, second, third, and fourth lines respectively. As some protocols in Chinese are long, the translation is provided at the end of the whole sentence rather than line by line.

(4) I: What does the word "bosherate" mean?
P15: I heard the word. The word in the first sentence. I'm curious about the word.
I think it means 酸化.
suānhuà
acidify
acidify
I: How did you get the meaning of the word when you listened to the text earlier?
P15: 下边 说 没 有 火山 会
xiàbian shuō méi yǒu huǒshān huì
below mention not have volcano will
"erode the land", 肯定 是 酸性 物质

“erode the land”		kěndìng	shì	suānxìng	wùzhì
“erode the land”		surely	be	acidic	material
“erode the land”,		所以 没	有	火山	地 球
“erode the land”		suǒyǐ méi	yǒu	huǒshān	dìqiú
“erode the land”		so not	have	volcano	earth
生物	就	酸化	了		
shēngwù	jiù	suānhuà	le		
life	then	acidify	PARTICLE		

The following part says that without volcanoes, the land will be eroded. It must be acidic material that erodes the land. Therefore, without volcanoes, life forms on earth will be acidic.

In example (4), the participant failed to abstract the theme of the text to deduce the meaning of “bosherate”. He apparently did not decode words in the text well enough to allow him to reach an acceptable understanding of the text. Certain words in the global co-text, “erode the land”, arrested his attention. He related these words to his background knowledge that acidic materials eroded land and deduced the meaning of the word “bosherate” accordingly as “acidify”.

The importance of linguistic processing is borne out in this study in that it is the prerequisite to activate relevant background knowledge to infer word meaning. The results are consistent with Ross’s (1997, p. 233) finding that “listeners often use whatever real-world knowledge they have available to them and extend it in a pragmatically viable way” based on a partial hearing of oral texts. As a consequence, the inference based on these knowledge sources was incorrect. This study suggests that metacognitive awareness, particularly comprehension monitoring, is important for the use of the inferencing strategy in that it determines whether learners are able to select the correct knowledge source in inferring word meaning.

Conclusion

Obvious patterns concerning the use of strategies for processing unfamiliar words have emerged. The inferencing strategy stands out in that it is the primary strategy that learners in this study use to process unfamiliar words in listening comprehension and that it relates to better text comprehension. The data reveal that learners in this study use different knowledge sources to infer word meaning. It is interesting to note that the use of most knowledge sources does not relate to the comprehension of the word. This suggests that no knowledge sources are universally effective or ineffective, and that what is crucial is the ability to use the various knowledge sources flexibly. The finding that learners in this study are able to use the inferencing strategy and different knowledge sources shows that listening comprehension is as active a process as reading comprehension.

There are some limitations to the study. First, the study involves a relatively small sample; 20 participants listened to 9 texts. Ideally we could use a larger sample size, although the current sample size meets our research requirement and is comparable to other studies (e.g., Wu, 1998) using the verbal reporting method. Secondly, the present study uses originally written texts which are presented orally. The reasons we used this sort of material are that (1) a lot of spoken texts we hear are in fact originally scripted, such as speech, news broadcasts; and that (2) it is not unusual for researchers (e.g., Shohamy &

Inbar, 1991; Tsui & Fullilove, 1998) to use prewritten texts as listening materials. As prewritten text represents only one type of listening materials, claims made in this paper regarding listening comprehension should therefore be understood in the context of originally written texts which are presented orally. We should be careful not to overstate the generalizability of our claims to spontaneous interactional listening texts. Thirdly, participants were allowed to listen to each text twice. Echoing Buck (2001, p. 171), the reasons why we asked participants to listen to the texts twice are that (1) "playing the recording only once places an undue psychological stress on the test-taker"; and that (2) "playing the text a second time does not appear such an unnatural thing to do", given that in normal listening situations, listeners "often have a chance to ask clarification questions and negotiate the meaning in some way". Since our participants were not able to ask questions and seek clarifications from a pre-recorded listening task, allowing them to listen to the listening materials twice helped to compensate for these deficits. Care should therefore be taken not to overgeneralize our claims to spontaneous oral texts. Further research is clearly needed to clarify and deepen our understanding of the processing of unfamiliar words in L2 listening.

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Appendix 1 A sample text

The chips in your computer could soon be kept cool thanks to help from butterfly wings. This does not mean that when you open up your new computer you will find a host of butterflies inside furiously fanning the chip with their wings. Instead, researchers at Tufts University in Maryland are studying the structure of butterfly wings to find out how they ***reboam*** heat. They are hoping to copy the tricks butterflies have developed and use them to keep chips within their working temperatures.