Cognitive Effects of the LV Approach on Kanji Learners: 
A Novel Approach Using Learner’s Personal Visual Cognition

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Abstract - This study focuses on the issue of how kanji learners mentally “deconstruct” a kanji as they view it and how they may update this visual deconstruction over time as they learn kanji. The research problem deals with the question of whether or not an innovative kanji learning approach, the “Learner’s Visualization (LV) Approach”, assists learners in significantly updating their personal kanji deconstruction visualization (which refers to how the learner visually divides a given kanji into smaller, manageable parts). With the LV Approach, in contrast to other kanji learning approaches, kanji learners themselves decide which way to divide a kanji into smaller parts, allowing them to thus choose the complexity level and number of parts of that particular kanji according to their personal visual cognition. To support the analysis of the kanji visualization process, we developed a kanji learning support system based on the LV Approach. The analysis of our results proves the existence of the positive effect of using this novel approach in kanji learning; learners progressively move towards visually dividing kanji into fewer and fewer blocks.

Index Terms – kanji, kanji learning approach, visual cognition, learning support system, kanji deconstruction visualization.

INTRODUCTION

This study deals with the issue of visual character deconstruction in a nonalphabetic system, namely the kanji characters in the Japanese language. The current study is intended to address the question of whether kanji learners progressively change the way in which they visually break down a kanji into groups of strokes or “blocks” (hereafter we refer to these shapes as “blocks”, “building blocks”, “components”, “parts”, or “elements” of a kanji).

The modern Japanese writing system uses a unique mixture of kanji, two kana syllabaries, and Roman letters and Arabic numerals borrowed from the West, all of which can be used together in a given text. Kanji are the Chinese characters. Both the kana syllabaries are entirely phonetic. Kana first developed because Chinese characters could not properly represent the grammatical elements and verb endings of Japanese. Originally, certain Chinese characters were used to write these elements phonetically; these characters were simplified over time to yield the kana syllabaries. Kanji (which makes up the core of the Japanese writing system) is derived from Chinese Hanzi characters, which generally have stable pronunciation in each language that uses them. The disadvantage of the kanji system is that the pronunciation of individual kanji can change according to context, and combinations of the blocks of a particular kanji can have a different meaning from what the blocks alone would suggest. The unique blend of scripts in Japanese offers fascinating questions for research, and kanji has been the main topic in numerous researches. In one work related to the present study, Tollini remarked on the importance of understanding how Westerners “see” kanji, especially during the initial stage of the learning process [1]. He stated that Westerners recognize kanji based on visual recognition laws that belong to non-kanji culture [1]. According to the work of Takagi, the complexity of recognizing a kanji can be reduced if learners visually break down kanji into small parts, and organize them [2].

COGNITIVE BACKGROUND

Regarding the difference between perceptual processing of kanji and kana, Usui et al [3] found that kanji and kana are processed in different areas of the brain, whereas the area for
processing kanji and object/picture naming is the same, implying that the shapes in a kanji have a strong effect on cognitive processing. In a study which analyzes holistic versus analytic perception, Nisbett and Miyamoto showed evidence that perceptual processes are influenced by cultural background [4]. Their findings establish that Westerners focus on discernible individual parts or objects, in contrast to East Asians, who focus more holistically [4]. Thus we find cognitive differences in the way people perceive.

**LEARNING MODEL BACKGROUND**

The present study is based on the cognitive orientation to learning and on the constructivist model which enables students to take an active role in their learning. Some modern educators and educational psychologists support a constructivist view of learning which holds that students create their own interpretations as they learn, and that cognition is a result of “mental construction” [5], [6]. Shifting the role of the learner from a passive to an active one occurs when students have richer units of learning and multiple sources of information. The twelve brain/mind learning principles developed by Renate Caine apply what we know about the function of the brain to teaching and learning. One of the most relevant principles is “each brain is uniquely organized” [5]. The learning model chosen for the basis of this study is the cognitive model. Figure 1 illustrates the mechanism of the cognitive model of learning according to Sharon Derry [7]

**KANJI-LEARNING APPROACHES BACKGROUND**

Methods for learning kanji have hitherto been focused on the following approaches:

I. **Radical Approach**

This method uses “radicals” (in Japanese, 部首 bushu) as the key elements of any kanji, grouping kanji according to radicals present within the characters. Limitations of this approach lie in the heterogeneity of the different groupings and in the fact that there are variations on the radicals’ shapes. Different dictionaries also identify different numbers of radicals, which leads to difficulties in learning even daily-use kanji (常用漢字).

II. **Frequency-Based Learning Approach**

This approach is based on Monbusho's Educational Kanji Chart (教育漢字の学年別漢字配当表). The main drawback of this approach is the fact that some kanji are taught without taking into account their visual components. For example, “eat” (た-beru, ku-rau/SHOKU) (食) is taught in the second grade, but its component, “good” (よ-i, RYOU) ( 良) is taught in the fourth grade. Teaching a kanji without previously teaching its elementary components is common but may not be efficient for foreigners.

III. **Component Approach**

This approach emphasizes learning the building blocks of kanji. All the parts of a kanji are identified as blocks. A block is a set of strokes which keeps the same visual shape. For example, 歌 is composed of the blocks: 可 and 欠. Blocks are associated with a pattern, which defines the relative position of different blocks. The main advantage of the component approach is that it emphasizes learning the building blocks of kanji. Heisig calls these basic blocks “primitives”, Foerster and Tamura call them “graphemes”, and Scott Alprin calls them “elements”.

IV. **Learner's Visualization (LV) Approach**

This novel approach proposed by Inostroza et al involves three elements: 1. the learner’s visual cognition, 2. multiform deconstruction of kanji, and 3. component analysis/synthesis. The first element, the learner’s visual cognition, is the way in which every learner visually divides a given kanji into “blocks”. The second element is the set of all the possible options of how that kanji could be broken down into blocks, from the highest number of small blocks down to just one block (which in this case is the whole kanji itself as a single unit). The third element is the analysis/synthesis cognitive strategy embedded in the approach which allows the user to analyze the given kanji by selecting any block inside it for further study, or to synthesize that block with a bordering block inside the same kanji, suggesting a larger block to be considered that combines the two smaller ones. These three elements are fused in a technique capable of enhancing the retention of kanjis’ shapes and meanings [8]. With the LV Approach, learners can use their own personal visual cognition (1), and the multiform deconstructions (2), to choose which construction works the best for them in visually analyzing, understanding, recognizing, studying, or simply viewing, that particular kanji, after which learners are guided in analyzing and synthesizing the different possible blocks of Kanji.
that kanji as appropriate for their specific visual cognitive processing style (3).

**DEVELOPMENT OF THE SYSTEM**

In pursuit of our study, we decided to develop a system based on the LV Approach in order to evaluate the possible cognitive effects of allowing learners to choose the way in which they divide a kanji and work based on their personal visual cognition, with the idea that this may reduce the foreignness of kanji and avoid discouragement during the learning process.

**Figure 2** illustrates the learning process sequence of our educational support system mentioning the features of its learning environment. The explanation is as follows:

- The system shows a certain kanji with its corresponding meaning, for example, the kanji for “to think, to remember”=“oku” (憶). Below the kanji, the system shows the different possible deconstructions into blocks into which the kanji can be divided. The users select their own way of dividing the kanji, according to their personal visual cognition. After selecting their deconstruction of choice, the system allows the users to examine and learn more with all the possible deconstructions. When users click on the zone of a block, the system gives relevant information about it.

- The system then suggests the learner consider a new and larger block which is constructed based on the block selected by the student combined with an additional block also present in the same kanji, bordering the selected block. The new assembled block turns out to be the “next complex element” in the kanji in study.

- Previously viewed kanji are displayed across the top of the screen in the order in which they were viewed, with the most recently viewed kanji on the left in the largest font size, followed by previously viewed kanji displayed in progressively shrinking font size. For example, in Fig. 2, the kanji 忆 was viewed before 懐.

Further, Fig. 2 shows the innovative analysis/synthesis technique of our system. The explanation is as follows:

While the user is working on the kanji 懐 and examining the block 立, the system shows some examples of other kanji that include a new assembled “next complex component”, in this case the suggested next complex component is 音. Learners can explore any of the examples just by clicking on one of them. The core of the technique lies with the recommendation of a “next complex component”. For example, if ‘立’ is the component or block selected by the learner, the “next complex component” suggested by the system is ‘立+日’=音 (as 立 is on top of 日 in the kanji). While it is true that other components can be built with ‘立’, for example, ‘立+女’ also forms another possible “next component” = ‘妾’ , this component ‘妾’ is not considered by the system as a suggestion, because in the situation of learning the kanji “憶”, the component ‘女’ is not part of the kanji in study で. The component ‘日’ is part of the kanji in study, so this component is used for being combined with the component selected by the learner (立).

Learners can also explore other kanji that include the block they selected. Examples of kanji that include the selected block appear at the bottom of the learning environment. Alternatively, learners can explore different kanji using a “random” function.

**EXPERIMENT**

According to standard classification of experiment design, we have conducted a Research Design of the type True Experimental Designs, specifically True Experimental Design: Post-Test Only Control Group Design. This Post-Test Only Design experiment (using a parallel group) was conducted to determine if there is a significant impact in the way learners personally visually deconstruct kanji.

**I. Evaluation question**

The evaluation question for the experiment was: “Do learners studying kanji through the Learner’s Visualization (LV) Approach significantly update their personal way of deconstructing individual kanji?” (Specifically, “Does the LV Approach assist kanji learners who did not grow up with a similar writing system in accelerating their natural progression towards perceiving individual kanji in fewer and fewer blocks or groups of strokes?”).

**II. Evaluation method**

During the course of the experiment, learners used our innovative educational support system, the Learner’s Visualization (LV) System, an implemented web-based system, for the learning session. At the end of the learning session they took a post-test. The learners were randomly assigned to one of two variants: the Control Group (G1), which used the traditional way of learning, and the Treatment Group (G2), which used the LV Approach.

**III. Participants**
The participants in this study were 42 university students. The group included people of 17 different nationalities. All participants had little formal training in kanji and were from regions that do not use a writing system similar to kanji. Most participants reported that they had studied some Japanese either formally or informally. Participants reported the length of their formal Japanese study in semesters. All were beginners. The mean length of formal study was 3.27 months and the standard deviation, SD, was 1.18 months. Although most participants had a conversational familiarity with Japanese, all the participants, had little, if any, formal study of the kanji writing system. The participants were exclusively speakers of languages that use an alphabetic script, namely: Arabic, Bengali, Dzongkha, English, French, German, Hindi, Lao, Sharchopkha, Spanish, Tswana, Urdu, and Vietnamese.

IV. Instructional Material

The total number of kanji in the LV System is 1960 and the total number of shapes (blocks) is 2016. (Nonetheless, the number of kanji with all their possible deconstructions into blocks or components identified is only 100.)

V. Design

The design of this experiment is as follows:

- Type of experiment: Research Experiment, Post-Test Only Control Group Design. True Experimental Design.
- Dependent variable: “kanji deconstruction level” (the mean number of blocks into which the user chooses to deconstruct a particular kanji).
- Independent variable: The presence or absence of individualized training in mentally deconstructing kanji (“learner-guided deconstruction technique”), which is the characteristic feature of the LV Approach.
- Design: Subjects are randomly assigned to treatment so that equal numbers are in the Control Group and the Experimental Group.
- Goal: Compare learners Pre-Test and Post-Test deconstruction level status between the two groups.
- Question to answer: “Is there a statistically significant difference in the mean of the level at which learners personally visually deconstruct the given kanji. This construct will also be referred to as “deconstruction visualization”. The smaller the number of blocks the learners visualized in a single kanji, the more the learners increased their scores. The whole unit deconstruction visualization (which occurs when the user chooses to visualize a given kanji as only one block) corresponds to the highest number of points. The whole unit deconstruction visualization gets the highest amount of points.

Figure 3 illustrates an archetype of the questions in the Kanji Deconstruction Test, showing all the possible deconstructions for the kanji “odoroki” (驚).

VI. Instruments

A background questionnaire and written instructions on how to use the LV System were given to each participant at the beginning of the experiment. In a kanji deconstruction test, used as a pre-test and later as a post-test, learners were asked to select their preferred deconstruction for each of the 20 kanji in the test. All the participants freely chose their own personal way of deconstructing the 20 given kanji; all the possible visual ways in which every kanji could be deconstructed were given. While every option was assigned a certain number of points, this did not appear in the test in order to prevent learners from being influenced by the point system and consequently generating unreal data.

“Personal kanji deconstruction level” (maximum score: 100) represents the accumulation of points that the participants scored after selecting all the 20 kanji deconstruction options of their preference. This item type was used to measure the level at which learners personally visually deconstructed the given kanji. This construct will also be referred to as “deconstruction visualization”. The smaller the number of blocks the learners visualized in a single kanji, the more the learners increased their scores. The whole unit deconstruction visualization (which occurs when the user chooses to visualize a given kanji as only one block) corresponds to the highest number of points.

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VII. Procedure

The pre-test was administered at the beginning of the learning session and the post-test upon completion. The test used for the post-test was the same as the pre-test.

VIII. Data Analysis

Descriptive statistics for the gain scores of the dependent variable were applied in order to examine the effect of the LV Approach on the learner's “kanji deconstruction score”.

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RESULTS AND DISCUSSION

I. Results

For this study we began with the assumption that kanji learners, regardless of the approach they use, do somehow gradually update their way of visually dividing kanji over time as they progressively learn the component shapes that make up individual characters. From there, we developed the hypothesis: “Learners studying kanji through the LV Approach could more quickly update their own deconstruction visualization,” which led us to our research questions: “Do kanji learners receive an impact in their current kanji deconstruction score (mean number of blocks per kanji, with a higher score corresponding to fewer blocks per kanji) after working with the LV Approach?”, and “Is that impact a statistically significant improvement?”.

The answer to these questions, according to the experiment performed, was affirmative. The statistical data of the groups in the post-test were: mean G1= 33.76, mean G2= 57.90; Standard Deviation G1=6.02, SD G2 =14.55.

Figure 4 shows the analysis of the results of the pre-test and the two groups' post-test scores in kanji deconstruction visualization. The descriptive statistics for the mean of the deconstruction level updates in the group that used the LV Approach compared with the other group suggest that the use of the learner-guided deconstruction technique facilitated significant improvement in the participants' current level of preferred visual kanji deconstruction.

It is worth mentioning that power/sample size calculations have been obtained in order to compare means of two independent samples based on normal distribution. The t-test was used because the experimental groups were defined by a variable that is relevant to the change in measurement. No standard assumptions have been violated.

The results of the performed t-test indicated there was a significant difference between the two sets of data at the .01 level. The two-tailed P value equals 0.0001, and by conventional criteria, this difference is considered to be statistically significant. This indicates there was a greater than 99% chance the mean of one group was in fact different than the mean of the other group. These data therefore tend to support the hypothesis that “learners, while studying kanji using their own preferred visual cognition, significantly and progressively acquire the ability to break down kanji into fewer deconstructed parts”.

II. Discussion

The results suggest that whether or not the LV Approach is used, kanji learners tend to adapt their own way of comprehending manageable substructures within each kanji. Some learners could be less naturally adept at comprehending visual inputs with multiple elements. These learners could be excessively distracted when visualizing many groups of strokes within a single kanji. Therefore, the importance of helping learners to update their kanji deconstruction “map” to visually divide individual kanji into progressively fewer groups of strokes is evident; this process becomes smooth with the LV approach, most importantly at the speed of the learner’s personal cognition. It is worth emphasizing that the change in kanji deconstruction map may happen in any learner despite the method used, however, the LV Approach accelerates this process.

The experiment revealed that learners' way of visually deconstructing kanji is impacted; learners gradually gain the skill to perceive a kanji in fewer and fewer numbers of blocks, following the iconicity principle, moving towards single unit visualization. This is congruent with the concept that the strength of learners’ ability to recognize kanji is attributed to iconicity, converging with the distinctive number of blocks that form the kanji [9],[10].

In Figure 4, the black outer circle represents a hypothetical learner's visualization of each kanji as a single unit (meaning in deconstructing a given kanji into its parts, one single block is the learner’s choice: the whole kanji). The purple line represents the visualization of each kanji as two blocks.
CONCLUSION AND FUTURE WORK

This study was designed to prove the existence of the positive cognitive effect of using a novel approach in kanji learning, the Learner's Visualization (LV) Approach, and in fact, a positive cognitive effect was found.

It is noteworthy that the core of the educational technique of the LV Approach lies in its strategy to help learners to accelerate the normal process of developing the ability to perceive visually complex characters (kanji) in fewer and fewer individual blocks of shapes, and thus accelerate cognitive processing of those characters.

I. Achievements

• First integration of learner’s personal visual cognition in a kanji-learning educational tool. This achievement could open the door to increasing the performance of future kanji-learning CALL systems.
• First finding indicating that, in the mind of kanji learners, deconstruction visualization changes.
• First evaluation of the effectiveness of taking into account the personal visual perception of learners.
• Proof positive that learners do update their own kanji deconstruction visualization map, and that this process can be accelerated.
• Proof that the LV Approach accelerates the ordinarily slow change in kanji deconstruction visualization.

II. Future Work

• To compare between beginner, intermediate and advanced learners how they visually deconstruct kanji and how they update the way they do this.
• To understand what is the normal speed at which foreign learners ordinarily update their kanji deconstruction map and compare this to the speed of improvement with the use of the LV Approach.

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