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<td>Chung, KKH</td>
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Effective Use of Hanyu Pinyin and English Translations as Extra Stimulus Prompts on Learning of Chinese Characters

KEVIN K. H. CHUNG, University of Hong Kong, Hong Kong

ABSTRACT Previous research has shown that the learning of second language words in the simultaneous presence of pictures or first language translation equivalents interferes with their acquisition. The purpose of this study was to investigate variables associated with the learning of Chinese characters as second language stimuli (L2). Acquisition for both naming of English translations and pronunciations was shown to proceed more rapidly under conditions in which each character was presented 5 s prior to its pinyin and English word equivalent, in contrast to simultaneous presentation conditions. These data were interpreted in terms of (a) interference, which can occur when students attend to multiple input simultaneously, and (b) the beneficial effects of attending to L2 stimuli prior to their associations in language learning contexts. It was concluded that the presentation of a character first, and the provision of its associated pinyin and English translation after a short delay is recommended when teaching characters for non-native speakers of Chinese at the early stage.

Introduction

In the initial stage of learning Chinese characters, a common and conventional way to introduce a new character to the learners is to present it together with its Hanyu pinyin spelling (or pinyin) and first language equivalent (L1). Pinyin is a romanised alphabet: the word literally means to form sounds used on the Chinese mainland into spellings. For example, a Chinese character 书 is paired with its pinyin ‘shù’ and English translation ‘book’. It is thought that the use of pinyin can effectively promote the learning of Chinese characters (Mingyuan et al., 1983; Jordan, 1971) for a number of reasons. First, it helps pronunciation in that even though Chinese characters generally contain a phonetic component, this component is not a systematic guide to pronunciation. Secondly, pinyin helps learners to pronounce new characters easily and correctly (Dai & Lu, 1985). Finally, knowledge of pinyin assists learners to pronounce new
characters via sub-lexical phonology without assistance from the teacher (Huang & Hanley, 1997). Along the same lines, it is commonly assumed that the first language word is generally useful in facilitating understanding of the meaning of the new word and in recalling the unfamiliar word more quickly (Nation, 1982; Kroll, 1993). In the learning of Chinese characters, the simultaneous presentation of a character with its pinyin and English equivalent, therefore, has become the most popular and conventional approach. Furthermore, instructional texts for beginners learning Chinese characters have often included the corresponding pinyin texts and English translations (Fredlein & Fredlein, 1994; Lee, 1993).

The practice of pairing a character with its pinyin and first language equivalent has been accepted as a convention (Fredlein & Fredlein, 1994; Lee, 1993), and yet the efficacy of this approach is seldom questioned and examined. Reference to the research literature on the effect of a picture prompt on sight word learning and the effect of presenting an L1 word during L2 vocabulary instruction, suggests that the presentation of pinyin and an L1 equivalent to assist the learning of a Chinese character may not be the best approach. Previous findings have consistently shown that teaching children to name a picture and then reinforcing the name of the picture inhibits the learning of written word (Wu & Solman, 1993; Solman & Wu, 1995). Also, related investigations into the teaching of L2 vocabulary have shown that the presentation of the L1 word during learning depresses the rate at which the L2 word is learnt (Solman & Adepoju, 1995; Solman & Chung, 1996).

Previous research has shown that the simultaneous presence of the L1 equivalent interferes with the learning of an L2 word (Solman & Adepoju, 1995; Solman & Chung, 1996; Adepoju & Elliott, 1997; Elliott & Adepoju, 1997). These studies have suggested that the presence of a familiar L1 word is likely to divert the learner’s attention from the unfamiliar to-be-learned word, an example of blocking or interference effect. Blocking refers to an event in which prior conditioning to one element prevents conditioning to other elements of a compound (Kamin, 1969; Kehoe, 1987). That is, if one stimulus of the simultaneous stimuli has been part of training preceding the use of both stimuli, the trained stimulus will retain all of the associative value while the new stimulus will fail to gain its associative strength (Kehoe, 1987; Rescorla & Wagner, 1972). The first-second language word problem is analogous to the phenomenon of blocking. That is, when an L1 and L2 are presented simultaneously, the presence of the L1 word monopolises all or most of the associative strength (or attention) and thus triggers the verbal response automatically. Consequently, the novel L2 word is likely to gain little or no associative strength with the verbal response. Consequently, the familiarity of a L1 word blocks the acquisition of its L2 word.

When learners begin their study of Chinese in Australia and United States, they often begin to acquire some spoken language through a system that represents Chinese via Roman alphabet script (pinyin) before they undertake the task of learning Chinese characters (Dawson, 1992; Zhang, 1992; McGinnis, 1997; Everson, 1998). At the same time, most of the learners are familiar with their English language since English is the learners’ mother tongue. When a character with its pinyin and English word are presented together, the acquisition of a pronunciation and naming response for a character may be hindered by the presence of the corresponding prompts, and this suggests that blocking or interference may occur. That is, during the simultaneous inclusion of a character with its associated pinyin and English translation, the presence of pinyin and English translation are likely to trigger their pronunciation and spoken response of an English equivalent automatically. This is because learners have strongly
associated the pinyin with its pronunciation response and the English translation with its spoken response. As a consequence, the already established associations interfere with the establishment of a new association between the character and its pronunciation and naming response.

A number of studies (Solman & Adepoju, 1995; Solman & Chung, 1996; Adepoju & Elliott, 1997; Elliott & Adepoju, 1997) have looked at different ways of manipulating the first language word, and the second language word (L2) to reduce the interference caused by the L2 prompt and to improve the learning of second language vocabulary in the short term. These studies have generally shown that a spacing technique, in which the L2 word is presented after the L1 word by 5 s, improves the acquisition of the response to the L2 word and reduces the blocking effect. Researchers (Solman & Chung, 1996; Elliott & Adepoju, 1997) have found that for English speakers, learning foreign language vocabulary such as Chinese and French is improved by a spacing technique during immediate learning and recall. They have suggested that temporal spacing between an L2 word and its L1 word allows the learners to pay attention fully to the new L2 word for 5 s before their attention is captured by its familiar L1 cue. In this way, it allows the L2 word to gain some attention from the learners more quickly, and speeds the acquisition of the verbal response of the L2 word. Using this technique may facilitate an associative process more quickly between the new word and its verbal response.

Elliott & Adepoju (1997) have also shown improvement in the learning of L2 vocabulary when the L2 word is presented before (as in the pair L2–L1), rather than after its L1 word cue (L1–L2). Based on the fact that literate English speakers read habitually and involuntarily from left to right (Sampson, 1985; Randall & Meara, 1988), this improvement has again been attributed to the left to right order of the L2 word and its L1 cue, allowing the former to briefly engage the learner’s attention before it is captured by the familiar L1 prompt. As a consequence, this enables the L2 word to form an association with the verbal response more quickly. Along the same lines, research studies on a word pair learning have shown that learning of an L2 word was faster when pairing of a word translation from L2 to L1 (backward translation) than that from L1 to L2 (forward translation; Kroll & Stewart, 1989, 1990), presumably because backward translation takes a direct lexical path while forward translation has to be mediated by concepts. It has been suggested that novice learners are more heavily reliant on lexical links and find concept mediation particularly difficult (Kroll, 1993; Kroll & Stewart, 1989, 1990). For novice learners, learning in the direction of L2–L1 is appeared to be the more effective than the order of L1–L2. Therefore, the order of L2 to L1 should be used when teaching of L2 vocabulary at the early stage of learning.

The aim of this study was to examine whether temporal spacing of a character and its associated pinyin and English equivalent prompts would enhance learning of meaning (English translation) and pronunciation relative to a condition where a character and its prompts were presented simultaneously. In addition, this study aimed to investigate whether presenting the order from the character to the familiar prompts would improve the acquisition more than the order from the prompts to the target stimulus.
Methods

Subjects
A total of 24 year 7 students were selected randomly from a male college in Sydney, Australia. A student was not selected if he:

- could not speak and read English;
- had obvious learning disabilities, behavioral or emotional problems;
- could recognise any of the Chinese stimulus characters;
- was not familiar with the pinyin system in the pre-learning phase.

The participants were required to answer a questionnaire indicating their experience learning languages and their exposure to and use of Chinese. None of the subjects had previously learned other foreign languages than Chinese. This was to make sure that no other foreign language skills were employed to learn the sounds and meanings of the characters in this study. All participants were Australian and spoke English as their first language and had been learning Chinese formally in the classroom for one year as their second language. All of the subjects reported that they have started taking Chinese course in high school since year 7 and knew fewer than 500 characters. The subjects all considered themselves to be non-fluent users of Chinese. They could pronounce and name correctly all of the pinyin spellings and the English words that were used in this experiment. The average age of subjects ranged from 11.9 to 12.5 years, with an average age of 12.2 years at the time the experiment started.

Materials
A pool of 40 Chinese nouns for learning and testing was selected from a few recommended textbooks used in Sydney secondary schools. These characters were usually in students’ daily speech as English words and had direct translations in English. There were 24 characters to be learned. The length of lists was decided on the basis of a pre-learning phase. As far as could be ascertained after consulting with the teachers concerned, participants in their studies prior to the experiment had encountered none of the Chinese items. The most commonly named characters were deleted and only 24 characters in the pre-learning were selected for the study. The characters with their pinyin spellings and English translations were divided into four groups as shown in Fig. 1.

There were five sets of flash cards:

- character-pinyin-English cards;
- pinyin-English-character cards;
- pinyin-English cards;
- three single cards including one with a Chinese character, one with a pinyin spelling and one with an English equivalent;
- picture cards.

Each stimulus was printed with a black on a 20 × 6 cm white card. The size of each stimulus was drawn in a 6 × 3 cm. The character-pinyin-English card had one character printed on the left and the pinyin and English word printed on the right. The pinyin-English-character card had one character printed on the right and the pinyin and English word printed on the left. The pinyin-English card had one pinyin printed on the
Character group (1)

电话 diànhuà telephone
皮肤 pífū skin
餐巾 cānjīn napkin

Character group (2)

蛋糕 dànɡāo cake
市场 shìchǎnɡ market
舞台 wǔtái stage

Character group (3)

足球 zúqiú soccer
戒指 jīezhǐ ring
庙宇 mìoyǔ temple

Character group (4)

乾酪 gānlào cheese
圆规 yuánɡuī compass
农夫 nónɡfū farmer

left and one English word printed on the right. The picture card had a picture only. The picture cards were only used for the pretests.

Design

The experiment tested one group of subjects on four different methods of learning, using a $2 \times 2$ factorial, repeated measures design. One factor was the order presentation of the Chinese character and its equivalents. The other factor was the spacing of the presentation of the Chinese character and its equivalents. There were four learning conditions in this experiment. The subjects experienced all the learning conditions during each of the learning sessions.
Simultaneous character-pinyin-English condition (CPE). The stimulus materials for this condition were character-pinyin-English compound cards. The experimenter pointed to the character first and then pointed to the pinyin and said, ‘This pinyin is pronounced as (pause)’. A response was expected during the pause. If the student pronounced the pinyin correctly, the experimenter reinforced the correct response by saying ‘Good. This is pinyin pronounced as____’. The student was then asked to repeat it once. But if the student gave an incorrect response, the experimenter provided the correct response by saying ‘No. This pinyin is pronounced as____’, and asked the student to repeat the correct response twice. After viewing the pinyin, the experimenter pointed to the English word and said ‘This word is (pause)’. A response was expected during the pause. If the student provided the correct naming response, the experimenter reinforced the correct response by saying ‘Good. This word is—’. The student was then asked to repeat it once. However, if the student gave incorrect naming response, the experimenter provided the correct response by saying ‘No. This word is—’. and asked the student to repeat the correct response twice.

Simultaneous pinyin-English-character condition (PEC). The stimulus materials for this condition were pinyin-English-character compound cards. The procedures were similar to those given in simultaneous character-pinyin-English condition (CPE), except that for the ordered presentation of the target stimulus and prompts. Learners were also positively reinforced for correct naming and pronunciation responses, and were asked to repeat that response one more time. If the learners were unable to give correct responses, the correct responses were given and they were asked to repeat that response twice.

Spacing character → pinyin-English condition (C → PE). The stimuli in this condition were the character single cards and pinyin-English compound cards. The character card was presented first, the experimenter then pointed to it. After an interval of 5 s, the pinyin-English compound card was presented side by side with its character card. The experimenter then pointed to the pinyin and said, ‘This pinyin is pronounced as (pause)’. A response was expected during the pause. If the correct pronunciation response was given, the experimenter further reinforced the correct response by saying ‘Good, This pinyin is pronounced as _____’, and asked the student to repeat it once. However, if the response was incorrect, the experimenter corrected the response by saying ‘No. This pinyin is pronounced as ____’. The student was then asked to repeat the correct response twice. The experimenter also pointed to the English word and said, ‘This word is (pause)’. A response was expected during the pause. If the correct response was given, the experimenter further reinforced the correct response by saying ‘Good, This word is ____’, and asked the student to repeat it once. If the response was incorrect, the experimenter gave the correct response by saying ‘No. This word is ____’, and asked the student to repeat the correct response twice.

Spacing pinyin-English → character condition (PE → C). The stimuli in this condition were the pinyin-English compound cards and character single cards. The procedures were similar to those given in spacing character → pinyin-English condition (C → PE), except that the ordered presentation of the target stimulus and prompts. Learners were also positively reinforced for correct naming and pronunciation responses and were asked to repeat that responses one more time. If the learners were unable to give correct
responses, the correct responses were given and they were asked to repeat that response twice.

Using independently randomised $4 \times 4$ Latin squares counterbalanced the presentations of the combinations of the four experimental conditions and the four groups of characters. This was to ensure that each group of characters appeared the same number of times in each experimental condition across the entire experiment. Furthermore, different random orders of the presentation of characters and the presentation of each condition were generated and rotated for each acquisition trial and session to reduce sequence effects. In the presentation of conditions with blocked character and word lists for each group of subjects.

As can be shown in Table I, for example, the characters in group 1 are presented under the simultaneous character-pinyin-English Condition (CPE) to the first six subjects, under the simultaneous pinyin-English-character condition (PEC) to the second six subjects, the spacing character $\rightarrow$ pinyin-English condition (C $\rightarrow$ PE) for the third six and the spacing pinyin-English $\rightarrow$ character condition (PE $\rightarrow$ C) for the last six.

### Procedure

The experiment consisted of the following phases.

**Pre-learning phase.** During the pre-learning phase, the students were randomly assigned to conditions in the experimental design. Twenty-four students were randomly divided into four groups. Each group contained six students.

All the students were tested individually on the characters, English words and pinyin. The pre-tests were given in order to ensure that the students could understand and read the English words and knew the pinyin spellings correctly, and to be sure that they did not know any of characters before the experiment.

The students were briefly tested on the understanding of the English words. A set of pictures cards and the English word cards was given to the students. The experimenter then said to the students, ‘Now, let’s look at these English word cards and picture cards, I want to see whether you know the meanings of these words. I would like you to match these English word cards with the picture cards’. If the students could not

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Simultaneous character-pinyin-English condition (CPE)</th>
<th>Simultaneous pinyin-English-character condition (PEC)</th>
<th>Spacing character $\rightarrow$ pinyin-English condition (C $\rightarrow$ PE)</th>
<th>Spacing pinyin-English $\rightarrow$ character condition (PE $\rightarrow$ C)</th>
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<td>01–06</td>
<td>Character group 1</td>
<td>Character group 2</td>
<td>Character group 3</td>
<td>Character group 4</td>
</tr>
<tr>
<td>07–12</td>
<td>Character group 2</td>
<td>Character group 3</td>
<td>Character group 4</td>
<td>Character group 1</td>
</tr>
<tr>
<td>13–18</td>
<td>Character group 3</td>
<td>Character group 4</td>
<td>Character group 1</td>
<td>Character group 2</td>
</tr>
<tr>
<td>19–24</td>
<td>Character group 4</td>
<td>Character group 1</td>
<td>Character group 2</td>
<td>Character group 3</td>
</tr>
</tbody>
</table>
match the picture with their English word correctly, the English word and picture were re-shuffled until the student could match the picture with proper English words. Following the picture-word test, the students were also asked to read out the English words on the single cards one at a time. The English words were randomly presented to the students and the students were verbally instructed to look at the English words and to read them out.

The pinyin on single cards were also presented, one at a time, to the student and the students were verbally instructed as follows: ‘Now, let’s look at the pinyin. I want you to read out these pinyin spellings to me if you happen to know them. It is OK if you do not know them; just say, I don’t know’. Each of the pinyin spellings was presented to the students for about 5 s or removed immediately after a response. If the students could not pronounce it correctly or gave no response, the experimenter told them the correct pronunciation and asked the students to repeat the pronunciation twice. The pinyin spellings were re-shuffled until the students could read out all of these pinyin spellings.

After viewing the pinyin, the students were finally tested on the characters. Each of the characters was individually presented. The experimenter said to the students, ‘Now, let’s look at the characters. I want to see whether you know how to pronounce any of these characters and their meanings. It is possible that you don’t know them because you have not learned them. If you know them, tell me what they are, but if you do not know them, please say “Pass”.’ Each of the characters was presented to the students for about 5 s or removed immediately after a response. The experimenter made no comments on the students’ response during this process.

After all the students were tested individually, the most commonly named characters were excluded and only 24 characters were selected. The classroom teacher further checked the characters before they were used in the experiment. This was necessary to ensure that they were useful and relevant to the students.

Learning and testing trials. In the learning phase, the students individually attended as many sessions as necessary to learn the 24 characters, with each session lasting no more than 40 min. In each session, the student learned the 24 characters through the four experimental conditions. The cards were displayed to the student one at a time. Each presentation was displayed across all the experimental conditions at a 20-s rate during the learning session. At the commencement of each learning session, the students were told ‘I am going to show you some cards’ and ‘I want you to look at the characters and listen to the pronunciations and the English words of these characters carefully, because I have to see how many pronunciations and the English words you can remember at the end of this lesson.’

At the end of each learning session, an immediate post-test on the 24 characters was followed. The experimenter told the students, ‘I am going to show you 24 characters. I want to see how many of these characters you can remember. I want you to pronounce these characters and tell me what they are in English. If you cannot remember its meaning or pronunciation, please say “Pass”.’ Each character was presented for approximately 10 s for the students to respond, unless they indicated that they wanted to pass that character. No feedback regarding their responses was given, but they were informed of their progress each time, for example whether they had remembered more words.

Each student’s correct responses for spoken of English translations and pronunciations were recorded for each condition. The learning and immediate testing trials
terminated when all the experimental conditions had reached the criterion of correct naming and pronunciation responses for all the four characters on three consecutive test trials. The student took part in the study for 2 or 3 days per week, and for one session per day. They were allowed to go back to the classroom to continue their classroom work between two consecutive learning sessions.

Retention. A retention test was carried out at two weeks after the student had reached the criterion. During each retention test, the learners were told, ‘I am going to show you those characters that you have learned before and I want to see if you still remember the pronunciations and English words of the characters.’ The 24 characters were randomly presented to the learner, one at a time. Correct naming and pronunciation responses were recorded.

Results

Separate analyses were carried out to examine the meaning (English translation) and the pronunciation data.

Each student’s learning was measured in terms of the correct responses to the naming of English translations and the pronunciations of the characters during the immediate post-tests for each of the four experimental conditions. The proportion of correct responses for the naming of English equivalents of pronunciations recorded for each student was obtained by dividing a student’s total number of correct responses by the total number of characters presented (i.e. number of test trials × six characters) when the criterion had been reached. The proportions of correct responses for meanings and pronunciations were averaged for each experimental condition and shown in Figs 2 and 4.
Analysis of variance was used to test for the significance of the three possible effects. The first comparison showed that a significant difference was found between the spacing conditions and the simultaneous conditions \( F(1, 23) = 21.92, P < 0.001 \). The second comparison indicated that there was a significant difference between the character prior to the English conditions and the character after the English conditions \( F(1, 23) = 20.64, P < 0.001 \). The third comparison indicated that the interaction of presentation order \( \times \) spacing was not significant \( F(1, 23) = 1.09, P > 0.05 \).

As shown in Table II, there were more subjects reaching criterion in the spacing character \( \rightarrow \) pinyin-English condition (C\( \rightarrow \)PE). A chi-square test of goodness-of-fit was conducted to see whether the observed frequency distribution significantly departed from an expected frequency distribution of no difference of the number of subjects reaching criterion among the four conditions. The chi-square value obtained indicated that there was a significant difference of the number of subjects reaching criterion among the four conditions \( \chi^2 = 25; P < 0.05 \).

The data obtained during the post-learning phase were analysed in terms of number of characters recognised under each learning condition. The mean number of the characters recognised in each group during the retention test is shown in Fig. 5. This

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Number of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simultaneous character-pinyin-English</td>
<td>3</td>
</tr>
<tr>
<td>Simultaneous pinyin-English-character</td>
<td>1</td>
</tr>
<tr>
<td>Spacing character( \rightarrow )pinyin-English</td>
<td>13</td>
</tr>
<tr>
<td>Spacing pinyin-English( \rightarrow )character</td>
<td>7</td>
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</tbody>
</table>
pattern of significance was exactly the same as that obtained when looking at immediate recall independently of delayed recall, with the spacing condition being significantly different to the simultaneous condition \( F(1, 23) = 27.36, P < 0.001 \). Character prior to the English differed significantly from the character after the prompt \( F(1, 23) = 26.74, P < 0.001 \). Finally, the test of interaction showed there was no interaction between these factors \( F(1, 23) = 2.23, P > 0.05 \).

**Pronunciation**

The first comparison showed that the difference between the spacing conditions and simultaneous conditions was significance \( F(1, 23) = 76.12, P < 0.001 \). The second comparison indicated that there was a significant difference between the character prior to the English word conditions and the character after the English equivalent conditions \( F(1, 23) = 34.95, P < 0.001 \). The third comparison indicated that the interaction of the presentation order \( \times \) spacing was not significant \( F(1, 23) = 0.40, P > 0.05 \).

As shown in Table III, there were more subjects reaching criterion in spacing character → pinyin-English condition \( (C \rightarrow PE) \). A chi-square test of goodness-of-fit also suggested that the distribution of the number of subjects reaching criterion among the four conditions was statistically significant \( \chi^2 = 18.25, P < 0.05 \).

The mean number of the characters recognised in each group during the retention test is shown in Fig. 5. This pattern of significance was exactly the same as that obtained when looking at immediate recall independently from delayed recall, with the spacing condition being significantly different to the simultaneous condition \( F(1, 23) = 11.22, P < 0.001 \). Character before the pinyin showed better performance than the character after the prompt \( F(1, 23) = 5.77, P < 0.05 \). Finally, the test of interaction showed there was no interaction between these factors \( F(1, 23) = 2.33, P > 0.05 \).
TABLE III. Mean number of trials to reach mastery criterion in pronunciation

<table>
<thead>
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<th>Conditions</th>
<th>Number of students</th>
</tr>
</thead>
<tbody>
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</tr>
<tr>
<td>Simultaneous pinyin-English-character</td>
<td>2</td>
</tr>
<tr>
<td>Spacing character→pinyin-English</td>
<td>12</td>
</tr>
<tr>
<td>Spacing pinyin-English→character</td>
<td>6</td>
</tr>
</tbody>
</table>

Discussion

Meaning

The results showed that temporal separation of a character from its English translation was superior to the conventional pairing of a character with its English stimulus simultaneously. This beneficial effect can be explained by considering that presenting the character before its English cue allows the character to be processed separately from the prompt. That is, it provides time for a character to be associated with its verbal response without having the attention captured by the prompt. In associative terms, spaced delivery encourages an increment in the associative strength of the character, and thus increases the strength of the association between the character and its verbal response. In other words, allowing the accumulation of associative strength to the target stimulus without the presence of the stimulus prompts capturing this associative strength reduces the interference that occurs in the simultaneous presentation. Previous studies (Solman & Chung, 1996; Elliott & Adepoju, 1997) have also indicated that separating the target word briefly from its stimulus prompt facilitates single word
learning. They support the view that initial attention to the target stimulus reduces the interference caused by the prompt.

The results also demonstrated benefit from presenting a character before, rather than after its English prompt, that is, recall for a naming response was generally better and faster when a character was presented on the left rather than on the right of the prompt. Presenting a character briefly before the prompt allows the character to be associated with its response without the prompt capturing the associative strength and this increases the rate of responding to the character. As demonstrated by a recent study (Elliott & Adepoju, 1997), a French word is learnt more quickly if it is presented prior to its English word, and they suggest that this presentation can reduce the inhibiting effect of the English equivalent. In addition, the present data are compatible with the work on paired-associate learning (Kroll & Stewart, 1989, 1990) which suggests that learning in the direction of a second-first language word is more effective than the association of first-second language word. Their works are based on the assumption that word translation from the first-second language word is mediated by an underlying conceptual system while that from the second-first language word takes a direct lexical route without going through the underlying concepts. Research studies (Kroll & Stewart, 1989, 1990) have argued that the association between second-first language word in stimulus-response terms is stronger than first-second language translation because the novice learners are more heavily dependent on lexical connections for learning translation equivalent, rather than use the process of concept mediation.

**Pronunciation**

The results indicated that the superiority of spacing procedure over simultaneous method was again obtained. The temporal separation of a character from its pinyin allows the character to be associated with its verbal response first before the occurrence of a pinyin. In this way, the development of an association between a character and its verbal response can be formed more quickly. Consistent with previous research (Solman & Adepoju, 1995; Solman & Chung, 1996; Elliott & Adepoju, 1997), temporal separating the target second language word, and the first language word prompt reduces the adverse effect of blocking and enhances the learning of second language vocabulary.

In addition, the results showed that pronunciation was better learned in the presentation of a character prior to the pinyin, rather than the format of a target stimulus after the prompt. The positive effect of presenting the character before the prompt is that it enhances the salience of the character before the appearance of the prompt and this additional attention will facilitate the acquisition of pronunciation. The current findings are in line with the Elliott & Adepoju (1997)’s study, which suggests that interference effect can be reduced by presenting the order of the second-first language words, rather than the first-second language words.

**General discussion**

The current experiment assesses both immediate and delayed recall of English equivalents and pronunciations of Chinese characters learned under conditions of traditional simultaneous presentation and spacing-based instruction.

The present study demonstrates that the conventional presentation of the pinyin and English translation prompts concurrently with the character, the pre-learning of the
stimulus prompts interferes with the acquisition of meaning and pronunciation of a character for both immediate and delayed recall after 2 weeks. This is contradictory to previously held view that the presentation of the character with its familiar prompts positively influences the rate of acquisition of learning of the characters. Consistent evidence from the first-second language studies (e.g. Adepoju & Elliott, 1997; Elliott & Adepoju, 1997) and the word-picture research (e.g. Solman & Wu, 1995; Wu & Solman, 1993) suggests that it is most difficult to learn to recognise the graphic representations of words when they are taught with simultaneously presented prompts such as first language words or pictures.

Moreover, evidence from this research suggests that learning of meaning and pronunciation of characters is more efficient when the pinyin and English translation prompts are presented a few seconds later with the character. The temporal separation of the character and its prompts allow time for the character to capture the attention of the learners briefly before the appearance of prompts. As a consequence, the new association between the character and its verbal responses is formed steadily. In addition, the present findings indicate that learning is better in the conditions where the character is presented on the left of the prompts rather than those where it is presented on the right. Based on the fact that English speakers read habitually and involuntarily from left to right (Sampson, 1985; Randall & Meara, 1988), this reading movement and mechanism is further attributed to the left to right order of the character and its two prompts by enabling the former to briefly engage the learners’ attention before it is captured by the familiar prompts. Therefore, reading from left to right enables the character to form an association with the verbal response more quickly and this promotes learning. The overall results demonstrates that presenting a character on the left of the pinyin and English translation, and providing the prompts after 5 s appears to reduce the interference caused by the prompts and it is likely that this presentation can be used as an useful device in teaching.

With the increasing use of multi-media technology in language education, research, which provides empirical evidence to guide instructional design and technique for language learning, is of growing importance. The current emphasis on multi-media language learning does not appear to derive from a discernible, coherent theoretical framework. It is driven by the existence of the technology rather than theoretical considerations or practical evidence of effectiveness. Nowadays, many available computer software packages for language learning are often too rich on the multi-media ‘impressive’ side, but too poor or not well organised on the learning material side. In addition, they usually cover a wide range of tasks and hardly concentrate the tasks in detail. During the early stage of learning a new language, perhaps it is necessary to concentrate on a limited range of levels and focus on the acquisition of vocabulary. As Nation (1982), states knowledge of vocabulary is crucial for the development of learners’ competence in reading and understanding in comprehension during the early stage of learning a new language. The results from this study may have implications for instructional design in language education, especially for newer forms of instruction such as multi-media.

Before reaching the general conclusion, some limitations of this research should be mentioned. The present study focused on the very beginning stages of vocabulary learning, and one cannot assume that learning occurs in similar ways at different stages of proficiency (Meara, 1984). In addition, this investigation has not assessed whether students can use these character items in a sentence demonstrating that they understand their meaning, nor has it ascertained whether the students know in which
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context these lexical items can be used. In other words, it is also important that these characters need to be practised in sentence contexts after learning the characters alone. According to Carter & McCarthy (1988) and Twaddell (1972)’s book, the best way of assuring that new words are remembered and assimilated is by placing them in some meaningful context or environment after learning the vocabulary in isolation. Further research is needed to answer these and related questions.

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Correspondence: Kevin Chung, Department of Psychology, University of Hong Kong, Hong Kong (kkhchung@hkucl.hku.hk).

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