Comparing Computer-based Instructional Methods for Chinese Character Learning

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Abstract

The present project aims to design a computer-based tutor that promotes the robust learning of Chinese characters for Chinese as a foreign language (CFL) learners. While much previous research has focused on the teaching of Chinese characters based on semantic radicals and phonetic components, these instructional methods can only be applied to a limited subset of characters. In this project, we aim to determine which general methods are effective in teaching all Chinese characters. Two experiments were designed to compare different methods for teaching Chinese characters. In the first experiment, I compared the effectiveness of rote memorization tasks vs. handwriting/pinyin-typing tasks for learning Chinese characters. In the second experiment, I compared the effectiveness of learning Chinese characters without context vs. within the context of a meaningful sentence. The results suggest that rote memorization exercises are more effective than handwriting/pinyin-typing exercises, and introducing characters without context is more effective than introducing characters within the context of a sentence.

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I would also like to thank John Kowalski, the research programmer for this project, who provided valuable suggestions for the design of the tutor and who worked tirelessly to prepare the experiment code. This project could not have been implemented without his help.

Finally, I would like to dedicate this thesis to my family and friends, who have never failed to provide me with care and support throughout my work on this project. Their patience, understanding, and encouragement were what helped me through the long hours of work. I am so grateful to be surrounded by such a caring group of people.

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Comparing Computer-based Instructional Methods for Chinese Character Learning

The Chinese language uses a logographic writing system, in which almost every character represents a single unit of meaning, or morpheme. Unlike in alphabetic writing systems, Chinese characters are not directly linked to units of sound, or phonemes, in a systematic way. Therefore, learners of Chinese cannot simply "sound out" unfamiliar Chinese words but must instead learn the pronunciation and meaning of each individual character. This can be a daunting task for Chinese language learners because it has been estimated that one needs to learn at least the 3,000 most common characters in order to read a Chinese newspaper of average difficulty (Shen & Ke, 2007).

Approximately 80% to 90% of Chinese characters are semantic-phonetic compounds containing a semantic radical and a phonetic component, which function as cues to a character's meaning and pronunciation, respectively. For example, the character 妈 /mā/ (mother) contains the semantic radical 女 (female) and the phonetic component 马 /mǎ/ (Shu et al., 2003). Previous studies on Chinese character learning have emphasized the role of these components in helping foreign language students to learn Chinese characters (Taft & Chung, 1999; Jackson, Everson, & Ke, 2003). However, despite the evidence showing the benefits of semantic and phonetic component instruction on character acquisition, this method of instruction cannot be used to teach all Chinese characters because (1) not all Chinese characters are semantic-phonetic compounds and (2) only a subset of semantic-phonetic compounds are composed of components which are reliable cues for meaning or pronunciation. An analysis of 2,570 elementary school level Chinese characters found that only 39% of the semantic-phonetic compounds contained phonetic components that were reliable cues for pronunciation, and only 65% of compounds contained semantic radicals that were reliable cues for meaning (Shu et al., 2003).

Since learners cannot rely only on semantic and phonetic component instruction to learn new characters, we need a more general method for effectively teaching Chinese characters in which semantic/phonetic component information is provided only as supplementary information rather than treated as the focus of instruction. Thus, the aim of this project is to determine which general methods for teaching Chinese characters are most effective and to ultimately create a computerized system for teaching Chinese characters using these methods. To achieve this goal, this project investigates two main questions: (1) How do rote memorization and handwriting/pinyin-typing tasks differ in their effects on character acquisition and retention? (2) How does learning Chinese characters with context vs. without context affect character acquisition and retention?

With regard to the first question, a previous study found that handwriting practice promotes character-meaning links, while pinyin-typing practice promotes character-pronunciation links (Guan et al., 2011). Thus, I hypothesize that writing/pinyin-typing tasks will promote better long-term retention of the characters but that rote memorization tasks will promote better immediate learning due to the repetitiveness of the task.

With regard to the second research question, previous research has shown that foreign language vocabulary can be learned and retained when presented in a sentence with strong context clues and that this type of learning is especially effective when learners receive feedback on their guesses about the meanings of the words (Grace, 1998). To my knowledge, however, no previous studies have investigated the effectiveness of learning Chinese characters within the context of a sentence. Thus, the second experiment of this study aims to compare the effects of learning Chinese characters individually vs. within the context of a meaningful sentence. One possible outcome is that, similar to vocabulary learning in other languages, Chinese characters

may be learned better within sentences because inferring word meanings from context allows for deeper processing. However, a possible alternative outcome is that Chinese characters may be better learned individually because unlike in most other languages, Chinese vocabulary learning requires learners to link the meaning of a word to a unique visual form, and introducing new characters in the context of a sentence may detract attention from this process.

Experiment 1

Experiment 1 was designed to examine the effectiveness of teaching Chinese characters when characters were introduced through computerized flashcards (rote memorization condition), compared with when characters were introduced through handwriting and pinyin-typing exercises that included semantic radical information for characters containing reliable semantic radicals (handwriting/pinyin-typing condition).

Based on the results of a study by Guan et al. (2011) which found that writing practice promotes character-meaning links while pinyin-typing practice promotes character-pronunciation links, I predicted that that the rote memorization condition will promote better immediate learning due to the repetitiveness of the task but that the handwriting/pinyin-typing condition will promote better long-term retention of the characters.

Methods

Participants. Eleven Carnegie Mellon University students (6 female, 5 male), aged 18-27 years (M = 20.27, SD = 3.47) and enrolled in Elementary Chinese I, participated in the experiment. All participants received $20 for their participation in the 2-hour experiment. Eight

students spoke English as a first language; one student's first language was Balochi; one student's first language was Urdu; one student's first language was Korean.

Materials and procedures.

Stimuli. A total of 59 items were used in Experiment 1 (see Appendix A). The items were selected from Lessons 11 and 12 in the Elementary Chinese I curriculum (Wu, Yu, Zhang, & Tian, 2010). These lessons had not yet been covered in class at the time the experiment was conducted. 39 items were single-character words, and 20 items were two-character terms. 24 items contained at least one character with a reliable semantic radical. The 59 items were divided into two groups.

Audio recordings of the Mandarin Chinese pronunciation of each item played during parts of the experiment. For each item, the recording consisted of the entire item pronounced twice, once by a female native Mandarin speaker and once by a male native Mandarin speaker.

Design. A within-subjects design was used to compare the effectiveness of teaching Chinese characters through two instructional methods: rote memorization vs. handwriting/pinyin-typing exercises. The condition in which each of the two groups of items was introduced and the order in which the conditions were presented were counterbalanced across learners. Dependent variables were response times and accuracy on pinyin transcription and English translation tasks in the pretest, immediate posttest, and delayed posttest.

Procedure. The tutor was programmed using Java and the study was administered online. The experiment consisted of two sessions lasting a total of approximately two hours. Session One included a pretest (approximately 10 minutes), a training session (approximately 25-35 minutes), and an immediate posttest (approximately 10 minutes) for each of the two conditions.

Session Two was the delayed posttest (approximately 15 minutes) and was administered two weeks after Session One.

In Session One, learners accessed the tutor online at a campus computer lab under the supervision of the researcher. Learners logged into the experiment using an assigned username, viewed an instruction screen explaining how to enter pinyin and English translation responses in the tutor, and then completed three practice items to get used to entering responses in the tutor. Learners then completed a pretest, training session, and immediate posttest for one group of character items in one condition. Afterwards, learners completed a pretest, training session, and immediate posttest for the other group of character items in the other condition. The order of the items in the pretest, training, and posttest was randomized.

In the pretest and posttest, learners were asked to give the pinyin and English translation for a group of character items which were presented one at a time (see Figure 1). Learners did not receive feedback on their responses and were not given a time limit for this task. The format of the pretest and posttest tasks was the same for both the rote memorization condition and the handwriting/pinyin-typing condition.

Figure 1. A response screen used in the pretest and posttest for both conditions and in the training session for the rote memorization condition in Experiment 1.

In the training session for the rote memorization condition, learners were instructed to give the pinyin and English translation for the character items, similar to the pretest and posttest tasks. The only difference was that learners received feedback on their responses in the training session. After learners submitted responses for an item, they were shown a feedback screen for 10 seconds (see Figure 2). An audio recording of the Mandarin pronunciation for the item played while the feedback screen was shown. Each item was shown once before the group of character items was shown again in a different random order. This cycle repeated until the end of the training session, which had a time limit of 35 minutes.

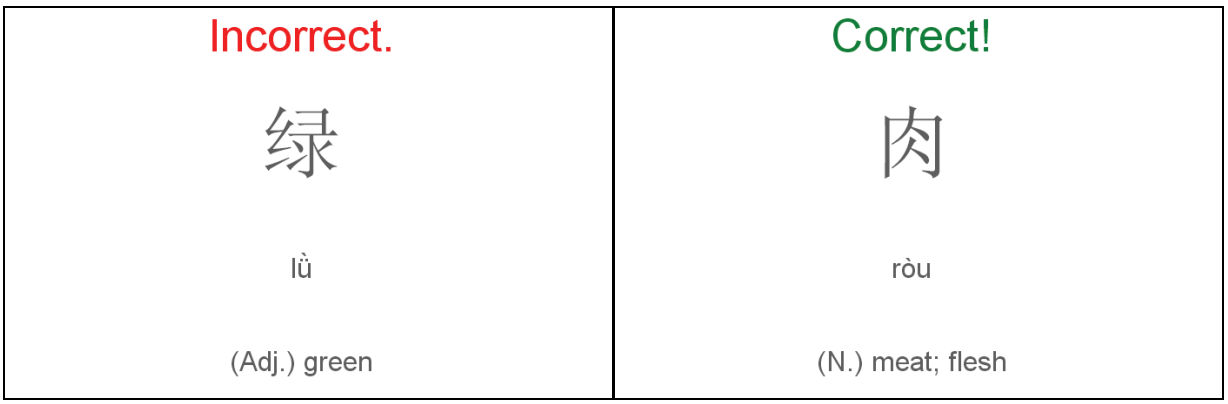

Figure 2. Rote memorization feedback screens in Experiment 1.

In the training session for the handwriting/pinyin-typing condition, learners worked on handwriting and pinyin-typing exercises for each item one at a time. The items were presented in a randomized order, and each item was presented only once during the training session. For the pinyin-typing exercise, learners were shown a screen with a character item and its English translation (see Figure 3). Learners were instructed to listen to the Mandarin pronunciation of the item and then enter the pinyin for the item. If their pinyin response was incorrect, they were

asked to try again (see Figure 3). Learners could listen to the Mandarin pronunciation of the item as many times as they wanted by clicking on the sound icon on the screen, and there was no time limit for their response. They were shown a feedback screen with the correct pinyin and English translation for the item for 10 seconds after a correct response (see Figure 4) or after five incorrect responses for the item (see Figure 5). The pronunciation of the character item automatically played again on the feedback screen.

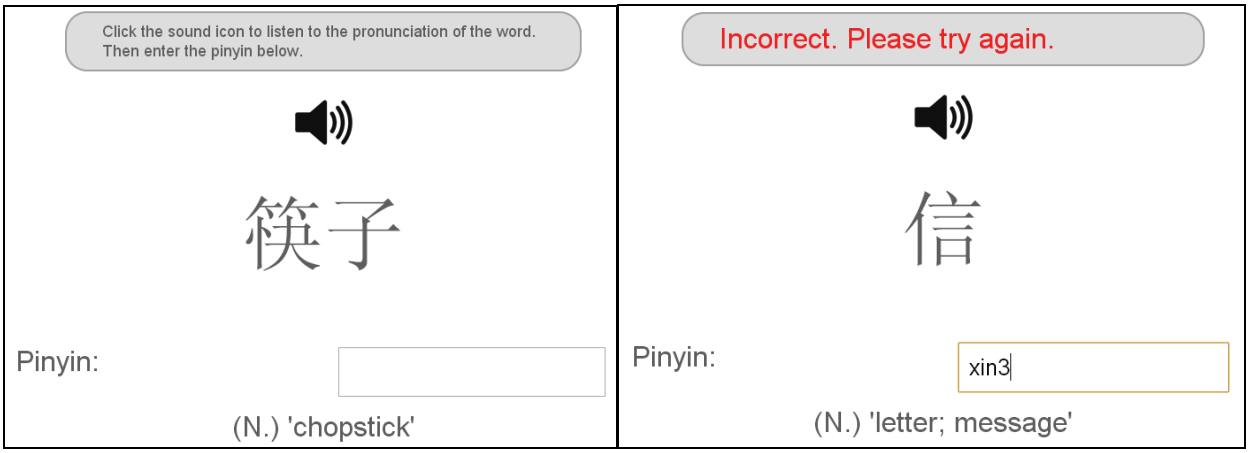

Figure 3. Pinyin-typing exercise screen in Experiment 1.

Figure 4. Pinyin-typing exercise correct response feedback screen in Experiment 1.

Figure 5. Pinyin-typing exercise feedback screen after five incorrect responses in Experiment 1.

After learners completed the pinyin-typing exercise for an item, they were presented with the handwriting exercise for the same item. The handwriting exercise screen was shown for a total of 70 seconds (see Figure 6). For the first 10 seconds, the instructions on the screen asked learners to study the meaning of the character item. If a character in the item contained a reliable semantic radical, information about the radical and its link to the item's meaning was shown on the screen. For the last 60 seconds, learners were instructed to practice writing the character item three times on a sheet of paper that they received at the beginning of the experiment. This sheet was collected at the end of the experiment to ensure that the learners completed this handwriting task. After 60 seconds, the screen automatically advanced to the pinyin-typing exercise for the next item. The training session for the handwriting/pinyin-typing condition ended when all the items in the set had been presented.

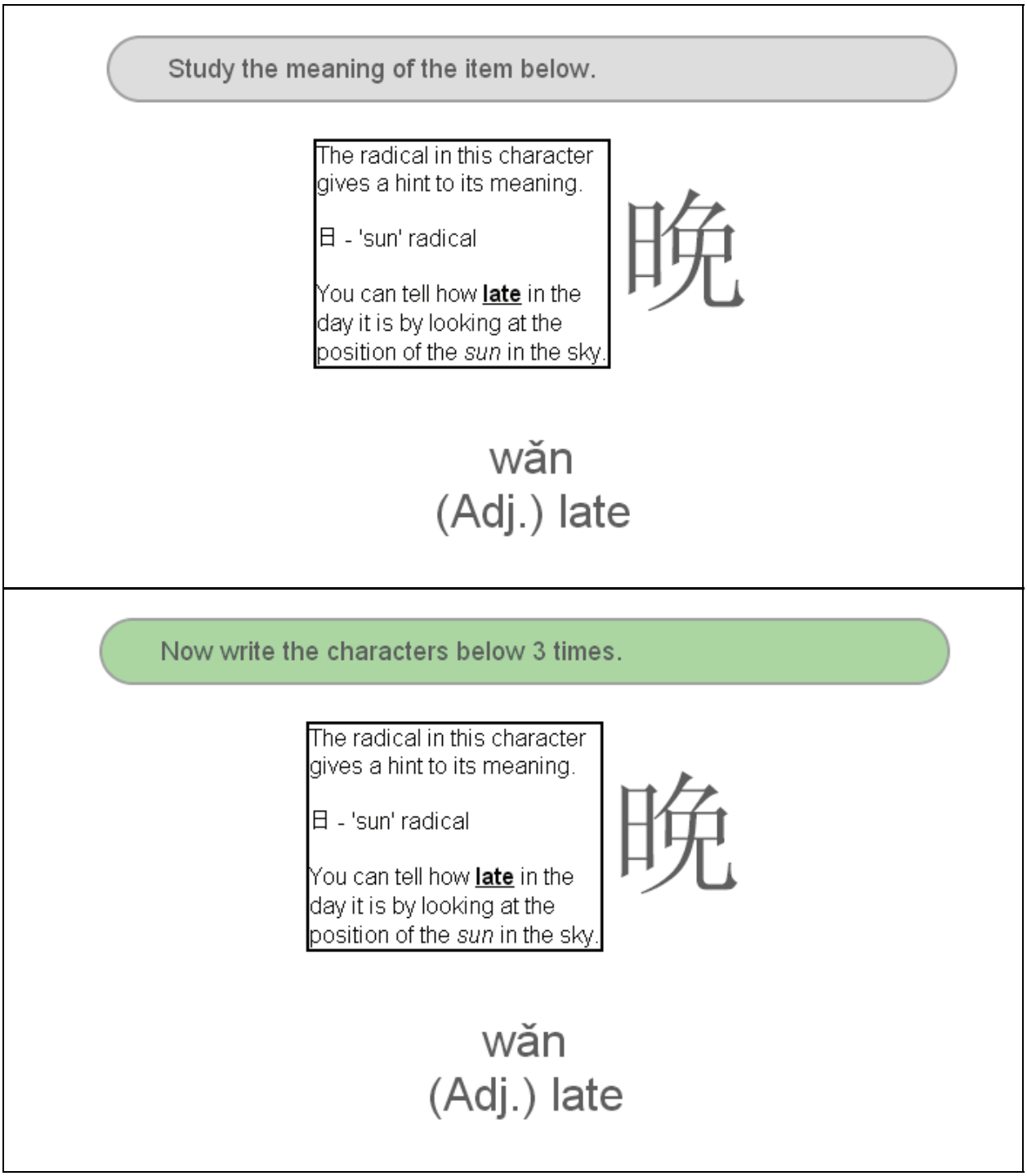

Figure 6. Handwriting exercise screens in Experiment 1.

In Session Two of the experiment, learners logged into the experiment with the same username as Session One and completed the delayed posttest. The task in the delayed posttest

was the same as in the pretest and posttest for Session One. Learners were asked to enter the pinyin and English translation for all 59 items, presented in a randomized order. They did not receive feedback on their responses.

Results

Analyses were conducted to compare the rote memorization condition and the handwriting/pinyin-typing condition in terms of gained and retained pinyin and translation accuracy. The pinyin accuracy and translation accuracy means are shown in Table 1 and Table 2, respectively.

Table 1

Descriptive Statistics Comparing Rote Memorization vs. Handwriting/Pinyin-typing Exercises (Mean Pinyin Accuracy) in Experiment 1

	Rote Memorization		Handwriting/Pinyin-typing	
	Mean Pinyin Accuracy	SD	Mean Pinyin Accuracy	SD
Pretest	.107	.168	.111	.139
Posttest	.629	.259	.355	.302
Delayed Posttest	.283	.266	.194	.164
Gained	.522	.211	.243	.227
Retained	-.346	.099	-.161	.189

Table 2

Descriptive Statistics Comparing Rote Memorization vs. Handwriting/Pinyin-typing Exercises (Mean Translation Accuracy) in Experiment 1

	Rote Memorization		Handwriting/Pinyin-typing	
	Mean Translation Accuracy	SD	Mean Translation Accuracy	SD
Pretest	.149	.215	.140	.186
Posttest	.780	.207	.506	.264
Delayed Posttest	.390	.285	.288	.248
Gained	.631	.179	.366	.174
Retained	-.390	.149	-.218	.123

A paired samples t-test was conducted to compare the effectiveness of rote memorization practice vs. handwriting/pinyin-typing exercises on gained pinyin accuracy from pretest to posttest. There was a significant difference between gained pinyin accuracy in the rote memorization condition (M = .522, SD = .211) and the handwriting/pinyin-typing condition (M = .243, SD = .227); $t(10) = 6.717$, $p < .0001$. These results suggest that the rote memorization practice was more effective than the handwriting/pinyin-typing exercises at improving learners' pinyin accuracy.

A paired samples t-test was also conducted to compare the effectiveness of rote memorization practice vs. handwriting/pinyin-typing exercises on gained translation accuracy from pretest to posttest. There was a significant difference between gained translation accuracy in the rote memorization condition (M = .631, SD = .179) and the handwriting/pinyin-typing condition (M = .366, SD = .174); $t(10) = 7.996$, $p < .0001$. These results suggest that the rote

memorization practice was also more effective than the handwriting/pinyin-typing exercises at improving learners' translation accuracy.

A paired samples t-test did not find a significant difference between gained response time for the rote memorization condition compared to the handwriting/pinyin-typing condition, $t(10) = 1.579$, $p = .146$.

A paired samples t-test was conducted to compare the effectiveness of rote memorization practice vs. handwriting/pinyin-typing exercises on retained pinyin accuracy from the immediate posttest to the delayed posttest. Figure 7 shows the pinyin learning trajectories of the rote memorization condition vs. the handwriting/pinyin-typing condition. There was a significant difference between retained pinyin accuracy in the rote memorization condition ($M = -.346$, $SD = .099$) and the handwriting/pinyin-typing condition ($M = -.161$, $SD = .189$); $t(10) = 2.957$, $p = .0144$. These results suggest that the pinyin of items learned in the handwriting/pinyin-typing condition were retained better over time than those in the rote memorization condition.

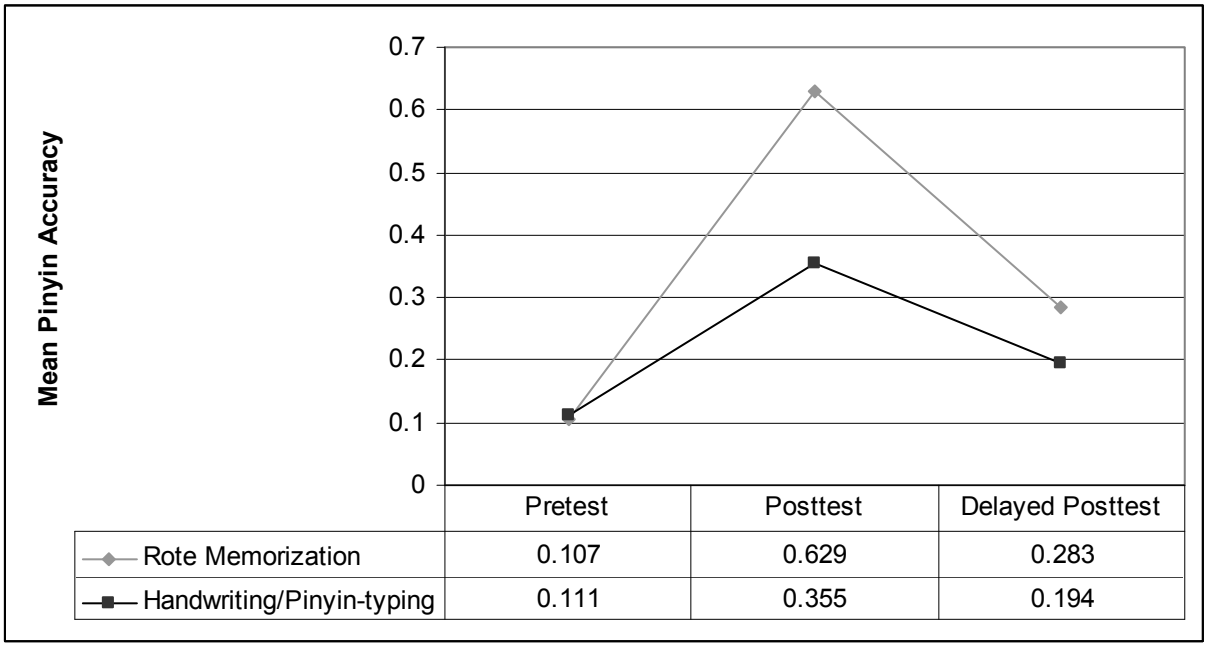

Figure 7. Mean Pinyin Accuracy of the Rote Memorization and Handwriting/Pinyin-typing Conditions in the Pretest, Posttest, and Delayed Posttest in Experiment 1.

A paired samples t-test was also conducted to compare the effectiveness of rote memorization practice vs. handwriting/pinyin-typing exercises on retained translation accuracy from the immediate posttest to the delayed posttest. Figure 8 shows the translation learning trajectories of the rote memorization condition vs. the handwriting/pinyin-typing condition. There was a significant difference between retained translation accuracy in the rote memorization condition (M = -.390, SD = .149) and the handwriting/pinyin-typing condition (M = -.218, SD = .123); $t(10) = 3.687$, $p = .0042$. These results suggest that the meanings of items learned in the handwriting/pinyin-typing condition were retained better over time than those in the rote memorization condition.

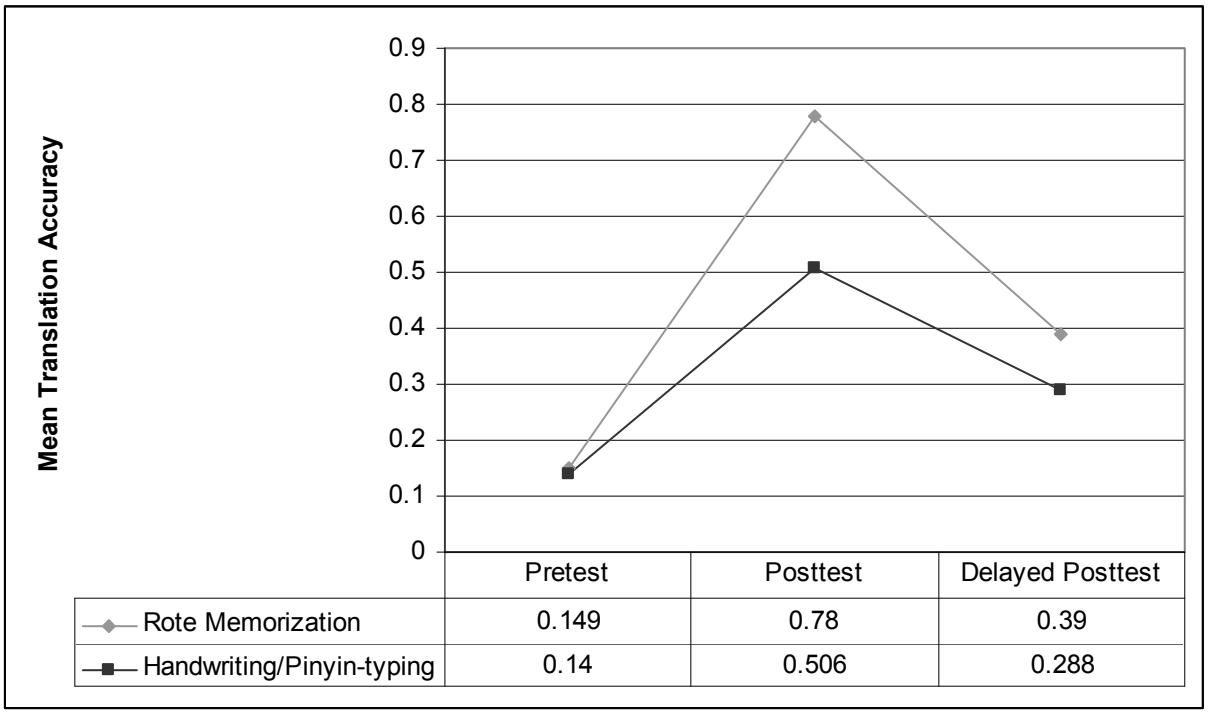

Figure 8. Mean Translation Accuracy of the Rote Memorization and Handwriting/Pinyin-typing Conditions in the Pretest, Posttest, and Delayed Posttest in Experiment 1.

A paired samples t-test did not find a significant difference between retained response time for the rote memorization condition compared to the handwriting/pinyin-typing condition, $t(10) = 1.811$, $p = .100$.

Discussion

The results of Experiment 1 showed that rote memorization tasks were more effective than handwriting/pinyin-typing tasks in increasing learners' pinyin and translation accuracy. However, the results also showed that items learned through handwriting/pinyin-typing tasks were retained better over the course of two weeks than those learned through the rote memorization tasks. I found no difference between the rote memorization and handwriting/pinyin-typing conditions in their effect on response time.

These results are in line with my original hypothesis that handwriting/pinyin-typing tasks would promote better long-term retention of character knowledge while rote memorization tasks would promote better immediate acquisition of characters.

Due to the repetitiveness of the rote memorization task, learners may have initially acquired the characters introduced with this method more easily because each character item had been presented several times during the training session. Furthermore, the task during the training session was identical to the task in the posttest with the exception of feedback screens, so there may have been a practice effect that boosted their performance in the immediate posttest but then faded for the delayed posttest.

On the other hand, the handwriting/pinyin-typing task may have promoted long-term retention of the characters because this method facilitated deeper processing of the characters. First, the length of time for a single exposure to each character item in the handwriting/pinyin-

typing condition was longer than in the rote memorization condition, allowing learners to study each character for larger chunks of time. Also, the pinyin-typing and handwriting tasks forced learners to engage more deeply with the study materials than simply making unguided guesses and viewing feedback. The handwriting task especially encouraged learners to study the structure of the characters by writing them down.

In summary, the results of Experiment 1 showed that rote memorization tasks promote better short-term character acquisition while handwriting/pinyin-typing tasks promote better long-term retention. To determine whether rote memorization tasks could be modified to improve long-term retention as well, I conducted a second experiment to determine whether including examples of character usage in context would promote both immediate acquisition and long-term retention.

Experiment 2

In this experiment, I looked at two competing hypotheses. One possible outcome would be that introducing characters in context would improve character acquisition and retention because inferring word meanings from context encourages deeper processing. The other possible outcome would be that including context would not improve character learning because the extra information might detract attention from the process of studying the character forms.

Methods

Participants. Ten Carnegie Mellon University students (6 female, 4 male), aged 18-27 years ($M = 20.5$, $SD = 2.55$) and enrolled in Elementary Chinese II, participated in the

experiment. All participants received $20 for their participation in the 2-hour experiment. Eight students spoke English as a first language; one student's first language was Urdu; one student's first language was Korean.

Materials and procedures.

Stimuli. A total of 60 items were used in Experiment 1 (see Appendix C). The items were selected from Lessons 1-5 in the Intermediate Chinese I curriculum, which the participants had not yet encountered in their Chinese classes (Wu, Yu, Zhang, 2007). 32 items were single-character words, and 28 items were two-character terms. The 60 items were divided into two groups of 30 items each.

Audio recordings of the Mandarin Chinese pronunciation of each item played during parts of the experiment. For each item, the recording consisted of the entire item pronounced twice, either by a female native speaker of Mandarin or by a male native speaker of Mandarin.

Design. A within-subjects design was used to compare the effectiveness of teaching Chinese characters when characters were introduced without context vs. within the context of a meaningful sentence. The condition in which each of the two groups of items was introduced and the order in which the conditions were presented were counterbalanced across learners. Dependent variables were response times and accuracy on pinyin transcription and English translation tasks in the pretest, immediate posttest, and delayed posttest.

Procedure. The tutor was programmed using Java and the study was administered online. The experiment consisted of two sessions lasting a total of approximately two hours. Session One included a pretest (approximately 10 minutes), a training session (approximately 30 minutes), and an immediate posttest (approximately 10 minutes) for each of the two conditions.

Session Two was the delayed posttest (approximately 15 minutes) and was administered one week after Session One.

The basic procedure for Session One in Experiment 2 was identical to Experiment 1. Learners logged into the experiment at a campus computer lab under the supervision of the researcher and completed a pretest, training session, and immediate posttest for each of the two sets of character items. The format of the pretest and posttest tasks was the same as in Experiment 1.

The format of the training session for the no context condition was identical to that of the rote memorization condition in Experiment 1. This training session had a time limit of 30 minutes.

The format of the training session for the context condition was similar to that of the no context condition except that an example sentence containing the target item highlighted in blue was shown at the top of the response screen (see Figure 9).

Figure 9. A response screen used in the training session for the context condition in Experiment 2.

After learners submitted responses for an item, they were shown a feedback screen for 10 seconds (see Figure 10). An audio recording of the Mandarin pronunciation for the item played while the feedback screen was shown. Each item was shown once before the group of character items was shown again in a different random order. This cycle repeated until the end of the training session, which had a time limit of 30 minutes.

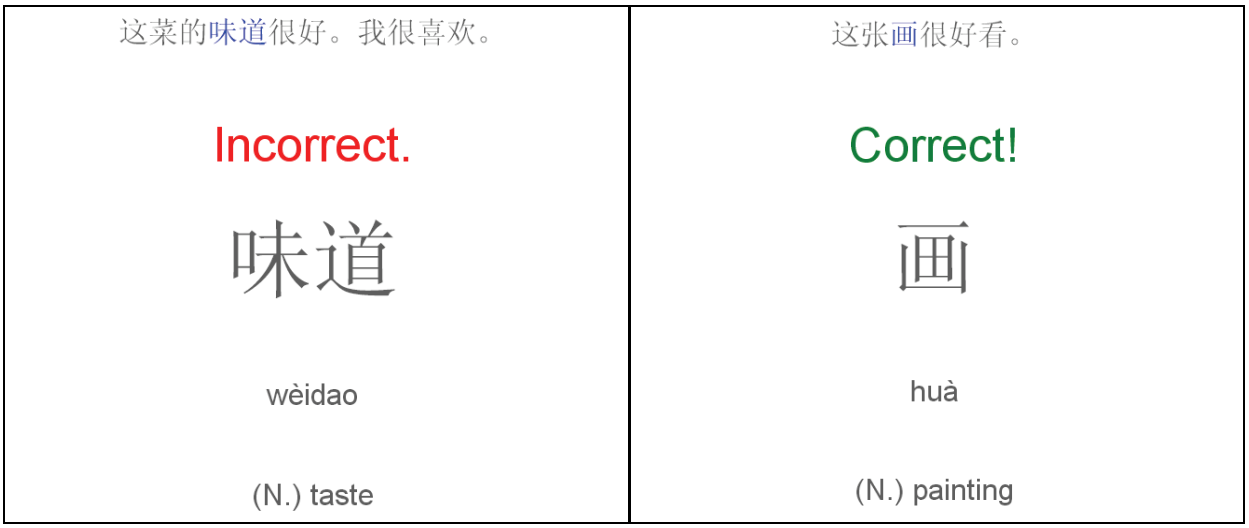

Figure 10. Feedback screens used in the training session for the context condition in Experiment 2.

Results

Analyses were conducted to compare the context condition and the no context condition in terms of gained and retained pinyin and translation accuracy. The pinyin accuracy and translation accuracy means are shown in Table 3 and Table 4, respectively.

Table 3
Descriptive Statistics Comparing Context vs. No Context Conditions (Mean Pinyin Accuracy) in Experiment 2

	Context		No Context	
	Mean Pinyin Accuracy	SD	Mean Pinyin Accuracy	SD
Pretest	.023	.032	.013	.023
Posttest	.303	.160	.453	.199
Delayed Posttest	.067	.090	.067	.074
Gained	.280	.149	.440	.191
Retained	-.237	.151	-.387	.157

Table 4
Descriptive Statistics Comparing Context vs. No Context Conditions (Mean Translation Accuracy) in Experiment 2

	Context		No Context	
	Mean Translation Accuracy	SD	Mean Translation Accuracy	SD
Pretest	.040	.060	.057	.079
Posttest	.533	.224	.680	.174
Delayed Posttest	.177	.234	.210	.177
Gained	.493	.201	.623	.160
Retained	-.357	.183	-.470	.149

A paired samples t-test was conducted to compare the effectiveness of introducing characters with context vs. without context on gained pinyin accuracy from pretest to posttest.

There was a significant difference between gained pinyin accuracy in the context condition (M = .280, SD = .149) and the no context condition (M = .440, SD = .191); $t(9) = 2.3372$, $p = .0442$. These results suggest that introducing items without context was more effective than introducing items with context at improving learners' pinyin accuracy.

A paired samples t-test was also conducted to compare the effectiveness of introducing characters with context vs. without context on gained translation accuracy from pretest to posttest. There was a significant difference between gained translation accuracy in the context condition (M = .493, SD = .201) and the no context condition (M = .623, SD = .160); $t(9) = 2.5722$, $p = .0301$. These results suggest that introducing characters without context was also more effective than introducing characters with context at improving learners' translation accuracy.

A paired samples t-test did not find a significant difference between gained response time for the context condition compared to the no context condition, $t(9) = 1.885$, $p = .092$.

A paired samples t-test was conducted to compare the effectiveness of introducing characters with context vs. without context on retained pinyin accuracy from the immediate posttest to the delayed posttest. Figure 11 shows the pinyin learning trajectories of the context condition vs. the no context condition. There was a marginally significant difference between retained pinyin accuracy in the context condition (M = -.237, SD = .151) and the no context condition (M = -.387, SD = .157); $t(9) = 2.077$, $p = .0676$. These results suggest that the pinyin of items learned in the context condition may be retained better over time than those in the no context condition.

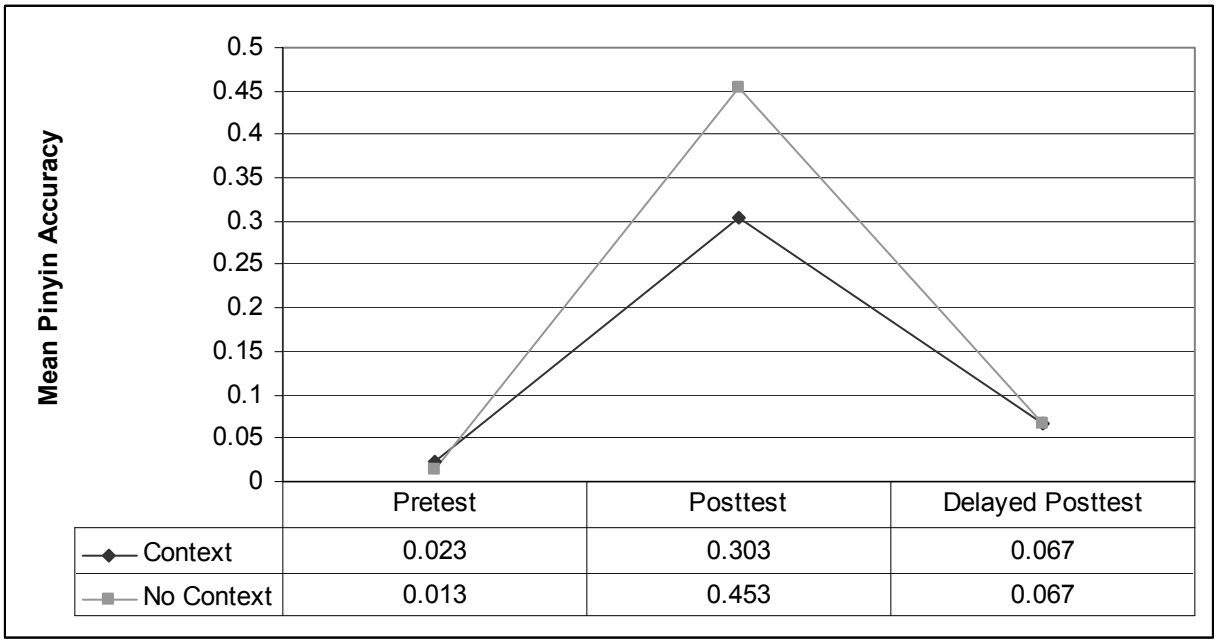

Figure 11. Mean Pinyin Accuracy of the Context and No Context Conditions in the Pretest, Posttest, and Delayed Posttest in Experiment 2.

A paired samples t-test was also conducted to compare the effectiveness of introducing characters with context vs. without context on retained translation accuracy from the immediate posttest to the delayed posttest. Figure 12 shows the translation learning trajectories of the context condition vs. the no context condition. There was a significant difference between retained translation accuracy in the context condition (M = -.357, SD = .183) and the no context condition (M = -.470, SD = .149); $t(9) = 3.285$, $p = .0095$. These results suggest that the meanings of items learned in the context condition were retained better over time than those in the no context condition.

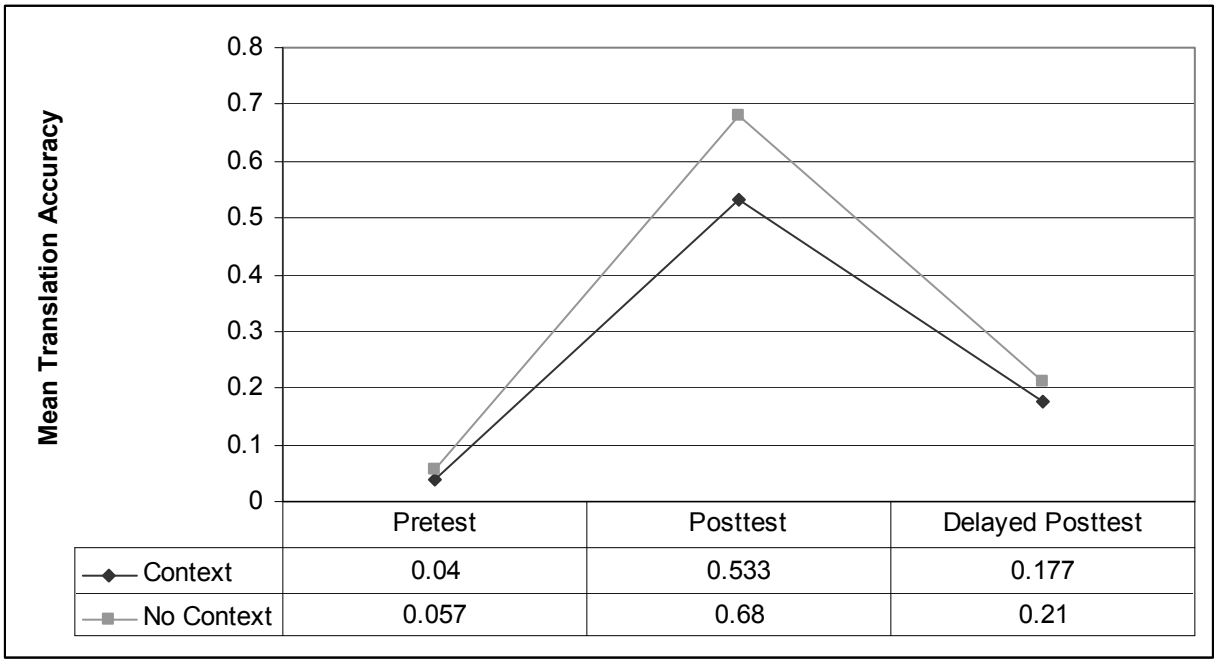

Figure 12. Mean Translation Accuracy of the Context and No Context Conditions in the Pretest, Posttest, and Delayed Posttest in Experiment 2.

A paired samples t-test did not find a significant difference between retained response time for the context condition compared to the no context condition, $t(9) = .626$, $p = .547$.

Discussion

The results of Experiment 2 showed that introducing characters without context was more effective than introducing characters within context in increasing learners' pinyin and translation accuracy. However, the results also showed that the meanings of items learned with context were retained better over the course of one week than those learned without context. There was a marginally significant effect of context on retained pinyin accuracy such that the pinyin of items learned with context tended to be better retained than those learned without context. I found no difference between the context and no context conditions in their effect on response time.

These results support the hypothesis that introducing characters with context does not improve character acquisition. In fact, the results show that introducing characters without context improves pinyin and translation accuracy over introducing characters with context. The reason for this may be because including the extra information during the initial introduction of the characters detracts learners' attention from the character itself. In this experiment, the feedback screens in the training sessions were displayed for the same amount of time in the context and no context conditions. If learners had been allowed to view the feedback screens for as long as they wanted before advancing to the next screen, the results may have been different because learners could have more time to devote their attention to the character itself in the context conditions.

However, the results did show that introducing characters in context improved long-term retention of character meaning and possibly also pinyin. This supports the hypothesis that introducing characters in context facilitates long-term retention because inferring meaning from context is a form of deep processing.

General Discussion

In this study, I asked two main research questions: (1) How do rote memorization and handwriting/pinyin-typing tasks differ in their effects on character acquisition and retention? (2) How does learning Chinese characters with context vs. without context affect character acquisition and retention?

In Experiment 1, rote memorization promoted immediate acquisition of both character meaning and pinyin while handwriting/pinyin-typing tasks promoted long-term retention of both character meaning and pinyin. In Experiment 2, introducing characters without context promoted

immediate acquisition of both character meaning and pinyin while introducing characters with context promoted long-term retention of character meaning and possibly of pinyin.

These results suggest that repetitive tasks that do not introduce too much information are best for initial acquisition of characters but that tasks that require deeper processing are more effective for long-term retention of character knowledge. With regard to the design of a computerized tutor for Chinese character learning, the results of this study suggest that an effective tutor should use a combination of both repetitive and deep processing tasks. The order in which these tasks should be utilized in the course of learning a set of characters is still unclear and should be the subject of future research. In addition, future studies should aim to examine the effects of tutor usage over the course of multiple sessions rather than just one session to see how frequent practice affects the results achieved through different instructional methods.

References

Grace, C. A. (1998). Retention of word meanings inferred from context and sentence-level translations: Implications for the design of beginning-level CALL software. *The Modern Language Journal, 82(4)*, 533-544.

Guan, C. Q., Liu, Y., Chan, D. H. L., Ye, F., & Perfetti, C. A. (2011). Writing strengthens orthography and alphabetic-coding strengthens phonology in learning to read Chinese. *Journal of Educational Psychology, 103(3)*, 509-522.

Jackson, N. E., Everson, M. E., & Ke, C. (2003). Beginning readers' awareness of the orthographic structure of semantic-phonetic compounds: lessons from a study of learners of Chinese as a foreign language. In C. McBride-Chang & H. -C. Chen (Eds.), *Reading development in Chinese children* (pp. 141-153). Westport, CT: Praeger Publishers.

Shen, H. H. & Ke, C. (2007). Radical awareness and word acquisition among nonnative learners of Chinese. *The Modern Language Journal, 91(1)*, 97-111.

Shu, H., Chen, X., Anderson, R. C., Wu, N., & Xuan, Y. (2003). Properties of school Chinese: Implications for learning to read. *Child Development, 74(1)*, 27-47.

Taft, M. & Chung, K. (1999). Using radicals in teaching Chinese characters to second language learners. *Psychologia, 42*, 243-251.

Wu, S-.M., Yu, Y., & Zhang, Y. (2007). *Chinese link: Intermediate Chinese, level 2/part 1*. Upper Saddle River, NJ: Prentice Hall.

Wu, S-.M., Yu, Y., Zhang, Y., & Tian, W. (2010). *Chinese link: Beginning Chinese, simplified character version, level 1/part 1*. Upper Saddle River, NJ: Prentice Hall.

Appendix A

Experiment 1 Stimuli

Item	Number of strokes	Pinyin	Translation	Radical Information	Group
门	3	mén	measure word for school courses		1
水	4	shuǐ	water		1
天	4	tiān	sky; heaven		1
月	4	yuè	month		1
半	5	bàn	half		1
打	5	dǎ	to hit	The radical in this character gives a hint to its meaning. 扌 - 'hand' radical A person uses his/her **hand** to **hit**.	1
过	6	guò	to pass	The radical in this character gives a hint to its meaning. 辶 - 'walk' radical One may **pass** through a place by **walking**.	1
肉	6	ròu	meat; flesh		1
汤	6	tāng	soup	The radical in this character gives a hint to its meaning. 氵 - 'water' radical **Soup** contains **water**.	1
早	6	zǎo	early		1
下午	7	xiàwǔ	afternoon		1
杯	8	bēi	cup	The radical in this character gives a hint to its meaning. 木 - 'wood' radical In ancient times, many **cups** were made out of **wood**.	1
鱼	8	yú	fish		1

Appendix A (cont.)

Item	Number of strokes	Pinyin	Translation	Radical Information	Group
差	9	chà	to lack; to be short of		1
面	9	miàn	noodles		1
秒	9	miǎo	second (as in time)		1
祝	9	zhù	to wish; to pray; to express good wishes	The radical in this character gives a hint to its meaning. 礻 - 'worship' radical **Wishing** and **praying** are often involved in **worship** activities.	1
绿	11	lǜ	green		1
做	11	zuò	to do		1
饺子	12	jiǎozi	dumpling	The radical in the first character gives a hint to its meaning. 饣 - 'food' radical **Dumplings** are a type of **food**.	1
就	12	jiù	as early as; precisely		1
果汁	13	guǒzhī	juice	The radical in the second character gives a hint to its meaning. 氵 - 'water' radical **Juice** contains **water**.	1
碗	13	wǎn	bowl	The radical in this character gives a hint to its meaning. 石 - 'stone' radical In ancient times, **bowls** were often made out of **stone**.	1
沙拉	15	shālā	salad		1
还是	16	háishì	or		1
馄饨	18	húntun	wonton	The radical in both characters gives a hint to their meaning. 饣 - 'food' radical **Wontons** are a type of **food**.	1

Appendix A (cont.)

Item	Number of strokes	Pinyin	Translation	Radical Information	Group
然后	18	ránhòu	then; after that; afterwards		1
学期	20	xuéqī	semester	The radical in the second character gives a hint to its meaning. 月 - 'moon, month' radical A **semester** is a period of time that can be measured in **months**.	1
睡觉	22	shuìjiào	to go to bed; to sleep	The radical in the first character gives a hint to its meaning. 目 - 'eye' radical A person closes his/her **eyes** when **sleeping**.	1
蛋糕	25	dàngāo	cake	The radical in the first character gives a hint to its meaning. 米 - 'rice' radical Certain types of **cake** are made from **rice** flour.	1
才	3	cái	not until; only then		2
分	4	fēn	minute		2
日	4	rì	day		2
双	4	shuāng	pair		2
写	5	xiě	to write		2
红	6	hóng	red		2
年	6	nián	year		2
先	6	xiān	first		2
每	7	měi	every; each		2
炒	8	chǎo	to stir fry	The radical in this character gives a hint to its meaning. 火 - 'fire, flame' radical A **flame** is needed for **stir frying**.	2

Appendix A (cont.)

Item	Number of strokes	Pinyin	Translation	Radical Information	Group
刻	8	kè	a quarter (of an hour)		2
茶	9	chá	tea	The radical in this character gives a hint to its meaning. 艹 - 'plant, grass' radical **Tea** is made from a type of **plant**.	2
信	9	xìn	letter; message		2
要	9	yào	to want; to desire		2
可乐	10	kělè	cola		2
瓶	10	píng	bottle	The radical in this character gives a hint to its meaning. 瓦 - 'earthenware pottery' radical In ancient times, **bottles** were a product of **pottery**.	2
盘	11	pán	plate	The radical in this character gives a hint to its meaning. 皿 - 'shallow container' radical A **plate** is a **shallow container**.	2
球	11	qiú	ball		2
晚	11	wǎn	late	The radical in this character gives a hint to its meaning. 日 - 'sun' radical You can tell how **late** in the day it is by looking at the position of the **sun** in the sky.	2
喝	12	hē	to drink	The radical in this character gives a hint to its meaning. 口 - 'mouth' radical **Drinking** is done with one's **mouth**.	2
地址	13	dìzhǐ	address	The radical in both characters gives a hint to their meaning. 土 - 'soil, ground' radical An **address** marks a location on the **ground**.	2

Appendix A (cont.)

Item	Number of strokes	Pinyin	Translation	Radical Information	Group
生活	14	shēnghuó	life	The radical in the second character gives a hint to its meaning. 氵 - 'water' radical **Water** is necessary for **life**.	2
现在	14	xiànzài	now		2
钟头	14	zhōngtóu	hour (mostly used in spoken form)		2
筷子	16	kuàizi	chopstick	The radical in the first character gives a hint to its meaning. 竹 - 'bamboo' radical **Chopsticks** are often made from **bamboo**.	2
饮料	17	yǐnliào	drink; beverage	The radical in the first character gives a hint to its meaning. 饣 - 'food' radical A **drink** can be consumed, just like **food**.	2
喜欢	18	xǐhuān	to like		2
餐厅	20	cāntīng	restaurant	The radical in the first character gives a hint to its meaning. 食 - 'food' radical A **restaurant** is a place where one eats **food**.	2
熬夜	22	áoyè	to burn the midnight oil; to stay up late	The radical in the first character gives a hint to its meaning. 灬 - 'fire' radical A **fire** is needed to **burn the midnight oil**.	2

Appendix B

Language History Questionnaire

Language History Questionnaire

- Age: _____
- Sex: ○ Male ○ Female
- Are you right-handed or left-handed? ○ Left-handed ○ Right-handed
- What is your native language (i.e. the language you speak most fluently)? _____
- Do you speak any other languages? ○ Yes ○ No
  If YES, please specify: _____
- Did you have experience with any dialect of spoken Chinese (e.g. Mandarin, Cantonese) prior to taking your current Chinese class? ○ Yes ○ No
  If YES, please specify the dialect and for how long: _____
- Did you have any experience with Chinese characters (traditional, simplified, kanji) prior to taking your current Chinese class? ○ Yes ○ No
  If YES, please specify the character system and estimate the number of characters learned: _____
- Are you learning simplified or traditional characters in your current Chinese class? ○ Simplified ○ Traditional

Appendix C

Experiment 2 Stimuli

Item	Number of strokes	Pinyin	Translation	Sentence Example	Group
扫	6	sǎo	to clean; to sweep	他把地扫的很干净。	1
死	6	sǐ	dead	我们什么时候吃饭？我快饿死了。	1
向	6	xiàng	toward	你要在前面向右走。	1
坏	7	huài	bad	没人喜欢坏男孩。	1
层	7	céng	floor; layer	这座楼有六层。	1
困	7	kùn	sleepy; dozy	我现在很困。我想睡觉。	1
画	8	huà	painting	这张画很好看。	1
转	8	zhuǎn	to turn	他们走了很远，然后又转过来了。	1
树	9	shù	tree	那棵树长得很高。	1
亮	9	liàng	bright	今晚的月光很亮。	1
栋	9	dòng	measure word for buildings	他住在一栋大房子里。	1
倒	10	dào	to move backwards; to reverse	请把车倒回去。	1
烫	10	tàng	burning hot	这菜太烫了，要等一下儿才能吃。	1
终于	11	zhōngyú	finally; at last	我找了很久，终于在这里找到你了。	1
装	12	zhuāng	to load; to pack	车厢里装了很多东西。	1
房东	13	fángdōng	landlord	我的房东每个月来收房租。	1
鼓	13	gǔ	drum	他在乐队里打鼓。	1

Appendix C (cont.)

Item	Number of strokes	Pinyin	Translation	Sentence Example	Group
墙	14	qiáng	wall	这两座房子中间是一面墙。	1
用品	14	yòngpǐn	product	我在店里买了很多用品。	1
各种	15	gèzhǒng	various; all kinds of	他在学校里要看各种书。	1
照片	17	zhàopiàn	photograph; picture	这张照片里的人是谁？	1
箱子	18	xiāngzi	box; case	这个箱子很重。	1
镜子	19	jìngzi	mirror	房间里没有镜子。	1
钥匙	20	yàoshi	key	这是房间钥匙。	1
欣赏	20	xīnshǎng	to enjoy; to appreciate	我们都很欣赏她唱的歌。	1
味道	20	wèidao	taste	这菜的味道很好。我很喜欢。	1
搭乘	22	dāchéng	to take (a means of transportation)	我们要搭乘飞机去中国。	1
相聚	23	xiāngjù	to be together; to get together	可以和朋友们相聚我就很高兴。	1
繁荣	26	fánróng	prosperous	上海是一个很繁荣的城市。	1
刀	2	dāo	knife	他用了一把大刀去切牛肉。	2
戏	6	xì	play; drama	他带我去看了一场戏。	2
别	7	bié	don't	什么都别说。	2
忘	7	wàng	to forget	我忘了带书了。	2
花	7	huā	flower	他给他的女朋友买了很多花。	2

Appendix C (cont.)

Item	Number of strokes	Pinyin	Translation	Sentence Example	Group
拐	8	guǎi	to turn	先往前走，然后拐到左边。	2
饱	8	bǎo	full; satisfied	我吃了很多，吃得太饱了。	2
挂	9	guà	to hang	图片挂在窗户上。	2
挺	9	tǐng	very	我觉得美国挺好的。	2
香	9	xiāng	aromatic; good-smelling	妈妈做的菜很香。	2
破	10	pò	broken	她打破了杯子。	2
脸	11	liǎn	face	她一想到那件事就会脸红。	2
农田	11	nóngtián	farmland; cropland	农田里种了很多菜。	2
变化	12	biànhuà	to change	从中国回来以后，他变化很大。	2
摆	13	bǎi	to place; to put	桌子上摆了很多书。	2
满	13	mǎn	full	我们带了太多东西。车里都放满了。	2
负责	14	fùzé	to be responsible for	让我来负责这件事。	2
附近	14	fùjìn	nearby	他就住在附近。从这里走 5 分钟就到他家了。	2
撞	15	zhuàng	to collide with; to hit; to strike	一辆汽车撞上了路灯。	2
失眠	15	shīmián	to be unable to fall asleep	他晚上失眠，所以每天都觉得很累。	2
座位	17	zuòwèi	seat	公共汽车上的人太多。我们找不到座位。	2
主意	18	zhǔyi	idea	我有一个好主意！	2

Appendix C (cont.)

Item	Number of strokes	Pinyin	Translation	Sentence Example	Group
请客	19	qǐngkè	to act as the host; to treat	你想吃什么？今天我请客。	2
弹奏	20	tánzòu	to play (a musical instrument)	他们都在弹奏自己的乐器。	2
降落	20	jiàngluò	to land; to descend	请准备好。飞机马上就要降落了。	2
钢琴	21	gāngqín	piano	她弹钢琴弹得很好听。	2
精神	23	jīngshen	energetic; high-spirited	你们还是跟以前一样，看起来很精神。	2
楼梯	24	lóutī	stair	去我的房间要先上楼梯。	2
整理	27	zhěnglǐ	to tidy up; to sort out	妈妈叫我去整理我的房间。	2