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ABSTRACT

A study conducted three experiments focusing on understanding the information processes children use in learning to read Chinese, evaluating the learning differences between skilled and unskilled readers. To understand the strategies of character identification children use, participants in experiment 1, 10 Taiwanese elementary students (five skilled and five unskilled readers), were asked to read a story that they had not yet read. The experiment collected data using the verbal protocol of "thinking aloud." With the same participants, experiment 2 inspected the function of the "pin-yin" system for Chinese children's skill in reading characters and the mediation of the phonological principle of Chinese characters without pin-yin clues. Experiment 3 investigated whether or not the children can distinguish the semantic and phonetic cues of 30 characters and understand the function of cues in Chinese characters. This task asked participants, 40 Taiwanese students (divided into skilled and unskilled readers) in the same fifth grade (including the 10 students from experiment 1), to discern the elements of Chinese characters, according to the structure of Chinese characters. Results of these studies indicated that skilled readers used different strategies in identifying the unknown characters, relying on phonetic cues more than unskilled readers; unskilled readers used graphic similarity more often than phonetic cues during character recognition. In addition, unskilled readers paid more attention to sentence context. A significant difference between skilled and unskilled readers was their capability to coordinate the cues of characters. Based on the study's hypothesis and results, these experiments suggest that the two groups used different strategies in coordinating cues, and that skilled readers were more prone to adopt phonological principles in character identification; skilled readers might have better phonological knowledge than unskilled readers. (Contains four tables of data and 24 references. Appendixes reproduce material in the experiments in Chinese.) (NKA)

Skilled and Unskilled Reading Among Taiwanese Fifth-graders:
A cross-cultural perspective

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Skilled and Unskilled Reading Among Taiwanese Fifth-graders: A cross-cultural perspective

Chinese is defined as a logographic or orthographic system that uses graphic symbols to represent morphemes, the meaning unit in language (Hoosin, 1991; Chung, Cheng and Leong, 1988). Most characters in Chinese directly correspond to the meaning of a character. The logographic system differs from the alphabetic system which requires the identification of sound symbols and a syllable before the whole word can be understood. Rather, the principle of identifying a character in Chinese is to initially extract the meaning of each character before the whole term can be comprehended. Beginning readers in the alphabetic writing system have to master the phoneme-letter-sound rules first. On the contrary, the Chinese characters map onto speech at the level of words rather than of phonemes. Hence, the initial perception of Chinese characters and of English words entail different processes.

The Relationship of Grapheme, Phoneme, and Semantics

Research showed that the three features of grapheme, phoneme, and semantics were sufficient for participants to identify the lexical status of Chinese characters. Peng, Guo, and Zhang (1985) suggested that graphemic information of Chinese characters was the most efficient indicator in the judgment task for both the young child and adult. The young child could perform more accurately and faster if the graphemic information was not separated from the phonemic tendency, but there was no such effect in the adult group. On the contrary, the graphemic clues were available for adults in the semantic similarity judgment task, but not for young children. They found that phonemic information has no significant impact on semantic similarity judgment for any group. A

study by Chen, Yung, and Ng (1988) found that graphemic and semantic cues were quickly identified and important in the lexical decision task. Because a Chinese character corresponds to a morpheme in meaning, the graphemic and semantic information was an activity of integration. The phonemic cue in determing the lexical task was much slower than graphemic and semantic cues. In contrast to English words, the processing of graphemic and phonemic information was faster than that of semantic information. This study by Chen et al. also used the semantic and phonemic cues to determine whether or not the cues had an effect on the judgment of a character's legitimacy. The result showed that the two cues equally facilitated the legal character's discernment. In view of the relationship of grapheme and semantics, a study by d'Arcais (1992) stated that the form and the meaning of a radical influenced the recognition of Chinese characters in terms of the facilitatory effect and the inhibitory effect. The facilitatory effect depends on the radical which is part of the complex character and which is the congruent meaning of the whole character. For example, 木 can mean "tree". The complex character 松 (pine) and 楓 (maple) have the same radical "木". Both of them represent a kind of tree. If participants did not know the two complex characters, they might conjecture their meaning by referring to the form and the meaning of 木 (tree). Whereas the pre-exposure for the radical was too short, a congruent meaning was not significantly different from an incongruent meaning. On the other hand, when the pre-exposed radical was inconsistent in meaning with the identified character, there was an inhibitory effect of activation of the semantic information.

Because of the lack of symbol-to-sound correspondence, visual coding is important in identifying Chinese characters. In other words, visual discrimination corresponds to the recognition of Chinese characters.

The Perception of Chinese Characters

A second recognition of Chinese characters showed "word superiority effect" as well as "word inferiority effect". In other words, when word association interacts with the letters or its context, the detection leads to the word superiority effect or the word inferiority effect. As Healy and Drewnowski reported in 1983, word superior identification came from the situation in which just one word or letter string was exposed at a time. C. M. Cheng (1981) stated that the word superiority effect came out of character perception in Chinese. He found that a character in a two-character word was easier to identify than in a two-character nonword (See Appendix A.1). Subsequent studies stressed that it was not appropriate to use a forced-choice procedure in detecting the word superiority effect in Chinese characters, because this paradigm was far from the real reading situation. In 1986, H. C. Chen applied the unitization model to test the word effect in Chinese by decoding the component of a character as radical. The study found that participants showed inferior radical detection when characters were embedded in a large section, such as ten characters or a passage. The explanation was that when a reader quickly identified a given character he would then immediately proceed to the next character no matter what the component of the target word was. This identification showed that the components of a target character and the character were processed in parallel. Moreover, if a target character stood alone from other words around it, participants would split the character into its components after the character was identified. For radicals, the word superiority effect appeared in the single-character display and the word inferiority effect easily occurred in continuous character displays.

Hue (1989) used naming tasks to examine the word superiority and word inferiority effect in Chinese two-character words. The results showed that the naming latency of high-frequency

words was shorter than for low-frequency words. The naming latency of low-frequency words was faster than nonwords. In addition, the naming latency of four-character words was longer than that of two-character words. The experiment also proved that a character embedded in a word context could be better identified, and a character embedded in a passage had an inferior effect because readers would not focus on the word information. Some reports hypothesized that reading Chinese characters might pass over the phonological coding. For example, Rozin, Poritsky, and Sotsky (1971) tested a group of second-grade students who had serious reading problems, but were able to rapidly learn and read Chinese sentences. Consequently, Rozin et al. concluded that a logographic language did not contain information about pronunciation. The recognition was not associated with speech coding. However, many of the studies showed that phonological representation was a part of identification (Cheng 1992; d'Arcais 1992; Hue 1992; Perfetti and Zhang 1991; Cheng and Shih 1988; Tzeng and Huang 1980; and Tzeng, Huang and Wang 1977). Tzeng and Huang in 1980 argued that the study by Rozin et al. was an overstatement.

Phonological Mediation in Chinese Characters

Perfetti and Zhang (1991) stated that identification of characters in Chinese was a post-lexical process. In other words, the naming task would occur only if the prime character has actually been identified (Perfetti and Zhang 1991, p638). This result assumed that the phonological access was naturally and automatically recognized after a printed character was accessed. This was different from the pre-lexical phenomenon in the alphabetical system (Perfetti, Bell and Delaney 1988).

d'Arcais (1992) said that the graphemic component in a complex character was available from the onset of the recognition access. The phonological and semantic components subsequently were interrelated in identification. The phonological information was activated earlier than the

semantic information, at least in naming tasks.

In 1985, Seidenberg observed latencies for naming Chinese and English words using high or low frequency of characters or words. The Chinese characters were adopted in different types in terms of phonogram and nonphonogram. The phonograms contain the phonetic information as phonetic-logographic compounds in contrast to nonphonograms. The phonological mediation associated with the naming latency was found only in the processing of low frequency characters or words, both in Chinese and English. For Chinese, low-frequency phonograms were named faster than low-frequency nonphonograms. The difference between the two writing systems was that readers used lexical information for low frequency Chinese characters, such as 挺 (character) related to 廷 (phonetic compound), and readers in English used grapheme-phoneme rules to act on the pronunciation of unfamiliar words.

A study by Hue (1992) used regular, irregular and unique characters with high or low frequency to test the naming latencies (See Appendix A.2). The regular characters are similar to phonograms and their pronunciation is consistent with their stems as phonetic compounds. The irregular characters seem to contain a stem, but they are not consistently pronounced as the stems. The unique characters are the same as nonphonograms. The experiment found that the type of character produced a significant difference in low-frequency characters, but not in high-frequency characters. For low-frequency characters, the regular characters were named faster than unique characters. Participants made more errors in naming the irregular characters. This study showed that phonetic compounds influenced character naming.

In the view of the available studies above, reading Chinese characters uses the phonological process despite the absence of a spelling-to-sound rule.

According to the traditional instruction at primary schools in Taiwan, Chinese students always rely on the "Pin-Yin" system to learn the pronunciation of characters. However, individuals had different responses to learning and that was the question addressed in this study: why common instruction results in different achievement among children. This study focused on understanding the information processes children use in learning to read the Chinese language. The purpose of this study was to evaluate the learning differences between skilled readers and unskilled readers. It also examined whether or not skilled readers use different strategies from unskilled readers in character identification. This study hypothesized that skilled readers can figure out an unknown character by means of the context clues. The context clues include the meaning in the text, Pin-Yin cues, and the components of an unknown character, such as semantic and phonetic radical/ stem cues. A skilled reader can coordinate all cues to identify an unknown character. Conversely, an unskilled reader just coordinates a few cues, or even none, to identify an unknown character.

Two main questions were asked in this study: (1) which cues do the children choose most frequently in reading Chinese characters? (2) are different strategies associated with higher or lower achievements? Three experiments were conducted in this study. The study was expected to provide a better method to facilitate the learning of Chinese characters.

Experiment 1

In order to understand the strategies of character identification children use, participants in Experiment 1 were asked to read a story that they had not yet read. One student at a time read in this experiment. When each participant read a story aloud, he or she would encounter some unknown characters which were difficult to identify in meaning and pronunciation. This

experiment collected data using the verbal protocol theory in terms of "thinking aloud". That is, in addition to reading the story aloud, participants had to think aloud and to report what they thought when they met the unknown character.

Method

Participants. The participants in this study were ten Taiwanese elementary school students, eleven years of age. The ten participants were initially divided into two groups: five skilled readers and five unskilled readers. These were selected by the teacher who was familiar with each student's reading ability and achievements.

Materials. The verbal material used in the study was a story, "Single Wild Geese", from volume one of a Chinese textbook (See Appendix B). This is a textbook issued to middle schools in Taiwan. In order to make this experiment more challenging for the participants, the content of this story was edited by the author of this study. Some low frequency characters were inserted into some sentences. This story consists of 496 characters. It was estimated that there were at least 16 unknown characters of low frequency for skilled readers.

Procedure. For this experiment , three questions were administered to each participant. First, the child was asked to read one story aloud: "Could you read it aloud for me, please?". When he or she stopped reading and gazed at a character, the second question was administered to him or her: "Could you show me how you read the character?". When a period of time passed and the child could not self-report, the author reminded him or her to think about the unknown character. Three additional sub-questions were then administered to the child. First, "Do you know what the right (or upper) side of the unknown character means?". Second, "What does the left (or lower) side mean?". Third, "How do you determine the sound of the unknown character?". After the

child finished reading a sentence containing the unknown character, the author asked him or her to go back to those initially unknown characters and to think his or her strategy aloud again. The third question was then administered to the child. "Can you explain to me how you figured out the character?". The participants were expected to self-report when they answered all the questions. The reading process, the questions asked, and the answers were recorded on tape.

During the recording, the participants were asked to elaborate on their answers. For example, when the author asked that "Could you show me how you read the character?", the participant might answer: "I just guess." Then, he or she was asked: "How do you guess its sound?" or "Could you teach me how to guess the sound when you meet the unknown character?". These participants were encouraged to think aloud while they answered all the questions. The verbal reports of reading a story were not timed.

Result

The results of verbal reports were encoded into different categories as shown in Table 1. The first category was "using phonetic cues" which meant that the participants identified the components of an unknown character and read the sound of the phonetic cue aloud. In the second category, the participants focused on the parts of an unknown character by its orthographic cues instead of phonetic cues, because this part of the unknown character was similar to another character. The participants recognized that the sound of the unknown character was consistent with the sound of a similar orthographic script. This situation was coded as the strategy of "using graphic similarity". In the third category, the participants did not pay attention to the phonetic or orthographic cues; they seemed to figure out the meaning of the unknown character from the context of the sentences. Subsequently, they remembered a familiar character whose meaning was

similar to the unknown character and gave this character the same pronunciation as that of the familiar character. This category was labeled as "using sentence context". The forth category was "wrongly pronounced". The participants would pay attention to the phonetic, orthographic, and semantic cues of an unknown character, but they made wrong inferences about the sound of the unknown character which were not related to the clues from the unknown character. The participants, finally, pronounced the unknown character erroneously. In the fifth category, some characters were pronounced with correct spelling, but the sounds of the unknown characters were pronounced with the "wrong tone".

In this experiment, the total number of the errors of pronunciation during the reading of a story was calculated and put into different categories. The categories represented the strategies children used to identify the unknown or unfamiliar characters. Each category showed the average rate of how often children used each category to pronounce the unknown or unfamiliar characters. The number of errors in each category relied on the participants' verbal reports and the results of the self-reports. Table 1 showed the results of verbal reports of reading a story by five skilled readers in comparison to the results of five unskilled readers.

First, there were obvious differences in the total number of errors between skilled and unskilled readers. The mean percentage (x=38%) in using phonetic cues to identify the sounds of the unknown characters was much higher in skilled readers than the mean percentage (x=18%) of unskilled readers. Second, the mean percentage (x=25%) of using graphic similar cues to identify the sounds of the unknown characters by unskilled readers was lower than that (x=28%) by skilled readers, but the two means were quite close to each other. Third, it was rather significant that unskilled readers used context sentences to identify the sounds of the unknown characters (x=24%) more often than skilled readers (x=15%). This finding showed that unskilled readers pay more

attention to the context of the sentences in the story. Fourth, these unskilled readers more often generated a wrong pronunciation (x=11%) than did skilled readers (x=4%). This means that students did not coordinate the phonetic cues, graphic cues and context clues to infer the sound of the unknown character. Fifth, skilled readers had a higher percentage (x =15%) of pronouncing the character with the wrong tone than did unskilled readers (x=6%). They seemed to pronounce the wrong tone regardless of which strategies they used in character identification. The reason might be that skilled readers were reading the story aloud and were careless on the character tones. In addition, only the unskilled readers had a mean percentage (x=17%) in non-pronunciation; this means that they did not pronounce some unknown characters.

In addition to verbal protocol reports, this study conducted Experiment 2 in terms of "Chinese Reading Diagnosis" to examine the function of phonetic cues in a Chinese character while reading the characters.

Experiment 2

In Taiwan, when first graders in primary schools start to learn how to pronounce a character, these children always follow a pin-yin system to read the characters. Children have to be familiar with the skill of pin-yin, and then they can read any characters with pin-yin symbols. The purpose of this experiment was to inspect the function of the pin-yin system for Chinese children's skill in reading characters and the mediation of the phonological principle of Chinese characters without pin-yin clues. Three questions were investigated in this experiment. First, do children make significantly different representations of characters with pin-yin clues as opposed to characters without pin-yin clues? Second, when characters were not composed with pin-yin symbols, could

children still identify the sound of the unknown characters, or not? Do the children have the concept of phonetic cues? Can they use the phonetic cue of a character to acquire information about the character's sound? Third, this experiment tried to discover how children approach the sound of the unknown characters without pin-yin symbols. That is, what strategies do children use to recognize the pronunciation of an unknown character?

Two lists, a non-pinyin list and a pinyin list, were conducted in this experiment in order to examine the three questions.

Method

Participants. The participants in this task were the same as in Experiment 1.

Materials. There were two phonology lists in this experiment: one to be a Non Pin-Yin List (NPL) without pin-yin clues; the other to be a Pin-Yin List (PL) with pin-yin clues. Thirty characters with word frequency were placed in each of two phonological lists. The characters of each lists were divided into two parts: (1) fifteen characters were phonetic compounds composed of one phonetic radical and one semantic radical; and (2) the other fifteen characters were logographic characters composed of two or more semantic radicals. They were randomly arranged in the two lists. Both of the lists included six high frequency characters, eight medium frequency characters and sixteen low frequency characters which were taken from "A Study of Writing Vocabularies in Elementary School Children" (Chang &Chiu 1972) and a Chinese dictionary.

Procedure. First, the NPL was administered to ten students. All students had to fill in pin-yin symbols beside the thirty characters. (See Appendix C) The task asked that the students did not to leave blanks by any character. They were encouraged to infer the sounds of the unknown characters by way of reading the stems of the characters. After they finished writing the NPL, the

PL was administered to each participant (See Appendix D). The child read each character aloud one by one to the author. The author, then , recorded the results of reading the pin-yin list.

Result

The analysis of this experiment was done from the results of this experiment by each of the ten participants. The analysis for NPL was based on the categories of the coding as shown in Table 2 and the results of these categories were discussed by mean percentage of errors. The result of reading PL was discussed by means compared to NPL's means.

The coding of NPL by skilled and unskilled readers was categorized into six items. First, the participants recognized the phonetic cue of an unknown character, and then identified the sound of the unknown character in accordance with the sound of the phonetic cue. This strategy was labeled as "phonetic cue". The second strategy was known as "graphic cue" which meant that the participants identified the sound of an unknown character by means of orthographic similarity. In other words, the orthographic cue of the unknown character was quite similar to the graphic cue of the other known character. The participants, thus, wrote the unknown character's pin-yin symbols the same as the known character. The third category was "coordination". The participants had looked at the components of the unknown character, but did not associate the cues of the unknown character with the pronunciation of the unknown character, or they misidentified the cues of the unknown character so that they linked the unknown character to the other orthographic script. Fourth, the "none" category mean that the participants did not show any skill related to the unknown character identification. The pin-yin symbol they wrote to the unknown character did not present any information from the context of the unknown character. Fifth, the unknown character should be pronounced with a vowel, but subjects might use the related consonant instead of the vowel

during identification. This was labeled as "spelling errors". The sixth category meant that the participants got the correct idea about the sound of the unknown character, but put the wrong tone into the character.

The percentage of error-type made by the ten subjects was given in Table 2-1.

The mean percentage of the errors on NPL were in using phonetic cues to identify the sound of an unknown character and was higher (x=34%) for skilled readers, compared to the mean percentage (x=22%) for unskilled readers. That is, skilled readers used the strategy of phonetic cues of the character more often than the unskilled readers. This was consistent with the results of Experiment 1. The mean percentage of the errors on NPL in using graphic cues was higher (x=35%) for unskilled readers, compared to the mean percentage (x=30%) for skilled readers. This result showed that unskilled readers used graphic cues to identify the sound of an unknown character more than skilled readers did. The percentage of errors of coordination made by skilled readers was 15% and was 17% by unskilled readers. There was no evidence that skilled readers coordinated the cues of phonetic cues or graphic cues of an unknown character better than unskilled readers. In addition, unskilled readers made a much higher percentage (x=23%) in "None" than skilled readers with x=9% of errors. Both groups made almost the same percentage on spelling errors (3% and 4%, respectively); that is, the participants got the right idea in the sound of an unknown character, but wrote down inappropriate pin-yin symbols. Skilled readers still showed a higher error-rate (9%) in using the wrong tone to pronounce a character's sound than did unskilled readers (0.8 %). This was similar to the result of reading a story aloud in Experiment 1.

For all ten participants in Experiment 1, reading the thirty characters in the Pin-Yin List was much easier than Non Pin-Yin List. The mean of right answers for the skilled group was 29.4 and 26.2 for the unskilled group (See Table 2-2).

In order to examine whether participants can correctly identify the specified cues in a character, Experiment 3 was conducted in this study.

Experiment 3

Experiment 2 had asked children to pay attention to the parts of the thirty characters. However, it did not account for the fact that children know the cues and can coordinate them during character recognition. This study was also concerned with whether or not children can interrelate the graphic information with phonetic and semantic information of a character in identifying Chinese characters. The purpose of Experiment 3 was to investigate whether or not the children can exactly distinguish the semantic and phonetic cues of the thirty characters and understand the function of cues in Chinese characters. For example, do the participants really recognize the parts of Chinese characters? Can the children coordinate the cues of the characters for character identification? Which cues do the children identify consciously in the character during the recognizing process? This experiment was part of "Chinese Reading Diagnosis". This task asked the participants to discern the elements of Chinese characters, according to the structure of Chinese characters. A component list served this purpose in this experiment.

Method

Participants. Participants in Experiment 3 were 40 Taiwanese elementary school students in the fifth grade, eleven years of age. The children were all enrolled in the same class, and included the 10 students from Experiment 1. In order to evaluate the coordinating ability and knowledge of cues, the 40 students were also divided into two groups: one of 20 skilled readers; the other of 20

unskilled readers. The division of the students depended on the number of total right answers from thirty characters in the component list. The 10 participants in Experiment 1 and 2 automatically went into their original groups. The remaining 30 students were divided by the median number of total right answers in the component list. The median number was six. Thus, the students with right answers above six were assigned as skilled readers. If the right answers made by the students were below or equal to six, the students were assigned as unskilled readers.

Materials. The component list consisted of thirty characters, the same as the phonological lists, and was designed as multiple-choice questions. Two variables, the semantic and phonetic radicals, were presented in the list. Each character was split into three parts which were extracted from the strokes/radical of a character and were assigned to each variable. A space item next to the radical variable served as a "none" choice. When participants were unable to identify the cues of characters, or did not agree with the radical items, they had to mark this space. (See Appendix E)

Procedure. The component list was administered to the forty participants. This list included a sheet which explained the operation of this task and a sample of how to do it. Before doing the task, the author would clearly explain the operation of this experiment, and every professional term in the list, such as semantic radical and phonetic radical, to the subjects. The subjects also were informed that they could pick more than one answer to one specific item if they agreed with the answers.

Result

The results of Experiment 3 were conducted with the one-way analysis of variance.

First, the right answer, which means that the participants chose correct answers both in semantic and phonetic radicals of a character, was calculated for each of the subjects. The right answer

indicated that the children had actual knowledge of a specific character. The means of right answers for skilled and unskilled groups were 8.6 and 3.75, respectively. Skilled readers had significantly different means from unskilled readers. That is, skilled readers showed a higher score for accurately differentiating the phonetic and semantic cues from orthographic information of the characters than did unskilled readers. Because of $F(1,38)=20.38$, $p < .05$, the null hypothesis was rejected. This explained that skilled readers could coordinate the elements of a character, either a semantic radical or a phonetic radical, better than unskilled readers. Second, the errors involving semantic or phonetic radicals were compared (See Table 3). For the semantic radical, the $F(1, 38)= 6.62$, $p < .05$ and the means for the two groups were 18.4 and 21.35, respectively. There were significant differences between skilled and unskilled readers. For phonetic radicals, the skilled group had a mean of 8.6 as opposed to the unskilled group which had a mean of 19.05, with $F(1,38)=31.44$, $p<.05$. One-way analysis of variance showed that there were significant differences between the two groups. Skilled readers showed a much lower error-rate in identifying phonetic radicals than did unskilled readers and had fairly good concepts of phonetic cues compared to unskilled readers.

As shown in Table 4.1, the errors in identification of the phonetic compounds in semantic radicals did not exhibit significant differences between both groups $x=8.55$ for skilled readers and $x=10.6$ for unskilled readers.

The same result was also found for logographic compounds, ($x=9.85$ and $x=10.75$, respectively). The results were not statistically significant $F(1,38) = 3.18$ and 0.26, $p>.05$. (See Table 4.2) Skilled readers were indeed not superior in these concepts of semantic cues in a compound character; however, there were significant differences in processing the phonetic radical. In Table 4-2, skilled readers made lower error rates, with both phonetic compounds ($x=4.0$) and logographic

compounds (x=4.60) than did unskilled readers (x=9.10 and x=9.95, respectively). The difference was found to be statistically significant --F(1,38)=21.88 and 18.7, which were greater than Fcv=4.10. This finding further suggested that skilled readers had a much better knowledge of phonetic cues during Chinese character identification than had unskilled readers.

Discussion

First, this study has found that skilled readers used different strategies in identifying the unknown characters. Skilled readers relied on phonetic cues more than unskilled readers. Unskilled readers used graphic similarity more often than phonetic cues during character recognition, even though skilled readers also paid attention to graphic cues. In addition, unskilled readers paid more attention to sentence context. It is interesting that this result was consistent with that of poor readers in English who also used sentence context for word identification. West and Stanovich (1978) found that a contextual facilitation effect contributed to poor readers' slower word identification. In terms of an interactive-compensatory model, Stanovich (1980) assumed that if a poor reader was deficit in a word's lexical knowledge, he or she would rely heavily on other knowledge sources, like contextual factors, in order to identify the unknown word in sentences. This compensatory effect also appeared in Chinese character identification by the unskilled readers of this study.

Second, one of the significant differences between skilled and unskilled readers was their capability to coordinate the cues of characters. Based on this study's hypothesis and results, these experiments have suggested that the two groups used different strategies in coordinating cues. Skilled readers in Experiment 1 had a higher percentage mean (81%) in using phonetic information,

graphic information and sentence context during character identification than had the unskilled readers (x=67%). In addition, unskilled readers had a higher error-rate (11%) in wrongly pronouncing the unknown characters than skilled readers (4%). This means that unskilled readers could not well interrelate the cues from characters and the meaning from context so that they made wrong inferences for the sounds of the unknown characters. In contrast, skilled readers were more able to employ the linguistic information of a low frequency character and linkage to the meaning of the context in order to decode the pronunciation of the unknown characters. Skilled readers obviously represented better coordination in character identification than unskilled readers. However, the error rate of coordination in Experiment 2 showed just a small difference between the two groups.

The third significant result was the phonetic knowledge of children. The experiment has shown that skilled readers were more prone to adopt phonological principles in character identification. Skilled readers might have better phonological knowledge than unskilled readers. In addition, Experiment 3 has found that the error rate of identifying phonetic radicals for skilled readers was much lower than for unskilled readers. Regardless of the difference of error rate between skilled and unskilled readers, the experiments showed that knowledge of phonological information in children was significantly different from the knowledge of semantic information. Phonological information became an important and necessary facilitator in character identification for children. In Experiment 3, two kinds of characters, phonograms (phonetic compounds) and nonphonograms (logographic compounds), were used to determine whether children's phonological concept is influenced by different character types. The results showed that the participants were likely to process phonological information regardless of phonogram or nonphonograms. This is consistent with the findings of Tan, Hoosain, and Peng (1995).

In comparison with an alphabetic system like English, phonological recording is the key process which assembles and converts a string of letters into pronunciation by means of letter-to-sound correspondence (Ehri, 1994). Like the English language, phonological mediation is part of Chinese character identification. Moreover, it is a post-lexical process, the opposite to the pre-lexical process in English (Perfetti, Zhang, and Berent,1992; Perfetti, et al. 1991, 1988). Therefore, after an orthographic processor was associated, the phonological processor would automatically be activated. With regard to the results of verbal reports and the Chinese Reading Diagnosis, this study has implied that phonological knowledge has an significant effect on reading fluency.

The results of Experiment 3 could be seen as supporting evidence in the skill of coordination for different readers. The purpose of this experiment was to see whether readers could exactly differentiate the cues of the characters and actually coordinate them. The experiment showed that there were statistically significant differences between skilled and unskilled readers. Skilled readers had a higher mean of right answers than unskilled readers. This means that skilled readers could coordinate the semantic and phonetic radicals of a character better than did unskilled readers. This also means that skilled readers had better cue knowledge, both in semantic and phonetic radicals, than unskilled readers. In addition to the experimental tasks, the author interviewed the 10 participants in Experiment 1 after reading a story aloud. One difference between skilled readers and unskilled readers was that each of the skilled readers read story books as well as their textbooks. They read at least one to two hours everyday. On the contrary, most of the unskilled readers were less interested in reading storybooks and rarely spent their time in reading.

In summary, this study can be reduced to three points for educational application. First, teachers can increase children's cue knowledge of Chinese characters and teach them how to

coordinate the cues while identifying an unknown character. The three experiments have suggested that skilled readers had better concepts of cues. Thus, teachers may guide their students to pay attention to the components of Chinese characters in terms of lexical context while learning new characters. This strengthens students' understanding of characters' mechanisms. This amplification for cue knowledge may gradually increase the students' ability of metacognition for character identification.

Second, instructors teach children to use effective strategies in identifying unknown or unfamiliar characters. The results of this study suggested that the different strategies children used produced different achievements in reading performance. Teachers should provide appropriate and useful methods to their students to promote children's ability to identify Chinese characters. This is especially important for low achieving students.

Third, teachers should encourage their students to read storybooks as well as their textbooks. Every skilled reader in Experiment 1 self-reported that reading was one of their favorite hobbies. When children read a lot, they also improve their knowledge of character as much as they improve their reading skills. In other words, the richer a reader's prior knowledge and experience of characters, the more automatic the identification may be. Therefore, the third way to improve unskilled readers' ability and achievement is to enhance their interest in reading.

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Table 1.

Table 1. The mean percentage of errors for reading a story aloud by skilled and unskilled readers

	The errors during reading	Used phonetic cue	Used graphic similarity	Used sentence context	Wrongly pronounce the character	Pronouncing with wrong tone
Skilled	**16**	**38%**	**28%**	**15%**	**4%**	**15%**
Unskilled	**29**	**18%**	**25%**	**24%**	**11%**	**6%**

Table 2.

Table 2-1. The mean percentage of errors for Non Pin-Yin List by skilled and unskilled readers

	Errors	Phonetic cue	Graphic cue	Coordina-tion	None	Spelling errors	Wrong tone
Skilled	**12**	**34%**	**30%**	**15%**	**9%**	**3%**	**9%**
Unskilled	**21**	**22%**	**35%**	**17%**	**23%**	**4%**	**0.8%**

2-2. The means of right answers in the Non Pin-Yin List and Pin-Yin List for skilled and unskilled readers

	NPL	PL
Skilled	**18.2**	**29.4**
Unskilled	**9.6**	**26.2**

Table 3.

Table 3. The means of errors and the analysis of variance of each variables for skilled and unskilled groups

	Skilled	**Unskilled**	F value
Semantic	X = 18.4	X= 21.35	F=6.62 (P< .05)
Phonetic	X= 8.6	X= 19.05	F=31.44 (P<.05)

Table 4.

Table 4.1 The means of errors of each variable for skilled and unskilled group in the Component List

	Semantic radical	Phonetic radical
Skilled	X1 = 8.55 X2 = 9.85	X1 = 4.0 X2 = 4.6
Unskilled	X1 =10.6 X2 = 10.75	X1 =9.1 X2 =9.95

X1 = Phonetic Compound
X2 = Logographic Compound

Table 4.2 The analysis of variance of different compound characters groups in the Component List

	Semantic radical	Phonetic radical
Phonetic Compound	F ratio = 3.18 F prob.> .05	F ratio = 21.88 F prob.< .05
Logographic Compound	F ratio = 0.26 F prob.> .05	F ratio = 18.70 F prob.< .05

The critical value of F (1, 38) = 4.098

Appendix A

1. Character: 察
   Two-character word: 觀 察
   Two-character nonword: 繃 察

2. Stem: 由 (Sounds yóu)

   The regular character: 油 (Sounds yóu)

   The irregular character: 抽 (Sounds chou)

   The unique character: 毛 (Sounds má**u**)

Appendix B
(Experiment 1)

Reading a story, "Single Wild Geese", aloud

孤　雁

在一個月色朦朧的夜裡，雁兒一對對交著頸子睡了。可是孤雁守著更，卻得不到安眠。寒星照在蘆葦上微微發光，猶如沾著了淚，風吹來，便真的簌窣地啜泣了。孤雁斂著翅膀，側著頭，蹺著身，小心地向四周偵望。

忽然間，看見蘆叢後火光一閃，又一閃。孤雁一緊張，便立刻引吭呼叫起來。正睡著的雁也都醒來了，瞻望四周，卻沒什麼事。大家於是發了怒，以爲孤雁故意撒謊，生生地將牠們的美夢擾醒了。啄！啄！啄得孤雁瑟縮地躲在一邊暗自悲傷。

雁兒們又入睡了。瞬時間，孤雁又看見一閃火光。牠警惕自己：「別再無端打擾人家！」然而，一閃，又一閃，孤雁於是更爲焦急，呼叫得更嘹亮了。「嘎咕！嘎咕！起來！起來！」然而，還是沒有什麼事。「守的什麼更！」孤雁自然又被啄了。

Appendix C
(Experiment 2)

Chinese Reading Diagnosis (I)

I. Reading each character aloud.

1.	樂
2.	但
3.	多
4.	蓋
5.	巍
6.	怙
7.	咆
8.	竄
9.	撥
10.	岳
11.	畋
12.	晢
13.	槃
14.	麈
15.	祝

16.	解
17.	功
18.	黔
19.	粟
20.	妤
21.	獅
22.	早
23.	妃
24.	邃
25.	吠
26.	履
27.	做
28.	恣
29.	辜
30.	爸

Appendix D
(Experiment 2)

Chinese Reading Diagnosis (I)

I. Writing Pin-Yin symbols into the spaces beside the thirty characters

1.	樂	16.	解
2.	但	17.	功
3.	更	18.	黔
4.	茫	19.	粟
5.	巍	20.	好
6.	怙	21.	獅
7.	咆	22.	早
8.	竄	23.	虹
9.	搬	24.	邃
10.	岳	25.	吠
11.	畋	26.	履
12.	晢	27.	做
13.	槃	28.	恣
14.	廛	29.	辜
15.	祝	30.	爸

Appendix E

(Experiment 3)

Chinese Reading Diagnosis (II)

A Multiple- Choice : Choosing the appropriate answers for semantic and phonetic radicals of each character.

Characters	Semantic Radical			None	Phonetic Radical			None
樂	白	絲	木		白	幺	木	
但	亻	日	三		亻	日	旦	
炙	夕	火	冂		夕	火	冂	
蓝	艹	出	山		艹	出	山	
巍	山	委	鬼		山	委	鬼	
怙	忄	古	口		卜	古	口	
咆	口	勹	包		口	勹	包	
竄	穴	鼠	臼		穴	鼠	臼	
搬	扌	舟	般		扌	舟	般	
岳	丘	山	正		丘	山	正	
畋	田	攵	亠		田	攵	乂	
揩	折	斤	日		日	扌	折	
槃	般	木	舟		般	木	殳	
廛	广	墨	土		广	墨	土	

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