IN THE LAST DECADE, the relationship between native language acquisition and foreign language learning has been extensively studied in regard to the interaction of English and other various languages in reading processes (e.g., Akamatsu 2003, Geva & Siegel 2000, Gottardo et al. 2006, Van Gelderen et al. 2004, Wade-Woolley 1999).1 Reading in either one’s first language (L1) or second language (L2) is a complicated activity requiring the activation of numerous lower (bottom-up) and higher (top-down) processes at word and text levels (Akamatsu 1998). While reading in a second language, readers not only concentrate on the execution of the cognitive activities of the second language, but also on the L1 knowledge in interaction with the L2. Whether the interaction between L1 and L2 is inhibiting or compensating in the comprehension of L2 is still a controversial issue (e.g., Stevenson, Schoonen & de Gloppen 2003).

Within the context of this controversial issue, two hypothetical domains have been proposed: the Linguistic Threshold Hypothesis and the Linguistic Interdependence Hypothesis. The Linguistic Threshold Hypothesis proposes that a certain threshold level of L2 proficiency is necessary for L1 reading ability to transfer to L2 reading (Alderson 1984; Schoonen, Hulstijn & Bossers 1998). According to Alderson, poor reading in a foreign language is due to a poor reading ability in the first language, leading poor first-language readers to read poorly in the foreign language and good first-language readers to read well in the foreign language. This is supported by the notion that poor reading in a foreign language is due to inadequate knowledge of the target language (Alderson 1984:4).

On the other hand, the Linguistic Interdependence Hypothesis suggests that once the child develops reading skills in L1, he or she is able to transfer those skills to L2 (Cummins 1991). Fikkink, Hulstijn, and Simis (2005) indicate that L2 reading performance is primarily a matter of possessing linguistic and strategic knowledge so that a complex interplay exists between linguistic fluency and strategy use. This has been supported by Walczyk (1995) who showed that a lack of linguistic knowledge or fluency can, to some extent, be compensated for by repair strategies that are part of a reader’s strategic knowledge. The general consensus is that a combination of these two hypotheses may provide the best explanation for the interaction between L1 and L2 reading processes (see Bernhard & Kamil 1995).

Literature about reading strategies, in both an L1 and L2 context, is voluminous (e.g., Sarig 1987, Taillefer & Pugh 1998, Yamashita 2002b). Although these studies provide

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valuable information concerning the proportion of attention devoted to various types of L1 and L2 strategies, several other dimensions have not been so fully addressed. For example, extensive evidence for lower-level components, such as phonological/orthographic processing, have been found in studies investigating subjects from various L1 linguistic backgrounds (see Sparks et al. 2006). A study by Koda (2000) indicated that both L1 and L2 morphological processing experiences promote the development of L2 lexical learning. Wang, Koda and Perfetti (2003) compared word identification between Korean and Chinese EFL learners, with results indicating that Chinese learners relied more on orthographic rather than phonological information. Wang and Geva (2003) suggested that Chinese ESL children relied more on holistic, visual information rather than on a phonological strategy in English spelling.

These findings supported the notion that different information-processing mechanisms may be involved in L2 reading by L1 readers who come from different background orthographies. As Nassaji mentioned, “L1 readers are different from L2 readers not only in terms of their breadth of vocabulary knowledge but also in terms of the totality of lexical representation for each lexical entry in their lexicon” (Nassaji 2006:398). In the reading research literature, a vast majority of the studies examining L1 and L2 reading strategy have focused on languages other than Chinese. Little is known about interaction between English and Mandarin Chinese, which differs from English in various aspects in word formation. For example, Chinese characters contain orthographic, morphological and syllabic information (Leong & Tamaoka 1998). Furthermore, Chinese characters contain both semantic and phonetic radicals. The semantic radicals are associated with the meaning of the character, while the phonetic radicals provide information or cues about the pronunciation of the character (Gottardo et al. 2006).

An investigation of learners’ English reading skills among native Chinese speakers allows us to examine both specific and common aspects of reading performance. Therefore, the main purpose of the present study was to examine strategy use and lower-level processing skills in the L1 and L2 reading comprehension of Chinese-speaking EFL learners. Accordingly, three specific questions were addressed:

1. What relationship exists among various lower-level processing tasks and reading comprehension in L1 and L2 for Chinese-speaking EFL learners?
2. Do Chinese EFL learners show differences in their strategy use in L1 and L2 reading?
3. What are the relative contributions of strategy use and lower-level processing skills to reading comprehension in L1 and L2?

1. METHOD.
1.1. PARTICIPANTS. Subjects were Chinese-speaking EFL learners at a university in Taiwan. Aages ranged from eighteen to twenty-four. They were drawn from various disciplines in their first, second, or third year of an undergraduate program. All subjects had studied English for at least six years in secondary school and had then taken additional English coursework upon entering the university. The test instruments in this study were administered
to a total of 356 students, with the number of cases remitted for analysis 264. Data from incomplete test instruments were omitted.

1.2. MATERIALS. In order to investigate the contribution of L1 reading comprehension and L2 proficiency to L2 reading comprehension, as well as the interaction of L1 and L2 strategy use in L2 reading among different groups of students, a series of tests were constructed based on Yamashita (2002a), Nassaji (2003), and Taillefer and Pugh (1998).

1.2.1. L2 READING COMPREHENSION. The test of L2 reading comprehension consisted of two parts: an English gap-filling test (cloze) and an English multiple-choice test. In the English gap-filling test, words which were judged to require a global-level understanding of a given passage were deleted. The reading passage (189 words) for the test was taken from an English reading textbook at a freshman level. In all, ten words were deleted. An English multiple-choice test (Section 3 of the TOEFL-reading comprehension) formed the latter part of the L2 reading comprehension test. It was comprised of 15 items, based on three reading passages. Cronbach’s alpha for this test was placed at 0.89.

1.2.2. L1 READING COMPREHENSION. The measure of L1 reading comprehension consisted of two parts: a Chinese gap-filling test and a Chinese text comprehension. Two newspaper articles were selected for this test battery. Similar to the English gap-filling test, 25 key words or words relevant to Chinese text comprehension were deleted in the first article. The topic of this article was antiwar ideology in the context of Taiwanese society. The test of L1 text comprehension contained 15 items. A second news article concerned the issue of stem-cell technology. There were 10 multiple-choice questions based on content from the article. This test also reached a high level of reliability (Cronbach’s alpha 0.90).

1.2.3. QUESTIONNAIRE ON L2 READING STRATEGIES. A questionnaire was constructed in English to determine subjects’ knowledge and use of English reading comprehension strategies. Strategies were divided into five categories: textual content (Q1–8), reader response (Q9–10), concrete techniques (Q11–21), task perception (Q22–25) and local problem-solving techniques (Q26–36). The subjects responded in scales ranging from one-to-five (code 1: strongly disagree; 2: disagree; 3: neither disagree nor agree; 4: agree; 5: strongly agree). This instrument was developed from the questionnaires employed previously by Taillefer and Pugh (1998) and Taraban, Rynearson, and Kerr (2000) with some modifications from this author. There were 36 items in this questionnaire.

1.2.4. QUESTIONNAIRE ON L1 READING STRATEGIES. To measure the subjects’ strategies used in L1 reading, the English version of the questionnaire on reading strategies was translated into Chinese. Parallel to the English questionnaire, the questionnaire in Chinese also contained 36 items, classified into five equivalent categories.

1.2.5. L2 LOWER-LEVEL PROCESSING SKILLS. The assessment of L2 lower-level processing skills consisted of three components. An English word recognition contained 20 English
words and 20 nonwords, from orthographically simple words (e.g., dove and *nete) to orthographically more complex words (e.g., accommodation, and *encouragement). Participants were asked to read the word list silently and then decide whether each item in the list was an English word or a nonword. For testing English phonological processing skills, we adopted the task used by Nassaji (2003), in which a list of 20 pairs of pseudowords that either sounded the same or different in English (e.g., waip/wayp and lape/laip) was used. Participants were asked to read and then judge as quickly as possible whether the pronunciation of words in the pairs matched. The measure of orthographic processing was similar to that of Siegel, Share, and Geva (1995). The task contained a list of 20 monosyllabic nonwords (e.g., file/filk, and tolz/tolb). Participants had to decide which of the two pair members looked more like a real English word.

1.2.6.1 Lower-level processing skills. The measure of Chinese lower-level processing skills was constructed to parallel the English test. The Chinese word recognition task contained 20 Chinese compound words and 20 nonwords ranging from orthographically simple words (e.g., 內在 ‘internal’/*新司) to orthographically more complex words (e.g., 膨腫 ‘fat’/*嶙峋). The task of Chinese phonological processing skills included 15 Chinese compound words (e.g., 詮釋 ‘interpret’) and 15 nonwords which have phonological similarity to Chinese real words (e.g., *怠惰). The task of Chinese orthographic processing consisted of 15 Chinese compound words (e.g., 畏懼 ‘fear’) and 15 nonwords which have orthographical similarity with Chinese real words (e.g., *書卓).

1.3. Procedure. Data were collected in English language classes offered to students at different levels in the undergraduate program. The tasks were divided among three sessions, with each session lasting about 50 minutes, and a 1-week interval between sessions. It was judged unlikely that students could improve their English and Chinese ability to the extent of affecting test results during this short testing period. The questionnaire on reading strategy use in each language was administrated directly after the task of reading comprehension in that language. Before the session started, the researcher explained the strategies found in the questionnaire to ensure that participants understood the meanings of those strategies.

1.4. Scoring. Each correct answer scored one point in all of the tests, except in the gap-filling tests. The list of tests with a maximum score is presented in Table 1. Scoring of the gap-filling tests was based upon lists of words considered as semantically acceptable substitutes for the deleted word. These word lists were composed in consultation with a minimum of two native speakers from each language before scoring occurred, and one point was given if the subjects’ response was found on the list. In the five-point scaled questionnaire in each language, subjects’ responses were registered first. The subjects responded in scales ranging from one-to-five. In order to calculate the number of strategies used by each student, only response 4 (agree) and 5 (strongly agree) were counted as positive use of the strategies involved. The number of strategies asked as part of the questionnaire totaled 36.

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2. RESULTS.

2.1. PERFORMANCE IN LOWER-LEVEL PROCESSING TASKS. The relationship among the component variables in lower-level processing in L1 and L2 reading was explored through a statistical measure of correlation. Pearson correlations for the lower-level processing tasks and reading comprehension in Chinese (L1) and English (L2) are presented in Table 2 (overleaf). The results show that L1 reading was significantly correlated with all variables except with L2 orthographic processing \( r = .089 \). The relationship of L2 reading comprehension with other factors was less obvious in that L2 reading was correlated only with L2 word recognition \( r = 0.171 \) and L1 reading comprehension \( r = 0.192 \). L2 word recognition was the only variable which was strongly correlated with all other variables.

In order to analyze whether EFL learners with different L2 reading ability show different performance in lower-level processing tasks, the sample \( (n = 264) \) was divided into two groups considered to contain skilled and less-skilled readers, based on the median split of readers’ raw scores on the L2 reading comprehension \( (\text{Mean} = 9.48, \text{SD} = 4.89) \) found in this study. Those who performed above the median \( (\text{Mdn} = 10) \) were classified as skilled readers with those performing below median classified as less-skilled readers. There were 140 in the skilled group and 124 in the less-skilled group. An ANOVA test was conducted to compare lower-level processing skills in L1 and L2 between skilled and less-skilled learners. The results, shown in Table 3 (overleaf), revealed that skilled learners performed better than less-skilled learners among all variables in L1 and L2. In L1 the strongest variable is considered to be orthographical processing. In L2 word recognition and orthographical processing in turn were seen as strong indicators differentiating skilled from less-skilled readers.

2.2. THE COMPARISON OF STRATEGY USE IN L1 AND L2. In order to demonstrate whether the participants had different performance in L1 and L2 strategy use, a t-test was computed to compare the means and standard deviation of positive strategy use in each category.

<table>
<thead>
<tr>
<th>Test</th>
<th>Tasks</th>
<th>Maximum score</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1 reading comprehension</td>
<td>Gap-filling test</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Multiple-choice questions</td>
<td>10</td>
</tr>
<tr>
<td>L2 reading comprehension</td>
<td>Gap-filling test</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Multiple-choice questions</td>
<td>15</td>
</tr>
<tr>
<td>L1 lower-level processing</td>
<td>Chinese word recognition</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Chinese phonological processing</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Chinese orthographic processing</td>
<td>30</td>
</tr>
<tr>
<td>L2 lower-level processing</td>
<td>English word recognition</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>English phonological processing</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>English orthographic processing</td>
<td>20</td>
</tr>
<tr>
<td>Questionnaire on L1 reading</td>
<td></td>
<td>36</td>
</tr>
<tr>
<td>Questionnaire on L2 reading</td>
<td></td>
<td>36</td>
</tr>
</tbody>
</table>

Table 1. List of tests and maximum scores in each test.
Results are presented in Table 4. Results indicated that Chinese subjects used significantly more strategies in four categories (textual content, reader response, concrete technique and problem solving) in performing Chinese reading than in English reading. On the other hand, participants used the strategy of task perception more in English than in Chinese.

2.3. The relationship between strategy use, lower-level processing skills and reading comprehension in L1 and L2. Table 5 provides correlations among variables considered in the study. An examination of correlation patterns among the variables shows that L1 reading strongly correlated with L2 reading ($r = .192$). Lower-level processing skills in L1 were significantly correlated with L1 reading ($r = .192$), but not with L2 reading. On the other hand, lower-level processing skills in L2 were significantly correlated with L1.

Table 2. Correlations among L1 and L2 lower-level processing tasks and reading comprehension. ** Correlation is significant at the 0.01 level (2-tailed) * Correlation is significant at the 0.05 level (2-tailed).

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. L1 word recognition</td>
<td>1</td>
<td>.563**</td>
<td>.635**</td>
<td>.360**</td>
<td>.076</td>
<td>.132*</td>
<td>.265**</td>
<td>.084</td>
</tr>
<tr>
<td>2. L1 phonological processing</td>
<td>.563**</td>
<td>1</td>
<td>.654**</td>
<td>.393**</td>
<td>.167**</td>
<td>.154**</td>
<td>.201**</td>
<td>.028</td>
</tr>
<tr>
<td>3. L1 orthographic processing</td>
<td>.635**</td>
<td>.654**</td>
<td>1</td>
<td>.394**</td>
<td>.092</td>
<td>.161**</td>
<td>.224**</td>
<td>.091</td>
</tr>
<tr>
<td>4. L2 word recognition</td>
<td>.360**</td>
<td>.393**</td>
<td>.394**</td>
<td>1</td>
<td>.176**</td>
<td>.175**</td>
<td>.267**</td>
<td>.171**</td>
</tr>
<tr>
<td>5. L2 phonological processing</td>
<td>.076</td>
<td>.167**</td>
<td>.092</td>
<td>.176**</td>
<td>1</td>
<td>.225**</td>
<td>.180**</td>
<td>.015</td>
</tr>
<tr>
<td>6. L2 orthographic processing</td>
<td>.132*</td>
<td>.154**</td>
<td>.161**</td>
<td>.175**</td>
<td>.225**</td>
<td>1</td>
<td>.089</td>
<td>.067</td>
</tr>
<tr>
<td>7. L1 reading comprehension</td>
<td>.265**</td>
<td>.201**</td>
<td>.224**</td>
<td>.267**</td>
<td>.180**</td>
<td>.089</td>
<td>1</td>
<td>.192**</td>
</tr>
<tr>
<td>8. L2 reading comprehension</td>
<td>.084</td>
<td>.028</td>
<td>.091</td>
<td>.171**</td>
<td>.015</td>
<td>.067</td>
<td>.192**</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 3. Comparison of lower-level processing skills in L1 and L2 (ANOVA) between skilled and less-skilled EFL learners. * $p < .05$, ** $p < .01$, *** $p < .001$. 

Skilled vs. less-skilled learners

<table>
<thead>
<tr>
<th></th>
<th>L1</th>
<th>L2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Scheffe’s F</td>
<td>Sig.</td>
</tr>
<tr>
<td>Word recognition</td>
<td>5.968</td>
<td>.015*</td>
</tr>
<tr>
<td>Phonological processing</td>
<td>7.498</td>
<td>.007**</td>
</tr>
<tr>
<td>Orthographical processing</td>
<td>20.760</td>
<td>.000***</td>
</tr>
</tbody>
</table>
strategy use, both in L1 and L2, did not show a significant correlation with L1 reading. Lower-level processing and strategy use in L2 were correlated with L2 reading (r = .107, respectively), but neither lower-level processing nor strategy use in L1 showed a significant correlation with L2 reading.

3. General discussion. As shown in Table 2, we can say that English word recognition is the most salient variable in Chinese and English reading to be found among all components, since it is the only variable which significantly correlated with all other variables. Comparison between skilled and less-skilled revealed that skilled readers performed better than less-skilled readers among all variables of the lower-level processing tasks. In Chinese, orthographic processing skills showed a higher contribution to the discrimination of skilled from less-skilled readers. On the other hand, in English, both word recognition and orthographical processing seemed to be stronger indicators than phonological processing.

Results demonstrated that participants exhibited more strategy use in the four categories in Chinese reading than in English reading. The only category in which participants used more strategies in English than in Chinese was in task perception. The sampling showed similarity and differences in strategy use between Chinese and English. Both in Chinese and English, the most frequently used strategies were concrete techniques (e.g., concrete technique).
making inferences, making emotional connection, visualizing, skimming, pushing ahead when encountering a comprehension difficulty, or underlining). However, when we examine strategy use qualitatively, there is a slight difference in the order following the category of concrete techniques. For example, in English the next most frequently used strategies were textual content strategies (e.g., linking information, anticipating, focusing on main ideas, or identifying the organization). This was followed by local problem-solving strategies (e.g., guessing word meaning, comparing the word with L1 or L2, looking for clues, analyzing affixes, analyzing grammar, or translating into L1), task perception (e.g., perception of the importance of the pronunciation or the meaning of each word, or feeling like an efficient reader) and reader response (e.g., learning something new, or response to the text).

In Chinese, the second most frequently used strategies were local problem-solving strategies, followed by textual content, reader response and task perception.

Lower-level processing skills and strategy use were significantly correlated in each language. Chinese lower-level processing skills were correlated with English lower-level processing skills and Chinese strategy use was correlated with English strategy use. As displayed in Table 5, the correlation between lexical processing skills in Chinese and English with Chinese reading comprehension was higher than strategy use in both languages. It indicates that the participants were more engaged in lexical processing than in using strategies when they were reading the texts in this study. Therefore, the influence of Chinese and English lower-lexical interaction in Chinese reading may be more than would be expected. In English reading comprehension, the contribution of English lower-level processing skills and strategy use to English reading was higher than that of Chinese counterparts. Chinese lower-level processing skills and strategy use showed no correlation with English reading. It is interesting that English lower-level processing skills showed a significant correlation with Chinese reading, while no relationship was found between Chinese lower-level processing skills and English reading. Nevertheless, a significant correlation between Chinese and English reading comprehension indicates the relationship between L1 reading and L2 reading should still not be ignored.

4. Implications and conclusion. Based on the findings of the present study, several implications can be drawn for foreign language (FL) reading instruction. First, the present findings suggest that lower-level processing skills have a stronger correlation with both L1 and L2 reading comprehension than with strategy use. This reinforces the findings in other studies to the effect that lower-level word recognition processes play a crucial role, in addition to higher-level processes, even in advanced readers (e.g., Bell & Perfetti 1994, Nassaji 2003). It is also worth noting that the influence of lower-level processes (especially word recognition and phonological processing) from L2 to L1 was stronger than from L1 to L2. One possible explanation may be that reading in English relies heavily on phonological processing, especially at the grapheme-phoneme-correspondence level. By comparison, reading in Chinese requires considerably more effort and complicated visual-orthographic analysis (Wang, Koda & Perfetti 2003:143). Therefore it may be easier to transfer letter-sound mapping skills in English reading to Chinese reading.
Second, the comparison between skilled and less-skilled readers indicates that skilled readers relied more on orthographic information than on phonological information in both L1 and L2 reading. This finding is similar to the study by Wang, Koda, and Perfetti (2003) in which Chinese ESL learners relied less on phonological information and more on orthographic information to identify English words than their Korean counterparts did (p. 129) and it further supports the notion that “different orthographic systems have an impact on cognitive processes in literacy acquisition” (p. 145). These findings may be explained by recent research on Chinese-English bilingual adults (e.g., Liu & Perfetti 2003, Tan et al. 2001) showing that reading Chinese actually activated some brain areas in charge of coordinating and integrating visual-spatial analyses of logographic Chinese characters when compared with reading English. Hence, it is beneficial to provide script information in order to facilitate reading in Chinese and English.

Furthermore, it is appropriate to point out that this study is mainly concerned with correlational analysis and therefore gives no evidence of causality. For example, that the results yielded no correlation between strategy use and reading comprehension does not mean that instruction integrating strategy use will not contribute to L2 reading comprehension. Although some researchers believe that students should possess a fluent access to words before they can successfully apply reading strategies in the classroom (Huckin & Coady 1999), numerous studies have since determined that reading comprehension strategies can in fact be taught to students, in order to improve student performance on comprehension and on recall tests (Carrell, Pharis, & Liberto 1989; Oxford & Cohen 1992). In the present study, participants showed similarities and contrasts in strategy use. Both in Chinese and English, the most frequently used strategies were comprised of concrete techniques. To facilitate reading in Chinese and English it is therefore recommended to integrate instruction with strategies such as making inferences, making emotional connection, visualizing, skimming or underlining. To improve English reading, instructors may provide training with textual content strategies, such as linking information, anticipating, focusing on main ideas, or identifying the organization. On the other hand, problem-solving strategies would be helpful to enhance Chinese reading, such as guessing word meaning, comparison with Chinese and English, looking for clues, analyzing affixes, analyzing grammar or translating into Chinese.

In conclusion, the present study showed various degrees of relationship between component variables of reading processes in Chinese and English. Lower-level processing skills demonstrated a stronger correlation with reading comprehension compared to strategy use. Orthographic processing demonstrated a higher contribution to the discrimination between skilled and less-skilled readers both in Chinese and English. Moreover, in English, skilled readers also used more word recognition skills than less-skilled readers. Finally, similarities and differences of strategy use in Chinese and English provided possible pedagogical implications which may be used to enhance reading comprehension in Chinese and English.
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