G-IM: An Input Method of Chinese Characters for Character Amnesia Prevention

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***Abstract*— Character amnesia is a recent phenomenon in which native Chinese or Japanese speakers forget how to write Chinese characters (Kanji in Japanese), but maintain the ability to read them. It is generally believed that the constant use of computers and mobile phones equipped with pronunciation-based Chinese-character input systems is to blame. Therefore, particularly in China, several element-based input methods that require users to input radicals of the Chinese characters have been developed. However, these methods are not effective for learning how to write unfamiliar characters. This paper proposes a novel pronunciation-based input method called G-IM. Unlike conventional methods, G-IM sometimes outputs incorrect character shapes, which forces users to pay close attention to the character shapes and thus strengthens retention and recall. Through user studies, we confirmed that G-IM significantly strengthens the retention and recall of character shapes as compared to conventional input methods and writing by hand.**

Keywords-input method of Chinese characters; character amnesia; incorrect character shapes; pronunciation-based input method; (re)building retention and recall of Chinese characters.

I. INTRODUCTION

Character amnesia is a recent phenomenon manifested by the inability of native Chinese or Japanese speakers to recall how to write Chinese characters (Kanji in Japanese), although they know these characters well and can still read them [1]. According to a poll commissioned by China Youth On Line, published on July 12, 2013, 94.1% of the respondents reported experiencing problems writing characters and 26.8% reported always have such difficulties [2]. A similar phenomenon has been noted in Japan and is considered a significant issue [3].

It is generally believed that the constant use of computers and mobile phones equipped with alphabet-based Chinese-character input systems is the cause of character amnesia [3][4]. In China, "Pinyin typewriting" is the most popular method for inputting Chinese characters. Pinyin is a widely used representation method of Chinese pronunciations that allows Chinese-character pronunciations to be expressed with Latin characters. In Japan, "Kana-kanji conversion systems" and "Romaji-kanji conversion systems" are widely used, where "Kana" means Japanese phonetic symbols, "Romaji" refers to Romanized Japanese words, and "kanji" is the Chinese characters. Thus, both in China and in Japan, people usually input Chinese characters with personal computers (PCs) and mobile phones based on their phonetic features, not on their shape features. Therefore, it is not necessary to recall how to physically write these characters when inputting. As a result, they increasingly lose the ability to write Chinese characters.

It has been argued that it is no longer necessary to be able to hand write Chinese characters. Custer [5] asserted that some characters are used frequently enough that it's nearly impossible to forget them, and that only when people have occasion to write a less common word by hand, they will look it up on their phones. Custer [5] therefore concluded that character amnesia is actually not a serious concern.

We, however, cannot agree. We conducted a dictation examination of frequently used Chinese characters, the details of which are described below in the User Study section. The examinees (research participants) were 30 Chinese postgraduate students. Surprisingly, the average accuracy rate for these students was only 22.8%, with the best score reaching only 56.3% and the worst actually 0%. Thus, even this highly educated group forgot approximately 80% of frequently used Chinese characters, which is against Custer's assumption. People easily forget even frequently used characters. Character amnesia thus appears to be a compelling problem.

This paper proposes a novel Chinese-character input method called G-IM, an acronym of "Gestalt Imprinting Method," to address character amnesia. The remainder of this paper is organized as follows: We present an overview of several related works in Section II. We then describe the basic idea of G-IM in Section III and illustrate its system setup in Section IV. Finally, we present the results of our user studies in Section V and discuss the usefulness of G-IM in Section VI. Section VII concludes this paper.

II. RELATED WORKS

A straightforward and naive way to prevent character amnesia is to continue Chinese-character education. Both in China and Japan, Chinese-character education is provided from early elementary school, with pupils in China learning approximately 3000 characters and those in Japan approximately 2000 characters by the end of junior high school. Several online learning systems have been proposed [6][7][8]. However, results of a questionnaire we conducted

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for 135 Chinese people using an on-line questionnaire site revealed that only 2.96% respondents (namely, only 4 respondents) were interested in using such online learning systems. Thus, as mentioned in Section I, there are many adults in both China and Japan who cannot write Chinese characters, demonstrating that education alone is not enough to prevent character amnesia.

Various new approaches have recently been attempted. A prominent approach is the use of edutainment and gamification. A very popular new Chinese television program, "汉字英雄" (translation: "A Hero of Chinese Characters"), is a game show where elementary and junior high school students are asked to correctly transcribe the dictation of Chinese characters. A smart-phone application that provides the same dictation game is also gaining in popularity and has been downloaded over 800 thousand times. In Japan, kanji reading and writing quizzes are very popular on many television programs. These entertainment programs and game applications provide some remedy for character amnesia. However, at least in Japan, the quizzes provided in such TV programs often use very difficult characters that are seldom seen in everyday life. A method inextricably related to everyday writing (or inputting) of Chinese characters is required.

In this sense, developing methods for Chinese characters that provide functions not only for inputting, but also for learning, is a promising solution. In Japan, the pronunciation-based Chinese character input systems, i.e., the Kana-kanji and Romaji-kanji conversion systems, are almost the only current practical methods for inputting Chinese characters on most PCs, cell-phones, and smart phones. In contrast, in China, not only pronunciation-based methods, such as the Pinyin input method, but also element-based methods are used.

"Wubi" is an element-based method. With Wubi, users input a Chinese character by inputting its radicals [8]. For example, to input "枠" ("frame"), the user must input the following three radicals: "木," "九," and "十." A combination of radicals almost uniquely relates to a specific Chinese character. Therefore, if the user masters Wubi, he/she can input Chinese characters faster than with the Pinyin method. However, it is difficult for people to master the Wubi method because there are 130 radicals; 5 times that of the alphabet. As a result, Wubi is not as widespread as the Pinyin method.

Another element-based Chinese-character input method is a stroke-based method that breaks down a Chinese character into strokes. There are five basic types of strokes:

1. Horizontal strokes: "一,"
2. Vertical strokes: "｜,"
3. Left-falling strokes: "丿,"
4. Right-falling strokes or dot strokes: "丶," and
5. Turning strokes: "フ."

These strokes are usually assigned to numeric keys one to five and a user sequentially inputs strokes that constitute a Chinese character in its handwriting order. For example, "康" ("healthy") can be input by sequentially inputting the basic strokes as follows:

康：丶一丿フ一一｜丶一丿丶

In this case, eleven strokes are required, which is quite cumbersome. The six-digit stroke-based Chinese-character input method [9] is a refined stroke-based method. With this method, only the first three strokes and the last three strokes are required to be input. Therefore, in the case of "康," only the following six strokes are necessary:

康：丶一丿一丿丶

Thus, the total number of strokes is reduced even when inputting complicated characters.

Various element-based and stroke-based methods have been proposed that aim at achieving flexibility and simplicity [10], investigate mapping of elemental strokes onto the keypad of mobile phones [11], and design a special keypad layout of a mobile phone's touch screen for selecting radicals to achieve fast and easy input of Chinese characters [12].

When a person becomes adept at using such an element-based method, he/she can overcome character amnesia. However, most element-based methods require users to be familiar with each character's shape, including handwriting order, in advance. Without this knowledge, users cannot use these methods. These methods provide no cure for character amnesia, as character amnesia is an obstacle to using these methods.

As a result of considering these conventional attempts, we concluded that pronunciation-based Chinese-character input methods require additional functions in order to solve the character amnesia problem. The pronunciation-based methods are most widely used both in China and Japan, and can be used without accurate knowledge of how to write Chinese characters in detail; even those suffering from character amnesia can use them. To the best of our knowledge, there have been no attempts to solve the character amnesia problem using a pronunciation-based Chinese-character input method.

III. BASIC IDEA OF G-IM

The basic idea of G-IM is very simple and straightforward: a function that compels users to verify Chinese-character shapes is added to a pronunciation-based Chinese-character input method. G-IM not only outputs correctly shaped characters, but also sometimes outputs incorrectly shaped ones. In other words, G-IM is an input method that sometimes miswrites, which sets it apart from conventional input methods. Figure 1 shows an example of

Figure 1. An example of a correctly shaped (left) and incorrectly shaped "歳" character (right). An extra horizontal stroke has been added to the example on the right.

correctly and incorrectly shaped characters: the one on the right is incorrect (it has an extra horizontal stroke). The incorrect characters output by G-IM are slightly different from existing correct ones.

When using a conventional pronunciation-based input method of Chinese characters, some homonyms are often incorrectly input. For example, the pronunciation of "歳入" ("annual income") is "sai-nyuu" in Japanese, which may be incorrectly transcribed as "再入" ("re-entrant"), whose pronunciation is the same as that of "歳入." However, when correcting "再入" to "歳入," the knowledge required concerns the combination of the characters (i.e., knowledge of idiom) rather than the shapes of the characters (i.e., the Gestalt of the characters). If someone noticed that he/she incorrectly input "再入," he/she would re-input "sai-nyuu" and correctly convert it to "歳入." In this correction process, he/she pays attention to the difference between "再" and "歳," but not to the detailed shape of "歳." Therefore, we employed incorrect characters that have shapes that differ slightly from the correct one in order to compel accurate attention to the detailed character shapes and to re-establish the correct Gestalt.

Since the conventional input methods never miswrite and always output correctly shaped characters, users exceedingly rely on these and never pay full attention to the detailed shapes. Eventually, these shapes are forgotten. However, because G-IM is not consistently accurate, the user has to always pay attention to the shape of each character and, if it is wrong, correct it, thus preventing and curing character amnesia.

IV. EXPERIMENTAL SYSTEM

It is not easy to modify the functions of existing Chinese-character input methods such as Microsoft Office IME™ [1] and JustSystems ATOK™ [2]. We therefore implemented a text editor, described later in this paper, instead of an input method to investigate the efficacy of the basic G-IM idea described in the previous section.

We first created a new font file consisting only of incorrectly shaped characters, like the one on the right in Figure 1, using the TTEdit™ font editor[3]. It is not necessary to create incorrect shapes for all Chinese characters. We created only the fonts necessary (shown in Figure 2) for use in our experiments. We then implemented a text editor equipped with a function that automatically replaces an input correct character shape from the existing input method with a similar, but incorrectly shaped, character with the same character code as the correct one as soon as one of the characters in Figure 2 are input. If a user tries to save the text file with incorrectly shaped characters, the save operation is rejected and a dialog box asking the user to correct all incorrectly shaped characters appears. Correction can be done by selecting the incorrect character, inputting its pronunciation again, and converting it. As a result, the incorrect character is replaced with the correct one. At this time, the quick change of the characters between correct and incorrect provides a visual animation-type effect and the difference in the shapes is emphatically demonstrated. Finally, after all characters have been corrected, the text file can be saved. By using this editor and font file, we can conduct user studies without implementing a completely new input method or modifying an existing one.

Figure 2. 54 Chinese characters prepared for the dictation pre-examination.

V. USER STUDY

We conducted user studies to investigate the efficacy of G-IM by comparing it to two Chinese-character input methods, specifically, handwriting (HW) and an existing input method (IM). We did not ask the research participants to use an element-based input method such as Wubi. Most of the participants had never used an element-based input method and hence would not be able to use it immediately. Furthermore, as will be shown later, most of the participants could not correctly write many of the Chinese characters that were used in the experimental examinations. When using the element-based input methods, the examinees could not input most of the test characters. Therefore, we did not use an element-based input method during our studies.

A. Procedure

The participants were 30 postgraduate Chinese students from the authors' institute. Character amnesia is a more significant problem for the Chinese than the Japanese because the Japanese can easily substitute Kana (Japanese phonetic symbols) for kanji. The Chinese do not have such a generally tolerated substitution method.

The user study consisted of three steps:

1. A pre-examination of Chinese-character dictation,
2. An exercise of inputting or writing Chinese characters using one of the input methods, and

[1] http://www.microsoft.com/ja-jp/office/2010/ ime/default.aspx

[2] http://www.atok.com/

[3] http://opentype.jp/ttedit.htm

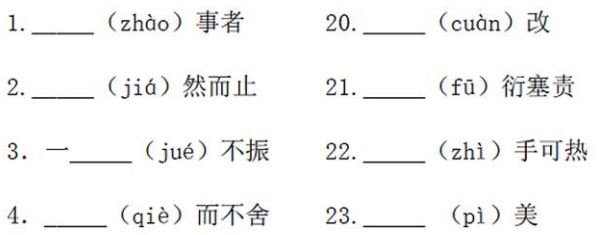

Figure 3. Examples of the problems in the dictation pre-examination.

3. A post-examination of Chinese-character dictation.

In Step 1, we prepared 54 characters selected from "100 frequently used Chinese characters that are often miswritten" [13] as the problems for the dictation pre-examination. Figure 2 shows the selected 54 characters and Figure 3 shows some of the problems in the pre-examination. The participants were required to fill in the blanks with the correct characters by hand referring to the adscript pronunciations. After the pre-examination, all the participants were not given the correct answers.

Based on the pre-examination results, we sorted the 54 characters by the miswritten-ratios and extracted 32 characters with higher miswritten-ratios. Figure 4 shows the extracted 32 characters and their miswritten-ratios. No participants were able to correctly write the top two characters. These 32 characters were used in the Step 2 tasks and in the post-examination of dictation in Step 3. In addition, based on the pre-examination results, we divided the participants into three groups, each of which included ten participants, so as to equalize the distribution of the pre-examination score of the three groups.

In Step 2, we assigned three different tasks to the three groups as follows:

- G-IM group: The participants were required to input sentences that included the 32 characters. Whenever one of the 32 characters was input, it was replaced by the corresponding incorrectly shaped character first and the participants then made the necessary corrections.
- IM group: These participants were required to input the same sentences as those provided to the G-IM group using a popular Pinyin input method. As described previously, with this method, the need for replacement of incorrectly shaped characters never arose.
- HW group: The participants of this group were required to write by hand the same sentences as those provided to the G-IM group.

For all groups, the sentences were read aloud. The participants listened then input the sentences or wrote them down. To avoid any unexpected effects of Step 1 from influencing the tasks of Step 2, we waited 15 days between Step 1 and Step 2.

In Step 3, occurring immediately after Step 2, we conducted the post-examination using the 32 characters shown in Figure 4. The form of the post-examination was similar to the pre-examination (Fig. 3): the examinees were required to fill in the blanks with correct characters by hand. Finally, we asked the participants of the G-IM and IM groups to answer a questionnaire on whether they had paid attention to the character shapes when inputting the sentences in Step 2.

Characters	Miswritten-ratio
鵹	100.0
霾	100.0
颐	97.0
赝	90.9
篡	90.9
斡	90.9
蘸	87.9
祟	87.9
霓	84.8
敷	84.8
腻	84.8
舆	84.8
嚎	84.8
锲	81.8
悍	81.8
靡	81.8
蹶	81.8
粱	81.8
慰	78.8
媲	78.8
寡	75.8
罹	75.8
肇	72.7
迥	72.7
戛	69.7
箴	69.7
炙	69.7
鼎	69.7
葵	63.6
耀	60.6
凿	57.6
覆	57.6

Figure 4. 32 extracted characters with higher miswritten-ratios based on the pre-examination results.

TABLE I. RESULTS OF THE PRE-EXAMINATION AND POST-EXAMINATION FOR THE THREE GROUPS.

Group	Pre-exam.		Post-exam.	
	Average	STDV	Average	STDV
G-IM	7.3	5.0	20.4	6.2
IM	8.4	4.4	12.0	5.7
HW	7.7	4.2	10.3	6.3

TABLE II. AVERAGE REQUIRED TIME IN MINUTES TO INPUT SENTENCES IN STEP 2 AND THE POST-EXAMINATION FOR ALL GROUPS.

Group	Step 2 (min.)	Post-exam (min.)
G-IM	25	8
IM	13	11
HW	33	7

TABLE III. PERCENTAGE NUMBER OF PARTICIPANTS WHO PAID ATTENTION TO THE CHARACTER SHAPES WHEN INPUTTING SENTENCES IN STEP 2.

Group	When selecting character	After selecting character
G-IM	40 %	100 %
IM	67 %	17 %

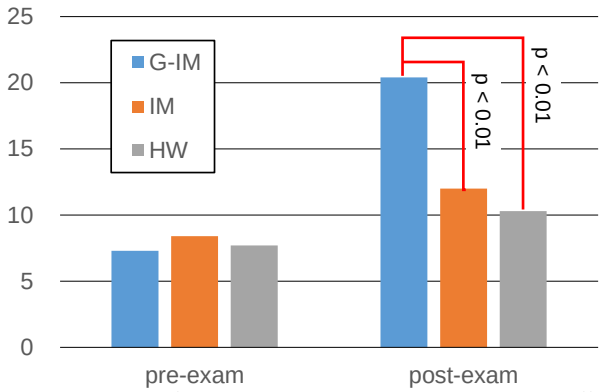

Figure 5. Results of post hoc test on the interaction: simple main effect of input methods at each examination.

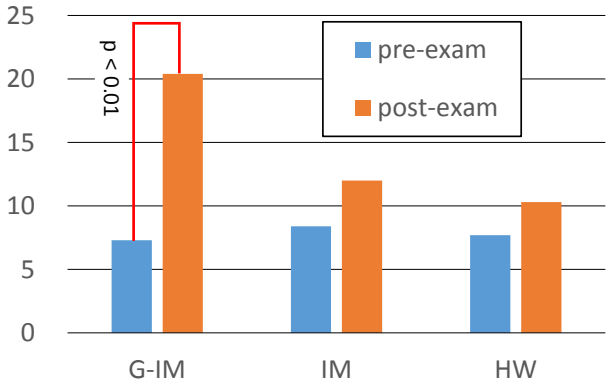

Figure 6. Results of post hoc test on the interaction: simple main effect of examinations at each input method.

B. *Results*

Table I presents the average scores and standard deviations (STDVs) for the pre-examination and post-examination of the three groups with a perfect score being 32. Therefore, the average score 7.3 is, for example, 22.8 points on a scale for which 100 is perfection. Table II shows the average time required to input the sentences (Step 2) and the average time for writing the answers down by hand in the post-examination for all groups. Table III displays the percentage number of participants who paid attention to the character shapes when inputting the sentences in Step 2.

To determine whether G-IM could improve the performance of the post-examination when compared to the other two methods, we performed a two-way ANOVA (three input methods and two examinations) on the results shown in Table I. The analysis results were:

- The main effect of the input methods was significant.
  ($F(2, 54) = 3.99$, $p < .05$)
- The main effect of the examinations was significant.
  ($F(1, 54) = 19.41$, $p < .01$)
- The interaction effect was significant.
  ($F(2, 54) = 5.25$, $p < .05$)

We performed additional post hoc tests. We first conducted Tukey's HSD (honestly significant difference) test on both main effects. The results were as follows:

- About the main effect of the input methods: A significant difference ($p < .05$) was found only between G-IM and HW.
- About the main effect of the examinations: A significant difference ($p < .01$) was found between the post-examination and the pre-examination.

Next, we performed a post hoc test on the interaction effect. Figure 5 shows the simple main effect of the input methods at each examination and Figure 6 shows the simple main effect of the examinations at each input method. Based on Figure 5, we can say that

- In the pre-examination, no significant difference was found among all three groups, but
- In the post-examination, significant differences ($p < .01$) could be found only between G-IM and the other two methods.

From Figure 6, we can also say that

- As for the G-IM group, a significant difference ($p < .01$) was found between the pre-examination and the post-examination, but

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- As for the other two groups, no significant differences could be found between the pre-examination and the post-examination.

From these results of the post hoc test on the interaction effect shown in Figures 5 and 6, we can clearly conclude that G-IM is superior to both the existing Pinyin input method and writing by hand. Although the performances of the participants of all three groups were equalized based on the pre-examination results, they differed significantly in the post-examination and the G-IM group achieved significantly higher performances than the other groups (Fig. 5). The G-IM group members' performances were significantly improved after inputting sentences using the G-IM method (Fig. 6).

VI. DISCUSSION

In order to confirm whether G-IM can actually prevent and cure character amnesia, further long-term investigation is necessary. However, it became evident that the recall and retention of Chinese-character shapes was certainly strengthened after using G-IM, which fortifies long-term memory of them. Accordingly, G-IM has the potential to prevent and cure character amnesia.

Those who are resistant to information technology often argue that we should not use the PC for writing and that writing by hand will solve the character amnesia problem. However, our experimental results dispute this claim. Even when writing characters by hand, the post-examination scores did not significantly improve (see the results of HW in Fig. 6). This means that writing by hand did not strengthen character shape recall. This is not surprising. When writing by hand, incorrect memories are not rectified. If someone thinks that the correct shape of "歲" is the one shown on the right in Figure 1 and always writes it this way, there is no chance to correct it. In addition, if he/she does not know how to write "歲" at all, he/she of course cannot write it and will not remember how to write it correctly. In such cases, those who are anti-information and technology believe that we should always refer to a dictionary. However, this is too cumbersome, time consuming, and impractical. It is also impractical that an expert of Chinese characters always checks the shapes of the written characters and corrects the mistakes. As a result, most people do not have any opportunity to develop correct memory of the character shapes. It is necessary to "push" the correct answers, not "pull" answers, such as referring to a dictionary.

The existing pronunciation-based input methods "push" the correct shapes. Opportunities to build recall and retention are provided whenever these methods are used. In this sense, pronunciation-based input methods are potentially learning support systems. However, we do not actually learn the correct shapes when using the existing input methods, which is most likely because the ordinary input methods never miswrite. We do not doubt the characters that are output by these systems and thus completely rely on them. The results shown in Table III support this view. When selecting a correct character, many of the IM participants paid attention to the character shapes. In contrast, most did not pay attention to them after selecting them. This suggests that they pay attention to the shapes when selecting, for example, "歲," and not "再," but they do not pay attention to the details of the shape of "歲." Therefore, because the correct answers are always provided, recall and retention are not reinforced.

In summary, although writing by hand forces attention on the detailed shapes of Chinese characters, it cannot correct mistaken memories. It is effective for maintaining existing correct knowledge, but is not effective for correcting incorrect knowledge or for acquiring familiarity with unknown character shapes. In contrast, although the existing input methods have the potential to correct mistaken memories, they do not force users to pay attention to shape details. G-IM provides a balance; it forces users to pay attention to detailed character shapes, as well as "pushes" correct shapes to correct flawed memories. Therefore, G-IM can be an on-the-job training system for writing Chinese characters. It is effective for acquiring the shapes of unknown characters, as well as maintaining and correcting already-learned ones.

The only disadvantage of G-IM is the extra burden of correcting the incorrect characters, which does not occur when using the existing input methods. As Table II shows, the G-IM group spent more time inputting the sentences in Step 2 than the IM group. This is an unavoidable trade-off. When we explained the G-IM method to other people at, for example, an academic meeting, many responded that they did not want to use such a cumbersome system. However, we believe that this minor inconvenience is not fatal considering the benefits and pay-off, just as foregoing taking the car and walking to your destination in order to get some fresh air and exercise, when it is not too far away and you are not in too much of a hurry, while less convenient, is preferable and beneficial to your health.

Similarly, we should approach the use of G-IM as opposed to the ordinary input methods on a case-by-case basis. If time is an issue, a conventional input method should be used. However, when convenient, G-IM should be used to correct and (re)establish knowledge, recall, and retention of Chinese characters. G-IM does not require as much time as studying educational materials. In addition, with G-IM, people can efficiently learn the correct shapes of common and frequently used Chinese characters, while educational materials require the additional study of characters that are seldom used.

This design policy, which does not just aim at improving the performance of inputting Chinese characters, has something in common with the Further Benefit of a Kind of Inconvenience (FUBEN-EKI) concept proposed by Kawakami et al. [14][15]. They argued that convenient tools hamper skill acquisition and motivation. They propose that designing tools that incorporate or retain some inconveniences is important. G-IM incorporated the input methods of Chinese characters with some inconveniences: users are required to maintain constant attention to the shapes of the output characters, which provides a different benefit from inputting efficiency, that is, the correction and (re)establishment of Chinese character memories. Kawakami

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et al. did not demonstrate any concrete method of incorporating such inconveniences. G-IM embeds quizzes in the operations of inputting Chinese characters. Thus, embedding quizzes (or, more generally speaking, embedding some gamifying functions) in everyday activities can be a concrete design methodology based on the FUBEN-EKI concept.

Another gamification approach may alleviate the cumbersomeness of G-IM. Scoring correctly saved text files and sharing scores among G-IM users can lead to enjoyable competition among users. We would like to implement such additional functions to make G-IM much more useful and enjoyable in the near future.

VII. CONCLUSION

This paper described a novel pronunciation-based Chinese-character input method called G-IM. The primary feature of G-IM is that it sometimes outputs incorrectly shaped Chinese characters, which the conventional input methods never do. G-IM forces users to pay attention to detailed character shapes in order to build, correct, and strengthen the memory of Chinese characters. We conducted user studies that compared G-IM with a conventional pronunciation-based input method and writing by hand. As a result, we confirmed that G-IM significantly strengthened the participants' memories of Chinese characters compared to the other two methods. Accordingly, we can conclude that G-IM has the potential to solve character amnesia, which is a current and increasing problem in both China and Japan.

In the near future, we would like to incorporate some gamification functions to alleviate the cumbersomeness of G-IM. We also would like to conduct more long-term user studies to estimate G-IM's efficacy more accurately. Furthermore, we need to conduct experiments in the wild for evaluating actual usefulness of G-IM and for confirming compatibility of G-IM as an inputting method of Chinese characters and as a learning tool of Chinese characters. We are now developing a new version of G-IM that can be applied to everyday usage to conduct such experiments.

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