Morphological Awareness and Chinese Children's Literacy Development: An Intervention Study

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Morphological Awareness and Chinese Children’s Literacy Development: An Intervention Study

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The purpose of this study was to investigate the relationship between morphological awareness and Chinese children’s literacy development. Of the 169 children from el-
Elementary schools in Beijing, China, who participated in the study, about half received enhanced instruction on the morphology of characters and words in the first and second grade. At the beginning of second grade and at the beginning of third grade, children were tested on morphological awareness, reading, and writing. The results showed that morphological instruction substantially improved children’s performance on the morphological awareness and literacy measures. The best-fitting structural equation models suggested a unidirectional causal relation in early second grade and a reciprocal relation in early third grade between morphological awareness and children’s literacy development.

The present study investigated the relationship between morphological awareness and young children’s progress in learning to read and write Chinese. Learning to read and write involves metalinguistic insights into the mapping between spoken and written language. The basic insights involve phonological and orthographic knowledge, in addition to knowledge of morphology. Research in reading development has documented the importance of phonological awareness (e.g., Adams, 1990; Bradley & Bryant, 1983; Goswami, 1999; Ho & Bryant, 1997; Hu & Catts, 1998) as well as orthographic knowledge (e.g., Cassar & Treiman, 1997; Cunningham, Perry, & Stanovich, 2001; Goswami, Gombert, & Barrera, 1998) in explaining variability in young children’s learning to read languages with different orthographies. However, reading and writing entail not only associating speech sound units with written forms but the connection of spoken and written forms with meaning, which at the level of words is represented by the morphology of the language.

Morphological awareness has been shown to be important in children’s learning to read and write, explaining variation beyond the contribution of phonological skills, prior reading level, vocabulary knowledge, or general intelligence (e.g., Brittain, 1970; Carlisle, 1995, 2000; Deacon & Kirby, 2004; Fowler & Liberman, 1995; Mahony, Singson, & Mann, 2000; Nagy, Berninger, & Abbott, 2006). This relation is not specific to reading an alphabetic orthography but extends to Chinese, a language with a logographic orthography. Several recent studies indicate that morphological awareness is strongly associated with the literacy development of Chinese children. McBride-Chang, Shu, Zhou, Wat, and Wagner (2003) presented measures of morphological awareness (e.g., “If we see the sun rising in the morning, we call that a sunrise. What should we say when we see the moon rising in the evening?” The desired answer is moonrise) to Chinese kindergartners and second graders. Morphological awareness accounted for significant unique variance in character recognition, after controlling for the effects of age, phonological awareness, and vocabulary. Ku and Anderson (2003) administered four tasks assessing morphological awareness (e.g., judging whether pseudo derivatives and compounds, such as cowhouse or muchable, are possible and meaningful) to Chinese-speaking and English-speaking second, fourth, and sixth graders. Morphological awareness was strongly related to reading comprehension in both language groups and all three
grades, after controlling for vocabulary knowledge. Despite recent research showing the importance of morphological awareness to learning to read and write, the evidence is still more limited than the evidence for the importance of other aspects of metalinguistic awareness, especially phonological awareness.

Writing systems vary in the extent to which they represent phonological and morphological information. According to DeFrancis (1989), Chinese represents more nearly the morphological endpoint of the world’s writing systems. It stands to reason that morphological awareness would make an important contribution to Chinese children’s reading and writing success.

First, the information about meaning embodied in Chinese characters and words tends to be obvious and reliable (see Shu, Chen, Anderson, Wu, & Xuan, 2003). Some Chinese characters have a graphic form that suggests the meaning of the character (e.g., 田 [field]) and over 70% of the characters children learn in elementary school contain a component called the semantic radical that conveys information about the meaning of the character. For example, the character 龙 (dragonfly), contains the semantic radical 虫, which means insect. Chinese words of two or more characters tend to be semantically transparent. For example, 电 (electric) and 脑 (brain) contribute in a clear way to the meaning of 电脑 (electric brain ‘computer’).

Second, the morphological information in Chinese characters and words is readily accessible. In contrast, the information in English words is often less accessible because of shifts in the pronunciation and spelling of morphemes in related words (e.g., keep → kept; convene → convention). Research shows that such shifts interfere with recognition of base morphemes (Carlisle, 1988; Leong, 1988; Mahony et al., 2000). There are few such shifts when complex words are formed in Chinese.

Third, the Chinese writing system does not represent speech phoneme by phoneme. Instead, whole syllables are associated with characters. This association is probably easier for children, and comes more naturally to Chinese children (see McBride-Chang, Bialystok, Chong, & Li, 2004), than isolating phonemes, associating the phonemes with individual letters and then assembling, or blending, the phonemes to produce the pronunciation of words. Thus, phonological awareness is less stressed in learning to read Chinese than in learning to read an alphabetic language (Tan, Spinks, Eden, Perfetti, & Siok, 2005).

Fourth, morphological awareness may be especially important in reading and writing Chinese because the language contains a vast number of homophones. There are thousands of morphemes in everyday Chinese but only 1200 syllables after differentiation by tone. Characters serve to specify meanings that may be ambiguous in spoken language. Anderson and Li (2005) argue that because of the numerous homophones in Chinese, “the Chinese child who is not morphologically aware, always alert to distinguishing meanings, habitually searching for information to discriminate meanings, is vulnerable to frequent misunderstandings” (p. 78).
Thus, the properties of the Chinese language and associated writing system make it reasonable to hypothesize that, while phonological awareness is primary in alphabetic literacy, morphological awareness is the aspect of metalinguistic awareness that is primary in Chinese literacy learning (Nagy & Anderson, 1999; Shu & Anderson, 1999). This hypothesis has been supported in several empirical studies. Li, Anderson, Nagy, and Zhang (2002) compared the relative contribution of phonological awareness and morphological awareness to Chinese reading in a study involving 400 first-grade and 400 fourth-grade students. Using structural equation models and hierarchical regression analysis, they found that although phonological awareness is important, morphological awareness is far more important in learning to read Chinese. A similar finding emerged from a cross-language study by McBride-Chang et al. (2005) comparing the roles of phonological and morphological awareness in the reading development of Chinese, Korean, and American second graders. As anticipated, phonological awareness was more important for learning to read English, morphological awareness was more important for learning to read Chinese, and both phonological and morphological awareness contributed to learning to read Korean.

Existing research in either alphabetic or non-alphabetic languages is open to interpretation about the fundamental relationship between morphological awareness and literacy development (Kuo & Anderson, 2006). One interpretation with intuitive appeal is that morphological awareness is a direct cause of reading and writing development, but another possibility is that the relationship is bidirectional, involving reciprocal causation, as research suggests may be the case with phonological awareness and learning to read English (Perfetti, Beck, Bell, & Hughes, 1987). In other words, it is possible that learning to read and write triggers consciousness of certain morphological features and, at the same time, that the development of morphological awareness leads to better literacy skills.

Intervention studies are the best means for establishing causal relations among constructs. In one of the few studies involving morphological instruction, Nunes, Bryant, and Olsson (2003) gave 7- and 8-year-old English children 12 weekly sessions in spelling using either morphological or phonological principles. Although the trained groups all performed significantly better than the control group in word reading, it is noteworthy that only the morphological training group significantly outperformed the control group on the use of morphological rules in reading pseudowords and in spelling derivational and stem morphemes. Similarly, Arnbak and Elbro (2000) found that training in morphology improved the reading and spelling of dyslexic Danish children. The results of these studies suggest that morphological awareness is on the causal path to improved literacy of children learning alphabetic languages.

We are aware of two previous intervention studies involving the morphological awareness of Chinese children. Nagy et al. (2002) implemented a one-year instructional intervention designed to increase morphological knowledge of first-
fourth-grade Chinese children. At both grade levels, explicit instruction in mor-
phological and graphomorphological features of Chinese significantly improved
children’s overall performance on literacy tasks as well as morphological aware-
ness tasks. The effect seemed to be due to increased understanding of the grapho-
morphological or graphosemantic features of characters, not the morphological
structure of words, probably because the intervention emphasized helping children
gain insights into features of characters that convey semantic information. In an
extension of this study, Packard et al. (2006) investigated the effects of the
one-year intervention targeting the semantic information in characters on learning
to write characters among Chinese first graders. They found that children who re-
ceived the intervention significantly outperformed their counterparts in the control
group.

To give an overview, the present study was a longitudinal investigation of the re-
lationship between morphological awareness and Chinese children’s progress in
learning to read and write. Children who received a morphologically enhanced
curriculum during first and second grade were compared to children with similar
backgrounds and similar entry-level reading and language skills who received the
standard curriculum. The study went beyond previous instructional studies with
Chinese children by extending the intervention to 2 years, improving the measure-
ment of constructs by including more items and editing weak items and especially
by addressing children’s understanding of the morphology of multi-character
words. The expectation was that more systematic instruction in morphology would
improve children’s literacy. The study sought to determine whether the instruction
improved literacy because it increased morphological awareness and, further,
whether the relationship of morphological awareness and literacy development is
unidirectional or bidirectional involving reciprocal causation.

METHOD

Participants

The participants in the study were enrolled in six classrooms from four public ele-
mentary schools in Beijing, China. The initial sample comprised 169 children (82
girls and 87 boys, mean age 6 years and 9 months) at the start of intervention in the
first semester of first grade; 84 students from three classrooms were in the control
group receiving no intervention, and 85 students from the other three classrooms
were in the experimental group receiving morphological instruction from the be-
inning of first grade through second grade. The sample size decreased to 154 stu-
dents (74 girls and 80 boys, 80 and 74 students from the control and experimental
group, respectively) by the beginning of the second grade and to 146 (73 girls and
73 boys, 72 and 74 students from the control and experimental group, respectively)
by the beginning of the third grade, because of loss of children who transferred to other schools or incomplete data from children who were absent from some test sessions. Due to the SARS epidemic, all school activities ceased for much of the second half of the school year in second grade. Neither traditional classroom teaching nor morphological instruction was provided during this period.

Tests and Procedures

Early in the first grade, before the intervention began, an IQ test and a battery of pretests including metalinguistic and early literacy measures were administered to the children. A Chinese version of the Raven’s Standardized Reasoning Test (Zhang & Wang, 1985) was employed to measure children’s general intelligence. Pretests measured children’s phonological awareness, morphological awareness, and early reading and writing skills.

Phonological awareness was assessed with two tests: discriminate tones and discriminate rimes, which required children to judge whether pairs of syllables had the same or different tones or rimes, respectively. Three tests were designed to measure children’s morphological awareness, radical form judgment, radical meaning judgment, and discriminate morphemes. In the radical form judgment test, children were asked to identify the one character among a group of four characters that had a different radical from the other three. The radical meaning judgment and discriminate morphemes tests had the same format as the Grade 2 morphological awareness measures described later.

Reading and writing skills were measured with pinyin dictation and pinyin sentence reading tests. Pinyin is an alphabetic script that children learn early in the first grade as an aid to learning character pronunciations. Pinyin achievement was evaluated instead of character knowledge to assess early literacy because the children had not yet had any systematic opportunity to learn to read or write Chinese characters. In the pinyin dictation test, children were required to write down the pinyin for syllables pronounced by the examiner, whereas in the pinyin sentence reading test, children were given incomplete sentences written in pinyin each accompanied with a picture and were required to complete the sentence with pinyin to fit meaningfully with the picture.

Children’s scores on the battery of pretests were aggregated into a single composite score through principal component analysis. The first principal component, accounting for 48% of the total variance in the pretest battery, served as an overall indicator of students’ initial literacy skills and abilities. The first component was the only component with an eigenvalue greater than 1.0, indicating that a one-factor solution gave a satisfactory representation of pretest performance. Students’ IQs and the pretest factor were used to statistically control any differences between the control group and the experimental group and to reduce extraneous variation among the students, allowing a more precise test of hypotheses.
Early in second grade and again early in third grade, children completed a battery of reading, writing, and morphological tests. We did not administer the tests at the end of first and second grade due to the school-mandated tests near the end of each school year. In second grade, 10 tests were administered to assess reading proficiency, writing proficiency, and morphological awareness. In third grade, a different battery of 8 tests was given to children to measure their morphological awareness and literacy skills. All were administered as group tests to the whole class.

Grade 2 reading tasks included:

1. *Sentence reading comprehension test.* Sentences were accompanied by four pictures. The students’ task was to select the picture that best represented the meaning of each sentence. The task consisted of 30 sentences and associated pictures.

2. *Vocabulary test.* A vocabulary checklist task included characters from the edition of national Chinese primary school textbooks introduced in 1995 and pseudocharacters as foils to correct for guessing. Students were asked to circle the characters they knew. There were a total of 190 characters on the test, 80 familiar characters, 70 unfamiliar characters, and 40 pseudocharacters. Familiarity was defined in terms of whether the character had been introduced in the school curriculum. The vocabulary score was the proportion of real characters marked as known corrected for the proportion of non-characters marked as known.

Grade 2 writing tasks included:

1. *Dictation test.* The task required children to write down (in Chinese characters) a total of 20 characters and 20 multi-character words pronounced by the examiner. Half of the characters and words were familiar to the students, in the sense that the items had been introduced in the school curriculum, and the other half were unfamiliar.

2. *Copy characters test.* The task required children to copy a list of 60 characters presented at the front of the classroom. Each character was presented for two seconds and then taken away. After the character was taken away, students were asked to reproduce it on the answer sheet. There were three types of characters: 20 familiar simple characters with no components or subcomponents, 20 compound characters with two familiar components, and 20 pseudocharacters with two familiar components appearing in illegitimate positions.

Throughout the article, we use second and third grade to denote the test time, but indeed performance on the tests reflected children’s development in first and second grade.
3. **Write characters test.** The task required children to write down from memory as many characters as possible in 5 minutes. The score was the number of correctly written characters.

Grade 2 morphological awareness tasks included:

1. **Interpret novel words test.** This task measured children’s knowledge of the morphology of compounds and derivatives. Items consisted of unfamiliar words composed of familiar characters. The students’ task was to select the best interpretation of the target word from three choices. For example: 简化 (simplify): (a) 慢慢地变化 (change gradually), (b) 非常简单明白的 (very simple and clear), (c) 把复杂的变简单 (make complicated things simple). In Chinese, 简 means simple and 化 is a bound morpheme functioning as a derivational suffix, -ize or -fy in English. In this example, in order to select the correct interpretation (c) 把复杂的变简单 (make complicated things simple), students have to understand that 简 (simple) is the root morpheme and 化 is the suffix -fy so that the whole word means simplify. The test contained 30 items.

2. **Discriminate morphemes test.** This task measured children’s ability to discriminate homophone morphemes in the context of different complex words. Twenty sets of four familiar two-character words were presented orally. In each set, the four words shared one homophone character, but this shared character had a different meaning in one of the four words. The students’ task was to identify the one in which the homophone character had a different meaning. For example, the first character in each of the following four words has the same pronunciation /jian4/: /jian4 she4/ (construction), 健康 /jian4 kang1/ (healthy), 健壮 /jian4 zhuang4/ (strong), 健美 /jian4 mei3/ (vigorous and graceful). The /jian4/ in 建设 (construction) meaning build is different from the /jian4/ in the other three words where it means strong. Therefore, 建设 /jian4 she4/ (construction) is the desired answer, which students indicated by circling “1” on the answer sheet.

3. **Radical meaning judgment test.** This task assessed application of the graphomorphological knowledge that radicals provide information about character meaning. The students’ task was to select among four choices the best character to complete a sentence. None of the choices were familiar to the students, but the radical part of each choice could provide them with a clue to pick the right answer. For example, 海__会飞，也会游泳。 (Sea gulls can fly as well as swim). The four choices were (a) 欧, (b) 段, (c) 鴛, (d) 鴴. The missing target is a kind of bird and using their knowledge of the radical enables the student to get the best answer 鴴, which contains the radical 鸟, bird. The task contained 20 items.
4. *Make words test.* This task measured the understanding that the same character could have different meanings or functions in different word contexts. This task contained 15 familiar characters with different meanings in different word contexts. For example, the familiar character 松 means *pine* in the word 松鼠 (pine-rat ‘squirrel’), whereas in 蓬松 (fluffy) it has a different meaning, *light and flaky or soft.* The students’ task was to compose as many words as they could with each of the 15 characters. Students were allowed to write down *pinyin* or homophone characters for the characters they were unsure about. Only responses that were real words were counted. The score was mean number of words composed per character.

5. *Make characters test.* This task measured children’s knowledge of the function of radicals and the semantic category conveyed by specific radicals. The students’ task was to write as many characters that contained a specific radical as they could. There were a total of 15 target radicals. The score was mean number of correctly written characters generated per target radical.

Grade 3 reading tasks included:

1. *Paragraph reading comprehension test.* A grade-appropriate cloze test was constructed to measure children’s reading comprehension. The task consisted of two passages with 24 missing characters. Children were asked to fill in the missing characters. In order to do so, they had to understand the overall meaning of the passage as well as the words in which characters were missing.

2. *Vocabulary test.* Same design as the second grade test.

3. *Reading fluency test.* Items consisted of obviously true or false sentences, such as 太阳给了我们光和热 (The sun brings us light and heat) and 老虎喜欢吃青草 (Tigers like to eat grass), all written in easy, familiar characters. The children read the sentences and circled True or False. There were 82 sentences to read in five minutes. The test was calibrated so that few, if any, children could finish all the sentences in the time available. The measure is characters per minute in correctly verified sentences.

4. *Correct wrong characters test.* This task assessed comprehension and stressed the ability to coordinate morphological, semantic, and syntactic information. Students read sentences composed of familiar characters and words that contained one incorrect character. The task was to find and correct the incorrect character. Full credit was awarded for both finding the incorrect character and writing down the correct form. Partial credit was given for finding the incorrect character but replacing it with another incorrect form. The test consisted of 35 sentences.
Grade 3 writing tasks included:

1. **Dictation test.** This task was similar to the dictation test taken in early second grade. However, the third grade test included only words, not single characters. There were a total of 60 items in the test, 30 familiar words and 30 unfamiliar words.

2. **Copy characters test.** Similar to the procedures in the second-grade test, a total of 30 characters were presented one at a time for two seconds and then taken away. Children were asked to concentrate on each character while it was in view and then, when it was removed, to write it on an answer sheet. There were two kinds of characters: 15 familiar characters and 15 unfamiliar characters. Again, familiarity was defined in terms of whether or not the character had been taught in school. The number of strokes and character structure were balanced in two types of characters.

Grade 3 morphological awareness tasks included:

1. **Interpret novel words test.** Same design as the second grade test.

2. **Discriminate morphemes test.** Same design as the second grade test.

**Morphological Instruction**

The intervention was intended to promote children’s morphological and graphomorphological awareness. Children receiving morphological instruction were helped to learn graphomorphological analysis of characters and morphological analysis of words and to cultivate the application of such knowledge when they encountered new characters and words.

The rationale behind the intervention came from the nature of Chinese characters and words. In characters that are pictographs or ideographs, the graphic form of the character suggests its meaning. The method of memorizing pictographs and ideographs by associating form and meaning has been advocated by Chinese scholars for 2000 years or more (Xu, 1979/121 A.D.; Yang, as cited in Kao, 1982). Pictographic and ideographic characters have been schematized over centuries of use, so the connection between form and meaning may not be

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Note: How to name the connections between form and meaning in pictographic characters, ideographic characters, and semantic radicals is a matter of some awkwardness since these forms have no counterpart in alphabet writing systems and do not fall within the scope of standard morphological analysis. We will use the expression *graphomorphological features* to indicate connections between form and meaning that are present in written language but not in spoken language. To keep the language from being too cumbersome, we have sometimes used *morphological awareness* as an umbrella term that includes graphomorphological awareness.
obvious to a modern student. However, when pointed out to the student the connection may then serve as a mnemonic to support character learning and memory.

Another type of Chinese character is the semantic-phonetic compound character, which consists of a semantic radical that provides a clue to the meaning of the character and a phonetic that provides a clue to the pronunciation of the character. Research shows that children who are aware of and trying to use the information about meaning in radicals make better progress in learning to read (Ho, Wong, & Chan, 1999; Shu & Anderson, 1997). Characters are the building blocks of written words, and most Chinese words are represented by two or more characters, the majority of which are semantically transparent.

Morphological features are not systematically taught in conventional Chinese reading and writing instruction, which instead stresses rote memorization and repetitive copying (see Wu, Li, & Anderson, 1999, for a detailed description of conventional Chinese language arts instruction), although probably every Chinese teacher draws children’s attention to some obvious pictographs and from time to time points out the function of common semantic radicals in compound characters. The intervention differed from conventional practice in that it was more thorough and systematic.

The intervention consisted of direct instruction and guided discovery to explain the shape-to-meaning connections in pictographs and ideographs, the function of the phonetic and semantic radicals to the pronunciation and meaning of compound characters, and the contribution of component characters to the meaning of two- and three-character words.

For pictographic and ideographic characters, the typical character teaching procedure was as follows. Show the character and a picture of the object the character represents. Compare the shape of the character and the object and explain how the character evolved to its current form. Teach the pronunciation and the sequence of strokes for writing the character. Explain the relationship between each stroke and the part of the object it represents. The example below is from the lesson plan of a reading teacher for the ideographic character, 笔 (/bi3/, pen), which consists of two pictographic parts, 竹 (/zhu2/, bamboo) and 毛 (/mao2/, feather). The challenge in teaching this character is to help the students rationalize the seemingly arbitrary connection between the two pictographic forms and the meaning of the entire character.

**Teacher:** (Show a traditional writing brush to the students) What is this?
**Students:** 笔 (/bi3/, pen)

**Teacher:** (Write down the pinyin and the character on the blackboard and ask the students to observe the strokes and the order in which they are written.)
Of which parts is the character made up?
Students: On the top are left-falling stroke, even stroke, dot, left-falling stroke, even stroke, and dot. Below that is 毛 (a known character meaning feather).

Teacher: The upper part is a variation of 竹 (a known character meaning bamboo). The stroke |’s are changed to dots when 竹 is used as a radical. Then, how do we memorize this character?

Students: The upper part is the radical 竹, the lower part is 毛.

Teacher: Why is the character made up of these two parts?

Students: Because a 笔 is made of bamboo and feathers.

Teacher: (Show the students fountain pens, ballpoint pens, and pencils and ask the students to look closely at them.) Are these pens made up of bamboo and feathers? How do you write the character this time?

Students: (Puzzled).

Teacher: Characters were created a long time ago when there weren’t any pens like the ones we use today. At that time, people only used brushes to write, which at that time were made of bamboo and feathers. That is why the character is written as 竹 and 毛 combined together. Although many other kinds of pens have appeared since then, the form of the character remains the same.

For semantic-phonetic characters, the typical character teaching procedure was as follows. Identify the semantic and phonetic components of the character. Analyze the contribution of the semantic component to the character meaning and the phonetic component to the character pronunciation. Explain the original and extended meaning of the character. Think of characters and words that contain the target character as a component and their meanings. An example (from Wu, Anderson, Li, Chen, & Meng, 2002) is the teaching of the semantic-phonetic character, 虾 (/xia1/, shrimp):

Teacher: (Shows a shrimp or a picture of a shrimp) What is this?

Students: 虾 (/xia1/, shrimp).

Teacher: (Writes the character down on the blackboard) Of what parts is this character made up?

Students: It is made up of two characters we know: The left part is 虫 (/chong2/, insect) and the right part is 下 (/xia4/, down).

Teacher: Why is the left part 虫? (Give the students enough time to consider this question. If they can’t figure it out, show them the shrimp again. If they can more or less get the answer, tell them to compare and confirm the answer with the picture.)

Students: 虾 looks like an insect.

Teacher: Yes, 虫 shows that 虾 has something to do with an insect. Then what is the function of 下 here?
Students: 下 has the same pronunciation as 虾, but a different tone.
Teacher: Please make up some words with the character 虾 in them, and the more, the better.

A major instructional activity to promote insight into the morphology of words was to make up words using newly learned characters. Among the insights fostered by this activity is that a character can have different meanings within different words. For example, when learning 松 (pine), students would be asked to make words that contain the character, say 松树 (pine-tree ‘pine tree’), 松叶 (pine-leaf ‘pine needle’), 松软 (loose-soft ‘loose and soft’), and 松散 (loose-scattered ‘loose’). Students would be asked to explain the meaning of each word and classify the words based on their meanings. Here, the former two should be in one group as the 松 in both of the words means pine, and 松 in the latter two words means loose. Likewise, when a new character with a certain radical or phonetic was introduced, the teacher would have the students discuss the meanings of other characters that share the same radical or phonetic. Take 罩 (/pao2/, robe), for example. Students would first be asked to identify the radical 衣 (related to clothes) and the phonetic 包 (/bao1/). Then a number of characters with the same phonetic but different radicals, such as 跑 (/pao3/, run), 喋 (/pao2/, roar), and 热 (/pao4/, soak) were listed. Students could easily get the pronunciation of these characters as they have the same phonetic. At the same time they could easily distinguish the meanings of the characters from their respective radicals—是 (related to foot), 口 (related to mouth), and 水 (related to water).

Morphological instruction was integrated into regular classroom instruction. First- and second-grade students have two 40- to 50-minute language arts classes during each school day. The amount of time spent on morphological instruction during each class period depended on the number, type, and difficulty of the new characters and words to be learned. In first grade, the instruction concentrated on helping children gain insight into the internal structure of characters. In second grade, the emphasis shifted to word structure and meaning.

Teachers who implemented the intervention attended a 3-day workshop in the summer before the first year of the study on how to apply morphological instruction methods in real classroom teaching. They also participated in seminars every week throughout both years of the study. The weekly sessions were led by an experienced teacher and two research assistants (two of the authors). In the sessions, morphological features of upcoming characters and words were reviewed and instructional activities to promote morphological awareness were discussed. Each teacher was given a set of four reference books to enable them to provide complete and accurate information to their students about Chinese characters and words. The research assistants observed one of the experimental classes once a week to make sure the morphological instruction was properly implemented.
RESULTS

The means and standard deviations of all measures given in second and third grade are provided in Table 1. Also shown are test reliabilities (Cronbach’s alpha). According to the rules of thumb provided by George and Mallery (2003), the reading proficiency measures and morphological awareness measures had acceptable ($\alpha > .7$), good ($\alpha > .8$), or even excellent ($\alpha > .9$) reliability. Some writing proficiency measures had lower reliability, with the dictation task in early second grade having a reliability of .61 and the copy characters task in early third grade of .53. Tables 2 and 3 present the intercorrelations among measures in the second grade and the third grade, respectively.

Table 4 presents descriptive statistics for the measures of initial literacy administered early in the first grade and loadings of the measures on the factor employed in subsequent analyses to represent initial literacy. The intervention group and the

### Table 1
Means (SDs) on Literacy and Morphological Awareness Measures for Intervention and Control Groups in Second and Third Grade

<table>
<thead>
<tr>
<th>Measures</th>
<th>Alpha</th>
<th>Control</th>
<th>Intervention</th>
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<tbody>
<tr>
<td><strong>Grade 2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sentence comprehension</td>
<td>.93</td>
<td>.67 (.22)</td>
<td>.79 (.19)</td>
</tr>
<tr>
<td>Vocabulary</td>
<td>.96</td>
<td>.55 (.12)</td>
<td>.65 (.14)</td>
</tr>
<tr>
<td>Dictation</td>
<td>.61</td>
<td>.49 (.11)</td>
<td>.52 (.11)</td>
</tr>
<tr>
<td>Copy characters</td>
<td>.80</td>
<td>.88 (.07)</td>
<td>.88 (.08)</td>
</tr>
<tr>
<td>Write characters$^a$</td>
<td>N/A</td>
<td>42.10 (10.80)</td>
<td>44.80 (10.50)</td>
</tr>
<tr>
<td>Interpret novel words</td>
<td>.76</td>
<td>.45 (.15)</td>
<td>.60 (.15)</td>
</tr>
<tr>
<td>Discriminate morphemes</td>
<td>.70</td>
<td>.72 (.12)</td>
<td>.75 (.12)</td>
</tr>
<tr>
<td>Radical meaning judgment</td>
<td>.80</td>
<td>.78 (.16)</td>
<td>.88 (.11)</td>
</tr>
<tr>
<td>Make words$^a$</td>
<td>.84</td>
<td>2.62 (.63)</td>
<td>3.02 (.56)</td>
</tr>
<tr>
<td>Make characters$^a$</td>
<td>.91</td>
<td>1.47 (.80)</td>
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<tr>
<td><strong>Grade 3</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paragraph comprehension</td>
<td>.83</td>
<td>.44 (.15)</td>
<td>.53 (.14)</td>
</tr>
<tr>
<td>Vocabulary</td>
<td>.96</td>
<td>.57 (.14)</td>
<td>.62 (.14)</td>
</tr>
<tr>
<td>Reading fluency (characters/min)$^b$</td>
<td>N/A</td>
<td>151.40 (55.20)</td>
<td>175.00 (51.90)</td>
</tr>
<tr>
<td>Correct wrong characters</td>
<td>.92</td>
<td>.54 (.22)</td>
<td>.73 (.16)</td>
</tr>
<tr>
<td>Dictation</td>
<td>.90</td>
<td>.50 (.14)</td>
<td>.59 (.10)</td>
</tr>
<tr>
<td>Copy characters</td>
<td>.53</td>
<td>.92 (.05)</td>
<td>.93 (.05)</td>
</tr>
<tr>
<td>Interpret novel words</td>
<td>.93</td>
<td>.68 (.14)</td>
<td>.75 (.17)</td>
</tr>
<tr>
<td>Discriminate morphemes</td>
<td>.76</td>
<td>.74 (.13)</td>
<td>.81 (.12)</td>
</tr>
</tbody>
</table>

*Note.*  
$N = 154$ for grade 2. $N = 146$ for grade 3. Except as noted, the scale was proportion correct.  
$^a$Write characters, make words, make characters scores are shown in number of correct characters or words.  
$^b$Reading fluency scores are shown in number of characters read per minute in correctly verified sentences.
### TABLE 2
Correlations Between IQ, Initial Literacy Skills, and Grade 2 Measures

<table>
<thead>
<tr>
<th>Measures</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>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
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</thead>
<tbody>
<tr>
<td>1. IQ</td>
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<td></td>
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</tr>
<tr>
<td>2. Initial literacy skills</td>
<td>.50</td>
<td>—</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>3. Sentence comprehension</td>
<td>.35</td>
<td>.50</td>
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<td>4. Vocabulary</td>
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<tr>
<td>5. Dictation</td>
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<tr>
<td>6. Copy characters</td>
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<td>7. Write characters</td>
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<tr>
<td>8. Interpret novel words</td>
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<td>9. Discriminate</td>
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<td>10. Radical meaning judgment</td>
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<tr>
<td>11. Make words</td>
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<td>12. Make characters</td>
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</tr>
</tbody>
</table>

Note. N = 169 for IQ and initial literacy skills. N = 154 for grade 2 tasks. Except as noted, the correlation was significant, p < .01.

- The correlation was not significant.
- The correlation was significant, p < .05.

### TABLE 3
Correlations Between IQ, Initial Literacy Skills, and Grade 3 Measures

<table>
<thead>
<tr>
<th>Measures</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>
<th>9</th>
<th>10</th>
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</thead>
<tbody>
<tr>
<td>1. IQ</td>
<td>—</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>2. Initial literacy skills</td>
<td>.50</td>
<td>—</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Paragraph comprehension</td>
<td>.34</td>
<td>.50</td>
<td>—</td>
<td></td>
<td></td>
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<td>4. Vocabulary</td>
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<tr>
<td>5. Reading fluency</td>
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<td></td>
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</tr>
<tr>
<td>6. Correct wrong characters</td>
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<td>7. Dictation</td>
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<td>8. Copy characters</td>
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<tr>
<td>9. Interpret novel words</td>
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<td></td>
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</tr>
<tr>
<td>10. Discriminate</td>
<td></td>
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</tr>
</tbody>
</table>

Note. N = 169 for IQ and initial literacy skills. N = 146 for grade 3 tasks. Except as noted, the correlation was significant, p < .01.

- The correlation was not significant.
- The correlation was significant, p < .05.
control group did not differ significantly in initial literacy, $F[1,167] = 2.84, ns$, whereas children in the intervention group had significantly higher IQ scores than children in the control group, $F[1,167] = 6.23, p < .05$.

The effect of morphological instruction was evaluated via multivariate analysis of covariance (MANCOVA), with the factor score representing initial literacy skills and IQ employed as covariates.\(^3\) Results showed that morphological instruction significantly improved children’s performance on the morphological awareness and literacy tasks in the second grade (Hotelling’s $T^2 = 81.78$, $F[10, 141] = 7.58, p < .001, \eta_p^2 = .35$) and in the third grade (Hotelling’s $T^2 = 48.10$, $F[8, 135] = 5.64, p < .001, \eta_p^2 = .25$). IQ did not have a significant effect in either second grade (Hotelling’s $T^2 = 16.11$, $F[10, 141] = 1.49, p = .15, \eta_p^2 = .10$) or third grade (Hotelling’s $T^2 = 6.48$, $F[8, 135] = .75, p = .65, \eta_p^2 = .04$). However, there was a strong association between literacy skills measured early in first grade and later performance on literacy and morphological awareness tasks administered early in second grade (Hotelling’s $T^2 = 79.19$, $F[10, 141] = 7.35, p < .001, \eta_p^2 = .34$) and early in third grade (Hotelling’s $T^2 = 79.34$, $F[8, 135] = 5.64, p < .001, \eta_p^2 = .34$). The morphological intervention accounted for 35% of the total variability in children’s performance on morphological awareness and literacy measures in second grade, and this number dropped to 25% in third grade. In both grades, the pretest factor representing initial literacy skills accounted for 34% of the variance.

\(^3\)The data structure is hierarchical with children clustered within classrooms/schools (three experimental classrooms from schools A and B, three control classrooms from schools A, C, and D). Though there were too few schools or classrooms to evaluate effects at these levels, it is important to note that there was little variance attributable to classrooms/schools per se. The students from the three experimental classrooms in two schools performed similarly. So did the students from the three control classrooms in three schools. The students in the experimental classroom in school A performed significantly better than the students in the control classroom in that school.
Second grade reading and writing scores were combined through the first principal component (explaining 46% of the total variance) as an overall indicator of children’s literacy skills when they entered second grade. MANCOVA analysis on the third grade measures with the second grade literacy composite as a covariate showed a strong association between morphological instruction and children’s performance on literacy and morphological awareness measures one year later in third grade (Hotelling’s $T^2 = 33.80, F[7, 124] = 4.57, p < .001, \eta^2_p = .21$).

Table 5 summarizes univariate tests of significance. Morphological instruction exerted a significant influence on all reading proficiency measures and most of the morphological awareness measures in second grade, showing that students who received morphological instruction performed significantly better on these measures.

<table>
<thead>
<tr>
<th>Measures</th>
<th>Univariate $F$</th>
<th>$\eta^2$</th>
<th>Partial $\eta^2$</th>
<th>Control</th>
<th>Intervention</th>
</tr>
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<td>Grade 2</td>
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<tr>
<td>Sentence comprehension</td>
<td>7.76**</td>
<td>.05</td>
<td>.69 (.65, .73)</td>
<td>.77 (.73, .81)</td>
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</tr>
<tr>
<td>Vocabulary</td>
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<td>.09</td>
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<tr>
<td>Write characters</td>
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<td>.02</td>
<td>42.08 (39.69, 44.47)</td>
<td>44.82 (42.33, 47.30)</td>
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<tr>
<td>Interpret novel words</td>
<td>29.34**</td>
<td>.16</td>
<td>.47 (.44, .50)</td>
<td>.58 (.55, .61)</td>
<td></td>
</tr>
<tr>
<td>Discriminate morphemes</td>
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<td>.73 (.71, .76)</td>
<td>.74 (.72, .76)</td>
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</tr>
<tr>
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<td>.08</td>
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<td>.87 (.84, .90)</td>
<td></td>
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<tr>
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<td>11.48**</td>
<td>.07</td>
<td>2.66 (2.53, 2.79)</td>
<td>2.98 (2.85, 3.11)</td>
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</tr>
<tr>
<td>Make characters</td>
<td>8.77**</td>
<td>.06</td>
<td>1.52 (1.33, 1.72)</td>
<td>1.95 (1.75, 2.15)</td>
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</tr>
<tr>
<td>Grade 3</td>
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</tr>
<tr>
<td>Paragraph comprehension</td>
<td>9.57**</td>
<td>.06</td>
<td>.45 (.42, .48)</td>
<td>.52 (.49, .55)</td>
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<td>Vocabulary</td>
<td>2.27</td>
<td>.02</td>
<td>.58 (.55, .61)</td>
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<tr>
<td>Reading fluency</td>
<td>4.92*</td>
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<td>153.67 (141.55, 165.78)</td>
<td>172.87 (161.10, 184.65)</td>
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</tr>
<tr>
<td>Correct wrong characters</td>
<td>33.82**</td>
<td>.19</td>
<td>.55 (.51, .59)</td>
<td>.72 (.68, .76)</td>
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</tr>
<tr>
<td>Dictation</td>
<td>17.58**</td>
<td>.11</td>
<td>.51 (.49, .53)</td>
<td>.58 (.56, .61)</td>
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</tr>
<tr>
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<td>.00</td>
<td>.93 (.91, .94)</td>
<td>.93 (.91, .94)</td>
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<tr>
<td>Interpret novel words</td>
<td>4.43*</td>
<td>.03</td>
<td>.69 (.66, .73)</td>
<td>.75 (.71, .78)</td>
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</tr>
<tr>
<td>Discriminate morphemes</td>
<td>8.23**</td>
<td>.06</td>
<td>.75 (.72, .78)</td>
<td>.80 (.78, .83)</td>
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</tr>
</tbody>
</table>

* $p < .05$, ** $p < .01$. 
than students in the control group, after controlling for general intelligence and ini-
tial literacy skills. The discriminate morphemes test was the only morphological
awareness task that did not yield a significant univariate $F$ in second grade,
whereas one year later in third grade, the two groups did differ significantly on this
test. Morphological instruction did not yield significant results for any of the writ-
ing measures in second grade but did show a significant influence on the dictation
task in the third grade.

In third grade, there were significant univariate $F$s on three out of the four read-
ing proficiency measures—paragraph comprehension, reading fluency, and cor-
rect wrong characters—but no overall difference between the experimental and
control group on the vocabulary test. However, a further comparison indicated that
the group that received the morphological intervention performed significantly
better on unfamiliar vocabulary items, $F[1,144] = 5.84, p < .05$, whereas on famil-
iar vocabulary most children were at ceiling and there was no difference between
the two groups, $F[1, 144] = 1.26, ns$.

Structural Equation Models of Reading and Writing Development

Structural equation models (SEMs) were constructed to evaluate whether the inter-
vention improved literacy because it increased morphological awareness. The ini-
tial theoretical model assumed that morphological instruction would increase mor-
phological awareness, which in turn would facilitate reading and writing in both
second and third grade, beyond the contribution accounted for by children’s early
reading ability. Early reading ability is a construct representing children’s IQ and
their performance on the battery of metalinguistic, reading, and writing tests ad-
ministered early in the first grade. If this model fits the data well, this would
strongly imply that increased morphological awareness is a causative factor in Chi-
nese literacy development. The key question is whether morphological awareness
can be placed on the path between morphological instruction and reading and writ-
ing.

The theoretical model was assessed using LISREL 8, a structural equation
modeling program (Jöreskog & Sörbom, 1993). Parameters were estimated using a
maximum likelihood fitting function. The observed variables IQ and the pretest
factor representing initial literacy skills were indicators of the latent variable early
reading ability. The reading, writing, and morphological awareness tasks were in-
dicators of the corresponding latent variables reading, writing, and morphological
awareness. For the latent variable morphological instruction, with the single ob-
served variable of group membership, we set the latent unit variance to 1.0 and the
error variance of the observed variable to 0.

The theoretical model was evaluated by assessing the fit between the model and
the sample data separately for the second and third grade. Several fit indices were
examined, including the chi-square test, the root mean square error of approximation (RSMEA), and the non-normed fit index (NNFI). Ideally, a good-fitting model will yield a nonsignificant chi-square value (Bentler, 1980). However, because the chi-square statistic is sensitive to sample size and deviations from normality of the observed variables (Jöreskog & Sörbom, 1993), the chi-square–to–degrees of freedom ratio statistic was also examined, for which values smaller than 2.0 are generally considered to indicate a good fit (Bollen, 1989). By convention, there is good model fit if RMSEA is less than or equal to .05 and an adequate fit if RMSEA is less than or equal to .08 (Browne & Cudeck, 1993). An NNFI greater than .90 means that little improvement can be gained from further modifications of the model (Bentler, 1990).

The initial theoretical model provided an adequate fit to the data collected early in the second grade, \( \chi^2(62, N = 154) = 111.58, p < .01, \chi^2/df \) ratio = 1.80, RSMEA = .07, NNFI = .93. Estimates of standardized path coefficient and factor loadings of individual tasks on their respective latent constructs are shown in Figure 1. All the path coefficients and factor loadings were significant with one exception: the write characters task did not have a significant loading on the latent writing factor (\( \lambda = .17, t = 1.84, ns \)). The significant loadings of all the other indicators on their respective constructs suggest that the latent variables—reading, morphological awareness, and early reading ability—were reliable and interpretable.

When the initial theoretical model was fit to the third grade data, the measures loaded on the appropriate factors and all of loadings and the standardized path coef-
ficients were significant. However, the model fell short of providing a good fit, yielding a significant chi-square, $\chi^2 (41, N = 146) = 84.67, p < .01$; a chi-square-to-degrees of freedom ratio greater than 2, $\chi^2/df = 2.07$; and a root mean square error of approximation above the cutoff value for an acceptable fit, RMSEA = .086. Modifications suggested by the LISREL program generated better fitting models, but these models were not theoretically plausible and are not considered here.

The initial theoretical model assumed the relation between morphological awareness and reading development to be unidirectional, with morphological awareness being the antecedent and cause of reading development. Another theoretical possibility is that their relationship is reciprocal, with each one influencing the other. This alternative model was tested for both second grade and third grade data. Results showed that the model would not converge for the second grade data, whereas there was a relatively good fit of the model to the observed data for third grade.

Figure 2 depicts the alternative third grade model and displays the standardized path coefficients and factor loadings, all of which were significant. The model has a fairly good fit to the data, $\chi^2 (40, N = 146) = 73.77, p < .01$, $\chi^2/df$ ratio = 1.84, RSMEA = .076, NNFI = .96. The chi-square difference between the initial and alternative models was employed to evaluate which model gives a better fit to the third grade data. The difference was significant, $\Delta \chi^2 (1) = 10.90, p < .001$, showing that the alternative model provides a better fit.

Thus, there seems to be a developmental change with respect to the relationship between morphological awareness and Chinese children’s reading and writing. In

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{third_grade_model.png}
\caption{Third grade model.}
\end{figure}
early second grade, the initial model yielded a reasonable fit, which is consistent with a unidirectional causal relationship. In early third grade, the alternative model, which posits a bidirectional rather than unidirectional relationship, provided a better representation of the connection between morphological awareness and literacy development.

We evaluated models containing other possible paths between the latent variables—reading, writing, and morphological awareness—but the models assuming other paths either would not converge or had an unacceptable fit to data. Among the models that would not converge with either the second grade or third grade data were ones assuming a bidirectional connection between reading and writing.

Growth in Literacy During the First and Second Grade

Hierarchical regression analyses were conducted to evaluate the role of morphological awareness and phonological awareness in growth in literacy, controlling for IQ and literacy level at the beginning of the year and pooling children who did and did not receive the morphological intervention. First principal component scores, explaining 46% of the total variance in the second grade literacy measures and 59% of the variance in the third grade literacy measures, served as composite indicators of children’s literacy skills. In the predication of the grade 2 literacy composite, early grade 1 morphological awareness accounted for significant additional variance ($\Delta R^2 = .05$, $p < .01$) when entered after IQ, grade 1 literacy, and grade 1 phonological awareness. In comparison, early grade 1 phonological awareness accounted for significant variance in the grade 2 literacy composite when entered after IQ and grade 1 literacy ($\Delta R^2 = .02$, $p < .05$) but its contribution was nil ($\Delta R^2 = .00$, $p = .36$) once grade 1 morphological awareness entered the equation. In the predication of the grade 3 literacy composite, early grade 2 morphological awareness accounted for significant additional variance ($\Delta R^2 = .02$, $p < .01$) when entered after the grade 2 literacy composite (phonological awareness was not assessed in the grade 2 battery). These analyses indicate that the level of morphological awareness children have at the beginning of the school year forecasts the growth they will achieve during the year.

DISCUSSION

The major result of this study was that morphologically enhanced instruction had robust effects on Chinese children’s literacy development in both the first and the second grade. Effects were obtained on a broad array of measures. Not only did morphological instruction influence performance on tasks directly tapping aspects of morphological awareness, but significant effects were seen early in the second grade on tasks tapping vocabulary knowledge and sentence reading comprehen-
sion and early in the third grade on measures of word dictation, reading fluency, and paragraph reading comprehension. An analysis controlling for early second grade performance—which, therefore, removed effects due to morphological instruction in the first grade—showed that morphological instruction in the second grade had benefits for literacy above and beyond those obtained from morphological instruction in the first grade.

Our results add to those of other intervention studies with alphabetic and non-alphabetic languages to confirm that expanding children’s morphological awareness accelerates their reading and writing. Of particular interest is the question of whether morphological awareness has a causal relationship to literacy development. Establishing a causal relationship requires sets of converging data, ideally involving longitudinal studies, training studies, and systematic contrasts with appropriate comparison groups. Our results clearly suggest that morphological awareness is a direct cause of literacy development. Not only did the morphological intervention lead to improved literacy, but the best-fitting structural equation models place morphological awareness on the causal path between the morphological intervention and improved literacy. An additional corroborating finding is that in each year of this longitudinal study morphological awareness at the beginning of the school year predicts growth in literacy during that year.

Early in second grade, the SEM that provides the best fit to the data assumes that morphological awareness has a unidirectional influence on literacy. But by early third grade, an alternative model, which posits a bidirectional rather than unidirectional relationship, provides a better representation of the connection between morphological awareness and literacy development. That the relationship changes over the first 2 years of school makes sense considering the demands of learning to read Chinese. Children cannot read with any fluency or independence until they have mastered a large number of characters. Over 400 characters are introduced in first grade and over 700 in the second grade (Shu et al., 2003, table 1, p. 31). Presumably, it is typically some time in the second grade before Chinese children have mastered enough characters to begin to read well. At this point, children can extend their insights about morphology while reading and writing and, hence, the relationship between morphological awareness and literacy becomes reciprocal. In other words, when children reach a certain level of mastery of basic literacy skills, the relation becomes causal in both directions; the experience children have while reading and writing influences the acquisition of morphology, and their knowledge of morphology affects their reading and writing.

Reading and writing are usually assumed to be interdependent. For instance, according to Ehri (1997), reading and spelling English words entail essentially one and the same process, because both draw on lexical memory and utilize knowledge of letter patterns and speech sounds. Similarly, it is natural to assume that reading and writing Chinese are reciprocal interdependent processes. Thus, we were surprised that SEMs assuming a reciprocal relationship between read-
ing and writing would not converge. Instead, simple models that assume that reading is antecedent to writing fit the data satisfactorily. Evidently, among Chinese first and second graders, reading exerts more influence on writing than writing on reading.

Several specific results of the present study were inconsistent with expectations. The write characters task, administered early in the second grade, did not discriminate between the group that received morphological instruction and the group that did not. This is inconsistent with Packard et al. (2006), who reported a strong influence of morphological instruction on this task. We do not have a ready explanation for the discrepant results.

Also unanticipated was the failure of the copy characters task to discriminate between groups. This failure is less difficult to explain. The version of the copy characters task employed in the present study was too easy in both second and third grade, not very reliable in the third grade, and did not include pseudocharacters constructed from familiar components in legal positions, the type of copy character item that in another study most strongly discriminated between good and poor readers (Anderson et al., 2004).

The intervention group and the control group differed significantly on the discriminate morphemes test in the third grade but not the second grade. The reason may be that the test requires an understanding of the morphological structure of two-character words, which received more emphasis in the second year of the intervention.

A final puzzle is why the dictation test strongly discriminated between groups in the third grade but not in the second grade. A possible explanation is that the second grade version of the dictation test included single-character words, as well as multi-character words, whereas the third grade version included only multi-character words. Writing words of two or more characters presumably makes greater demands on morphological knowledge than writing single characters (see Kuo & Anderson, 2006, p. 173) and, therefore, the task employed in the third grade was probably more sensitive to the effects of morphological instruction. Another probable reason is that writing multi-character words benefited from the increased emphasis on the morphology of multi-character words during the second grade.

Two features of the present study might be considered strengths from some perspectives but limitations from other perspectives. One such feature is that the measures used in the third grade were different from the measures used in the second grade. This is a strong point in that it provides a wider base for conclusions about the effects of morphological instruction; however, it is a limitation when trying to make comparisons across grades. A second such feature is that the intervention addressed several aspects of graphomorphological and morphological awareness and involved a variety of instructional activities. This contributes to ecological validity and quite probably the effectiveness of the instruction, but it is a limitation when it comes to determining exactly which component or components of the intervention were im-
portant for growth in literacy. Indeed, since the control teachers did not participate in a workshop or weekly seminars, the study leaves open the possibility that any kind of relevant training for teachers would have led to better student outcomes.

The results from this study suggest that the literacy achievement of Chinese children can be accelerated through systematic morphological instruction. However, the instruction involves a departure from tradition, requires extensive teacher training, and is not necessarily easy for teachers to implement. In an interview at the end of the first grade, one teacher said that morphological instruction was difficult at the beginning because we must teach so much more about the characters, but now the children understand the structure of characters. This was hard work for the teacher, because the children attending this school don’t know much about characters. But, once they learned the structure of characters, children were able to “teach themselves” new characters. So, later the method was easier than the traditional method.

In conclusion, the present findings appear to strongly confirm that morphological awareness is a key factor in the literacy development of Chinese children. Morphologically enhanced instruction had significant effects on an array of measures in both second and third grade. Models fit to the data suggest that morphological awareness is a cause of growth in literacy and that, when children begin to master basic literacy, the relationship between morphological awareness and literacy becomes one of mutually supportive reciprocal causation. Our study provides a distinctive angle for examining the impact of morphological awareness on children’s reading and writing, since most literacy research is conducted in the West with children learning alphabetic languages. Despite the differences between the Chinese language and alphabetic languages and despite the differences in the culture and pedagogical practices of China and Western countries, the findings of this study parallel those obtained in the West, underscoring the universal importance of morphological awareness for literacy development.

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REFERENCES


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