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Technical Report No. 615

ROLE OF RADICAL AWARENESS IN THE CHARACTER AND WORD ACQUISITION OF CHINESE CHILDREN[1]

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Center for the Study of Reading

TECHNICAL REPORTS

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174 Children's Research Center
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Abstract

A total of 292 Chinese children in the first, third, or fifth grade participated in one of two experiments investigating *radical awareness*; that is, the knowledge that a component of most Chinese characters, called the radical, usually provides information about a character's meaning. The technique was to present two-character words familiar from oral language but which the children had not seen before in print. One of the characters was written in Pinyin, the alphabetic system that every Chinese child learns in the first two months of first grade. The children's task was to select a character to replace the Pinyin. The first experiment showed that third graders and fifth graders are able to select characters containing the correct radicals even when the characters as a whole are unfamiliar to them, which must mean that they are aware of the relationship between a radical and the meaning of a character. The second experiment showed that children are better able to use radicals to derive the meanings of new characters when the radicals are familiar and the conceptual difficulty of the words is low. Children rated by their teachers as high in verbal ability display more awareness of radicals than children rated lower in verbal ability.

ROLE OF RADICAL AWARENESS IN THE CHARACTER AND WORD ACQUISITION OF CHINESE CHILDREN[1]

A fundamental feature of languages is that groups of words share morphological features. For example, in alphabetic languages like English, words such as *worker*, *worked*, *workshop* share the stem *work* and their meanings are related. In nonalphabetic languages like Chinese, the words 电视 (television), 电话(telephone), and 电影 (movie) share the character 电 (electric) and they are semantically related.

Morphological relationships among words influence the way words are represented in memory and the process by which skilled readers recognize complex words and derive their meanings (Anshen & Aronoff, 1988; Nagy, Anderson, Schommer, Scott, & Stallman, 1989; Taft, 1985). This conclusion has been reached in studies involving several languages (Feldman & Fowler, 1987; Grainger, Cole, & Segui, 1991; Schriefers, Friederici, & Graetz, 1992). There is also evidence that morphology may influence children's vocabulary acquisition (Tyler & Nagy, 1989; White, Power, & White, 1989; Wysocki & Jenkins, 1987); however, this research has been done only with English speaking children. What the present study seeks to answer is: Does the morphological structure of Chinese words influence Chinese children's character and word acquisition? If it does, in what ways?

English-speaking children begin to acquire some knowledge of morphology before entering school (Berko, 1958), and this knowledge continues to develop during the school years (Freyd & Baron, 1982; Nagy, Diakidoy, & Anderson, 1993; Tyler & Nagy, 1989; Wysocki & Jenkins, 1987). In a pioneering study, Freyd and Baron (1982) investigated whether above-average American fifth graders are more likely than average eighth graders to figure out word meanings through analyzing words into roots and suffixes. They asked students to supply definitions for a list of morphologically simple words (e.g., *vague*) and for a list of derived words (e.g., *acceptable*). Then, using a paired-associate learning task, they asked students to learn and recall pairs of nonsense words. Half of the pairs were related by consistent derivational rules (e.g., *skaf* = steal, *skaffist* = thief), and half were unrelated (e.g., *jeve* = study, *kruttist* = pupil). Good and average students performed equivalently on the morphologically simple words. However, good students did better on the derived words.

In a more recent investigation, Wysocki and Jenkins (1987) taught fourth-, sixth-, and eighth-grade American students the meanings of infrequent words such as *stipulate*, then tested their knowledge of derivatives such as *stipulation*. Students were able to use morphological information to recognize the relationship between the taught words and their derivatives. Sixth and eighth graders were more skilled than fourth graders in using morphological clues.

One of the most sophisticated studies of the acquisition of English morphology was completed by Tyler and Nagy (1989), who tested fourth-, sixth-, and eighth-grade American students for knowledge of different aspects of derivational suffixes. Knowledge of morphology increased with grade. When given a low frequency derivative of a high frequency word, fourth graders could recognize the relationship between unfamiliar derivatives and known words. However, knowledge of the syntactic function of derivational suffixes and knowledge of distributional constraints on their use increased through the eighth grade. Like Freyd and Baron (1982), Tyler and Nagy found that students of above-average ability made more use of morphology than students of lower ability.

Extending the research of Tyler and Nagy (1989), Nagy, Diakidoy, and Anderson (1993) explored the development of knowledge of the meanings of 10 common English suffixes among 630 fourth-grade, seventh-grade, and high school students. They found that knowledge of derivational suffixes underwent significant development between fourth grade and high school. Even in high school, however, there were some students who showed little knowledge of suffixes. While knowledge of suffixes was related to general verbal ability, it seemed to be a distinct component of skilled reading.

Many words in English, particularly infrequent words, can be divided into roots and affixes. The meaning of a derived or compound word is not always predictable from the meanings of its components. Nonetheless, a great many English words can be figured out at least in part based on their roots, prefixes, and suffixes (Nagy & Anderson, 1984). For this reason, morphological analysis is generally assumed to be one of the cornerstones of vocabulary development among English-speaking children (Nagy & Anderson, 1984; White, Power, & White, 1989; Wysocki & Jenkins, 1987). Chinese linguists and educators also assume that knowledge of morphology contributes to character and word acquisition in Chinese, although there is little empirical research to support this assumption.

Chinese words have two levels of morphological structure. First, the majority of Chinese words are compounds made up of two or more characters, each of which represents an independent meaning. For example, in the two-character word 牛奶 (cattle-milk) the meaning of the whole word can be readily understood by combining the meanings of the two separate characters. In Chinese, words that share the same character usually are semantically related. For example, 牛奶 (cattle-milk), 牛肉 (cattle-meat), 牛油 (cattle-oil).

Another level of analysis of Chinese involves the internal structure of characters. About 80-90% of the characters in modern Chinese are composed of two components: a component called a *radical* that gives a clue to meaning and a component that offers a clue to pronunciation (Hoosain, 1991). Large groups of characters, sometimes numbering more than one hundred, share the same radical. For example, the characters 吠 (bark), 吻 (kiss), 喊 (shout), 唱 (sing), and 喝 (drink) have the same radical 口 which means mouth. In most cases, the meaning of a character has a clear relationship to the meaning of its radical. In some irregular cases, of course, the meaning of the character is unrelated to the meaning of its radical. In the former case, the meaning relation between the radical and the character can be called *transparent*, while in the latter it is *opaque* (Flores d'Arcais, 1992; T'sou, 1981).

Both levels of morphological structure of Chinese have been found to affect the processing of words by skilled readers. In several recent studies, the reaction time for recognizing compound words was influenced by the frequency of the component characters. For a two-character word, the reaction time was affected more by the frequency of the first character than by the frequency of the second (Taft & Zhu, 1992; Zhang & Peng, 1992; Zhou & Marslen-Wilson, 1993).

Hatano, Kuhara, and Akiyama (1981) asked Japanese students to match compound words, such as *leukemia*, with their definitions. Students performed better when words were presented in Kanji, the Japanese version of characters, for example, 白血病 (white-blood-disease), than in Kana, the Japanese writing system for representing pronunciations. It seems that the morphological information in compound Kanji words helps readers to infer word meanings.

Zhang, Zhang and Peng (1990) asked college students to make speeded judgements about whether or not a series of one-character words signified females. The reaction time was shorter when a word had a radical whose meaning was consistent with the meaning of the word than when it had a radical whose meaning was inconsistent with the meaning of the word. One of the former cases is the word 姑 (aunt) which has a 女 (female) radical. The word 婿 (son-in-law) which also has a 女 (female) radical is one of the latter cases.

Miao and Sang (1991) asked students to verify sentences such as "a swallow (member) is a bird (category)." Half of the target words were of high frequency and half were of low frequency. Three types of sentences were presented. The first type contained target words with radicals consistent with the categories. For example, in the sentence "a lion is an animal," the target 狮 (lion) has an 犭

(animal) radical. The second type contained target words without radicals. For example, in the sentence "a swallow is a bird," the target 燕 (swallow) does not have a 鳥 (bird) radical. The third type contained target words that had radicals inconsistent with the categories. For example, in the sentence "a whale is an animal," the target 鯨 (whale) has a 魚 (fish) radical. No difference was found in the reaction time among the three types of sentences when the target words were of high frequency. In contrast, when sentences containing low frequency words were verified, the reaction time for the second and the third type of sentence was much longer than that for the first type.

Whereas most previous empirical studies of Chinese morphology have examined skilled readers, the present study explored the role of morphological knowledge in Chinese children's character and word acquisition. Basic morphological knowledge, only at the level of character radicals, was investigated. That is, the study addressed whether children are able to recognize and make productive use of the relationship between a word and the radical of a character in the word.

We investigated five questions in two experiments: (1) Are elementary school children aware of the radicals in characters? (2) Does radical awareness help children in remembering familiar characters, and learning unfamiliar characters? (3) How do children use the information in radicals to derive the meanings of unfamiliar characters? (4) Is there a developmental progression over the early school years in the use of radicals? (5) What differences are there between good and poor readers in utilizing radicals to learn characters and words?

Experiment 1

In the first experiment, we concentrated on the basic question: Are children aware of the function of radicals? The technique was to present a series of familiar two-character words in which one of the characters was written in Pinyin. The children's task was to replace the Pinyin in each word with a character.

Pinyin is a Chinese alphabetic system that provides the pronunciation of characters. Children learn Pinyin early in the first grade and, according to teachers, most children easily master the system. Since all of the words used in the experiment were familiar from oral language, we assumed that children would know their meanings when they read them with the assistance of Pinyin.

For each word, four characters with the same sound components but different radicals were presented as options. For example, 瞳, 撞, 僮, and 潼 were the options to replace the Pinyin in tóng 孔. If children are sensitive to the relationship between a radical and the meaning of a word, they ought to be able to select the correct character, even when it is unfamiliar to them.

Method

Subjects. A total of 220 students from an elementary school in Beijing participated in this experiment. Most of the students were from workers' families. Sixty-seven first-grade, 71 third-grade, and 82 fifth-grade students were included. Children were divided into high, average, and low verbal ability groups based on their teachers' ratings of ability.

Design and procedure. A 3 (grade) X 3 (ability) X 3 (familiarity of character) X 3 (morphology of character) mixed design was used, in which grade and ability were between-subject variables, and the familiarity and morphology of characters were within-subject variables.

For each grade, there were 90 target characters selected from the standard reading/language textbooks used throughout China. Thirty of the characters were classified as familiar because they had been introduced in the textbook two grades earlier, and the children had encountered them numerous times.

For example, the familiar characters for third graders were from the first-grade textbook. The familiar characters for first graders were those introduced one semester before. At each grade, 30 characters had been recently learned. These came from the textbook students were using in the present semester. Finally, 30 characters were classified as unfamiliar to students because they would not appear in the textbook until two grade levels above the students' current grade.

For each degree of familiarity, three types of characters were included: 10 characters were morphologically transparent in that their radicals were very helpful in figuring out the meaning of the whole (e.g., the character 烛 (candle) which contains the radical 火 (fire)). Ten were morphologically opaque characters. These contained radicals that contributed little or nothing to word meanings (e.g., the character 练 (practice) contains the radical 纟 (silk)). The remaining 10 were unanalyzable characters that cannot be broken into components (e.g., the character 欠 (owe) consists of only one part). The morphological transparency of the target characters was rated by three graduate students and researchers on a three-point scale, in which 1 stood for opaque and 3 stood for transparent. The characters rated 1 by all three of the raters were classified as morphologically opaque while those rated as 3 by all of them were classified as morphologically transparent.

The target characters were compiled into 90, familiar, two-character words, each word consisting of one target and one nontarget character. The target appeared in Pinyin and the nontarget as a character. For each word, children were asked to replace the Pinyin with one of four characters. The distractors were three characters having the same sound components, but different radicals from the correct character. For example, for the item tiao 望 , (look into the distance from a high place), the correct answer is the character 眺 which has the radical 目 (eye) and means look from a high place. The three distractors were the character 挑 which has the radical 扌 (hand) and means pick; 跳 which has the radical 足 (foot) and means jump; and 佻 which has the radical 亻 (person) and means skittish. For the unanalyzable characters (e.g., 再), the distractors were three characters that were visually similar to the target (e.g., 冉 , 甩 and 耳).

The items were presented in the form of a paper-and-pencil multiple-choice test suitable for group administration to an entire classroom of children. An item was scored 1 when the correct answer was selected, and scored 0 when a distractor was selected. The data were analyzed using unweighted means analysis of variance. Prior to analysis, the raw proportions were transformed using an arcsin transformation, because some children obtained perfect or near perfect scores with some types of characters.

Results and Discussion

Children's mean proportions correct for the different types of characters are shown in Table 1. It is apparent that children performed better on familiar than less familiar characters. It is also apparent that under most conditions children performed better when the characters were morphologically transparent than when they were either morphologically opaque or unanalyzable.

[Insert Table 1 about here.]

The analysis of variance confirmed that the main effect of character familiarity was significant ($F(2,416) = 1490.81$, $P < .01$, $MSE = .08$). That is, children obtained high scores on familiar characters, but their performance declined as the familiarity of characters decreased.

The main effect of morphology of characters was significant ($F(2,416) = 513.07$, $P < .01$, $MSE = .06$). The mean proportion correct on morphologically transparent characters (.83) was much higher than that on the unanalyzable (.75) or opaque characters (.64). These results imply that children are aware of radicals, and that radical analysis is helpful in their character learning.

The interaction of morphology and familiarity ($F(4,832) = 53.63, P < .01, MSE = .06$) was significant. Table 2 suggests that radical analysis contributed differently depending upon character familiarity. When the characters were familiar to children, the difference between morphologically transparent characters and the other two types of characters was relatively small, although it was significant ($F(1,208) = 42.96, P < .01, MSE = .03$). Children performed much better on morphologically transparent characters than on unanalyzable and opaque characters, both when the characters were recently learned ($F(1,208) = 281.72, P < .01, MSE = .06$) and especially when the characters were unfamiliar to them ($F(1,208) = 402.86, P < .01, MSE = .07$). Similar interactions between morphological structure and frequency of exposure to words or characters have been reported in experiments with adults (Miao & Sang, 1991; Seidenberg, 1985).

[Insert Table 2 about here.]

The fact that the importance of morphology became larger as character familiarity decreased may mean that children do not routinely decompose familiar characters into components in order to access the internal lexicon. Or, it may mean that they have encoded elements of familiar characters that are not systematically related to morphology. But the performance of children on less familiar characters clearly shows an influence from morphological structure. The children must have identified radicals and recognized the relationship between the meanings of radicals and the meanings of words containing the radicals. The results imply that children use the information in radicals to learn and remember characters recently introduced in school and to make inferences about the meanings of unfamiliar characters.

A significant interaction of grade by morphology by familiarity ($F(8,832) = 9.11, P < .01, MSE = .06$) suggests a developmental progression in the use of information in radicals. First graders did not yet show a clear ability to utilize the semantic information in radicals. In contrast, third and fifth graders assuredly were using radical analysis to derive unfamiliar characters as well as to learn and remember characters recently introduced in school.

There was a significant interaction of familiarity and ability ($F(4,416) = 14.43, P < .01, MSE = .08$). Table 3 indicates that children with different levels of ability did equally well on the familiar characters ($F(2,208) = 2.55, P > .05, MSE = .16$), but as familiarity decreased, the performance of higher and lower ability children diverged. Higher ability children got significantly better scores than lower ability children on recently learned characters ($F(2,208) = 35.97, P < .01, MSE = .24$), and also on unfamiliar characters ($F(2,208) = 25.44, P < .01, MSE = .24$). Two possible explanations are: High-ability children may have more specific character knowledge than low-ability children, including knowledge of some characters not yet introduced in school. Alternatively, high-ability children may have more facility than low-ability children in decomposing complex characters and using morphological knowledge to assimilate new characters.

[Insert Table 3 about here.]

Experiment 2

In Experiment 2, the process of morphological analysis was explored further. Nagy and Scott (1990) propose that general knowledge of word structure, knowledge of specific roots, prefixes, and suffixes, and strategies for using the knowledge when encountering new words are important in morphological analysis of English words. Similarly, we assume that analyzing an unfamiliar character into its parts, accessing the semantic information in the radical, and using the information in the radical to figure out the meaning of the word are required for productive morphological analysis of Chinese words. Specifically, in Experiment 2, we aimed to get partial answers to two questions: How do children use radicals to derive the meanings of unfamiliar characters? What are the differences between high- and low-ability children in radical analysis?

Because it has been found that morphological analysis is more likely, and more important, when processing low-frequency words (Miao & Sang, 1991; Seidenberg, 1985; Shu & Zhang, 1987), in this experiment all of the targets were unfamiliar characters. We varied whether the target characters had familiar or unfamiliar radicals. For example, the radical 隹 of the character 雏 (young bird) means bird, but few people know it. We also varied whether the words containing the target characters were associated with easy or with difficult concepts. We hypothesized if the familiarity of the radical and the conceptual difficulty of word are important in the process of figuring out unfamiliar characters, performance will be heavily affected when either of the factors is changed.

Method

Subjects. The subjects were 39 third- and 33 fifth-grade students from the same school as the subjects in Experiment 1. The children were rated as high, average or low verbal ability by their teachers.

Design and procedure. A 3 (ability) X 2 (conceptual difficulty of word) X 3 (morphology of character) mixed design was used. Ability was a between-subject variable, and the conceptual difficulty of words and the morphology of characters were within-subject variables.

The format of the multiple-choice test students received and the procedures for measurement were similar to those used in the first experiment. All of the target characters in the multiple-choice test were unfamiliar to children. The target characters for third graders were selected from the Chinese reading/language textbooks for fourth-, fifth-, and sixth-grades, and the targets for fifth graders were from the textbooks for seventh-, eighth-, and ninth-grades.

For each grade, there were 60 target characters of three types: 20 characters were morphologically transparent and contained radicals familiar to children (e.g., the character 眺 (look from a high place) has the radical 目 (eye)). Twenty were morphologically transparent but contained radicals unfamiliar to children (e.g., the character 雏 (young bird) has the radical 隹 (bird)). The remaining 20 characters were morphologically opaque (e.g., the character 练 (practice) has the radical 纟 (silk)). Within each of these three types of character, 10 were formed into conceptually easy words and 10 into conceptually difficult words.

The familiarity of radicals was rated on a two-point scale by two school teachers. The radicals rated as 1 by both of the teachers were included in characters with unfamiliar radicals, while radicals rated as 2 by both teachers were included in characters with familiar radicals. Similarly, the words formed using the target characters were rated on another two-point scale, in which two school teachers were asked to check whether a word might be in children's oral vocabulary or, if not, whether the meaning of the word would be understandable to children. The words rated 1 by both of the teachers were classified as conceptually difficult, while the words rated 2 by both of the teachers were classified as conceptually easy. As in Experiment 1, the data were analyzed in an unweighted means analysis of variance following an arcsin transformation.

Results and Discussion

The main effect of the conceptual difficulty of the words was significant ($F(1,64)=85.07$, $P<.01$, $MSE=.03$). Children's performance was better on characters that were constituents of easy words (.46) than on ones that were constituents of difficult words (.32). This result is consistent with the previous studies with English-speaking children (Nagy, Anderson, & Herman, 1987).

The main effect of morphology was also significant ($F(2,128)=37.94$, $P<.01$, $MSE=.02$). Children's performance on transparent characters with familiar radicals was considerably higher (.50) than on transparent characters with unfamiliar radicals (.35) or opaque characters (.32). This confirms the finding of Experiment 1 that third and fifth graders indeed use the information in radicals when they encounter new characters.

The set of transparent characters with unfamiliar radicals provides an additional control, beyond those employed in Experiment 1. The relatively poor performance of the children on this set strengthens the conclusion that analysis of radicals was responsible for the good performance on transparent characters with familiar radicals.

An interesting interaction appeared between conceptual difficulty and morphology ($F(2,128) = 7.07$, $P < .01$, $MSE = .01$). Table 4 displays the interaction. What stands out is the children's superior performance on the conceptually easy words when the characters were morphologically transparent and had familiar radicals. Neither a conceptually easy word nor accessible morphology was very helpful alone. Evidently the process of deriving the meaning of an unfamiliar character is strongly facilitated when a child is able to triangulate two sources of information.

[Insert Table 4 about here.]

A significant interaction of ability with morphology was obtained in this experiment ($F(4,128) = 4.22$, $P < .01$, $MSE = .02$). Table 5 shows that there is no difference in performance on opaque characters among the children with different levels of rated ability ($F(2,64) = 2.68$, $P > .05$, $MSE = .02$). Similarly, there was no significant difference on morphologically transparent characters with unfamiliar radicals as a function of ability ($F(2,64) = 1.61$, $P > .05$, $MSE = .05$). However, on morphologically transparent characters with familiar radicals, high-, average-, and low-ability children performed quite differently ($F(2,64) = 9.65$, $P < .01$, $MSE = .04$).

[Insert Table 5 about here.]

If the advantage of higher ability children were attributable to their greater knowledge of specific characters, then they would have done better than low-ability children on all three types of characters. In fact, they did better only on characters with accessible morphology. Therefore, it appears that the explanation for the advantage is that average, and, especially, high-ability students make use of morphology, while low-ability students cannot or do not.

General Discussion

In both experiments, we obtained evidence that many Chinese children have a functional awareness of the relationship between the radical in a character and the meaning of words containing the character. Knowledge of morphology was found to develop with grade. It was not clearly found among first graders, but was plainly evident among third graders and fifth graders. Probably children's knowledge of morphology increases as they have more experience with printed language.

First graders may treat characters as unanalyzed wholes, or at least they do not make systematic use of the components of characters used by skilled readers of Chinese. This would explain why first graders do well on characters familiar to them, but relatively poorly on unfamiliar characters, even ones that are morphologically transparent.

While third graders and fifth graders might process familiar characters holistically, the studies reported in this paper clearly show that they are able to decompose characters into informative parts. The key evidence is their superior performance on unfamiliar, morphologically transparent characters, as compared to other kinds of characters for which morphological analysis could not be helpful. Evidently, children as young as third grade are able to differentiate the semantic information provided by radicals, integrate this information with the meanings of words, and successfully infer the meanings of unknown characters.

Experiment 2 established boundary conditions for successful morphological analysis. The results show that knowledge of specific radicals, knowledge of word meanings, and command of the strategy of using morphological analysis are all necessary. First, children must know the meaning of the radical in the new character. When the semantic information that a radical provides is vague, or the radical is unfamiliar, children's attempts to derive characters are seriously hindered. Second, the word containing a new character must be conceptually easy. When a new character appears in a conceptually difficult word, regardless of whether the radical provides useful semantic information or whether the radical is familiar, children have a low probability of deriving the character. Third, children must possess the strategy of integrating radicals and word meanings. Even when all of the information for deriving a character was available, low-ability children typically did not make the inference. This must mean that making inferences based on morphology is not a strategy that is inevitably acquired as children get older and learn more words.

Low-ability children either have not discovered the basic morphological features of Chinese, or they do not spontaneously use what they know about morphology to derive new characters. A possible practical implication of this finding is that low-ability children might benefit from explicit instruction in morphology or strategies for using morphology.

A common assumption among teachers in China and elsewhere is that sustained vocabulary growth depends upon instruction, drill, and practice in school. The present results call this assumption into question. The results show that many Chinese children are able to learn independently new characters and words. When they are reading on their own, these children are likely to be able to use their knowledge of morphology and information they glean from the text to derive the meanings of new characters and words.

Research establishes that natural learning of word meanings while reading is by far the most important avenue for vocabulary growth among English-speaking children (Anderson & Nagy, 1992). It is a plausible hypothesis that independent reading is a major source of vocabulary growth among Chinese-speaking children, as well.

Indeed, Shu, Anderson, & Zhang (in press) have already reported evidence that favors this hypothesis. They completed a cross-cultural investigation of natural learning of word meanings while reading. A total of 447 Chinese and American children in third and fifth grades read one of two cross-translated stories and then completed a test on the difficult words in both stories. The results showed significant learning of word meanings while reading in both grades in both countries.

In the Chinese part of the Shu, Zhang, and Anderson (in press) study, amount of out-of-school reading was investigated at the beginning of the spring semester. The children were asked to write down the names of books that they had read during the immediately preceding winter vacation. Scores on a vocabulary test were directly proportional to the amount of reading the children reported. Moreover, children who reported reading extensively had a much higher likelihood of learning the meaning of a previously unfamiliar word simply from reading a text containing the word. The likelihood of learning the meaning of a word for children who reported reading eight or more books during winter vacation was over three times as great as for children who read four to seven books, and over seven times as great as for children who read three or fewer books. Evidently, Chinese children who read extensively outside of school have *learned how to learn* unfamiliar words. Morphological analysis is implicated as a key element in these word learning strategies.

The present experiments provide evidence that many Chinese children are aware of aspects of the morphological structure of Chinese characters and words. The experiments further show that Chinese children's knowledge of morphology develops over the school years, and there are differences in functional knowledge of morphology associated with verbal ability. Similar findings have been obtained with English-speaking children (Freyd & Baron, 1982; Nagy, Diakidoy, & Anderson, 1993; Tyler & Nagy, 1989; Wysocki & Jenkins, 1987). Indeed, there do not appear to be any substantial differences in children's knowledge and use of morphology in Chinese and in English, despite the vast differences between the writing systems.

Footnote

[1]The authors gratefully acknowledge the assistance of Hongmei Zeng and Hua Song in collecting the data.

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Table 1

Mean Proportion Correct as a Function of Type of Character and Grade

		Morphology		
Grade	Familiarity	Opaque	Unanalysable	Transparent
1st	Unfamiliar	.36	.57	.57
	Recently learned	.77	.87	.84
	Familiar	.89	.85	.92
3rd	Unfamiliar	.37	.55	.77
	Recently learned	.46	.61	.76
	Familiar	.83	.94	.96
5th	Unfamiliar	.42	.57	.70
	Recently learned	.72	.84	.97
	Familiar	.94	.96	.98
Total		.64	.75	.83

Table 2

Mean Proportion Correct as a Function of Character Familiarity and Morphological Structure

	Morphology		
Familiarity	Opaque	Unanalysable	Transparent
Unfamiliar	.38	.56	.68
Recently learned	.65	.77	.86
Familiar	.89	.92	.95

Table 3

Mean Proportion Correct as a Function of Character Familiarity and Ability

	Ability		
Familiarity	Low	Average	High
Unfamiliar	.45	.55	.63
Recently learned	.64	.79	.83
Familiar	.89	.93	.94

Table 4

Mean Proportion Correct as a Function of Morphology and Conceptual Difficulty

	Morphology		
Conceptual Difficulty	Opaque	Transparent Unfamiliar Radical	Transparent Familiar Radical
Difficult	.28	.30	.39
Easy	.35	.40	.62

Table 5

Mean Proportion Correct as a Function of Morphology and Ability

	Morphology		
Ability	Opaque	Transparent Unfamiliar Radical	Transparent Familiar Radical
Low	.36	.34	.39
Average	.30	.33	.53
High	.33	.41	.60

ANOVA Summary for Experiment 1

Source of Variation	*SS*	*DF*	*MS*	*F*	Sig of *F*
1. Grade	14.42	2	7.21	14.95	.000
2. Ability	30.60	2	15.30	31.72	.000
3. Grade X Ability	4.45	4	1.11	2.30	.060
4. Subject	100.35	208	.48		
5. Familiarity	233.59	2	116.80	1490.81	.000
6. Grade X Familiarity	31.94	4	7.99	101.93	.000
7. Ability X Familiarity	4.52	4	1.13	14.43	.000
8. Grade X Ability X Familiarity	1.25	8	.16	2.00	.046
9. Familiarity X Subject	32.59	416	.08		
10. Morphology	64.52	2	32.26	513.07	.000
11. Grade X Morphology	5.79	4	1.45	23.03	.000
12. Ability X Morphology	.18	4	.05	.72	.579
13. Grade X Ability X Morphology	2.01	8	.25	4.00	.000
14. Morphology X Subject	26.16	416	.06		
15. Familiarity X Morphology	12.88	4	3.22	53.63	.000
16. Grade X Familiarity X Morphology	4.37	8	.55	9.11	.000
17. Ability X Familiarity X Morphology	.43	8	.05	.89	.523
18. Grade X Ability X Familiarity X Morphology	1.36	16	.09	1.42	.126
19. Familiarity X Morphology X Subject	49.97	832	.06		
20. TOTAL	621.38	1952			

ANOVA Summary for Experiment 2

Source of Variation	*SS*	*DF*	*MS*	*F*	Sig of *F*
1. Grade	.06	1	.06	.98	.325
2. Ability	.36	2	.18	3.07	.053
3. Grade X Ability	.02	2	.01	.17	.841
4. Subject	3.80	64	.06		
5. Concept	2.16	1	2.16	85.07	.000
6. Grade X Concept	.02	1	.02	.61	.436
7. Ability X Concept	.15	2	.07	2.93	.060
8. Grade X Ability X Concept	.04	2	.02	.86	.426
9. Concept X Subject	1.62	64	.03		
10. Morphology	3.00	2	1.50	64.49	.000
11. Grade X Morphology	.58	2	.29	12.39	.000
12. Ability X Morphology	.39	4	.10	4.23	.003
13. Grade X Ability X Morphology	.11	4	.03	1.17	.327
14. Morphology X Subject	2.97	128	.02		
15. Concept X Morphology	.46	2	.23	15.69	.000
16. Grade X Concept X Morphology	.18	2	.09	6.17	.003
17. Ability X Concept X Morphology	.04	4	.01	.65	.629
18. Grade X Ability X Concept X Morphology	.09	4	.02	1.51	.202
19. Concept X Morphology X Subject	1.88	128	.01		
20. TOTAL	17.93	419			