

# Design and Implementation of Novel Word Learning System “Überall”

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**Abstract.** Previous research has found that in many cases, paper-based materials are better tools than digital-based products for learning and memorizing words. However, the advantage of digital media is that functions can be easily added. In this paper, we demonstrate a new digital system for memorizing words that is connected to the real world for each word. The use of this system is based on taking photos in daily life. The system detects the squares in the photo taken, and the square becomes the space for a word. We present a design and an evaluation using a mock-up of the system.

**Keywords:** Memory · Learning words · Photo · Smartphone

## 1 Introduction

Recently, with the development of smartphones and tablet devices, analog devices like paper are gradually being replaced by digital devices. Even in the academic sphere, tablet devices are being actively championed as notebook and pencil replacements. For example, in Saga prefecture, tablet devices are used at high schools [1], and for correspondence courses run by a major company for elementary schoolchildren, an original tablet device has been adopted [2]. However, the effectiveness of these digital devices compared with that of analog systems has not yet been widely investigated.

Some researches has compared the use of paper and digital media [3, 4]; however, only the moment at which the user was actually using one of these two media was considered. We previously researched the ability of a group of Japanese and German subjects to remember words the following day, three days after learning and a week after they first tried to memorize them [5, 6]. The results demonstrated that users who want to learn in the short term would benefit from using digital media only if they had significant experience using digital media. However, if a user wants to learn something over the long term, paper-based learning materials may be better. Our research was based on

testing with the flash card method for learning and memorizing. This method is very popular among Japanese and German students.

We concluded that digital media was not so effective when the digital media product was similar to the paper product. Therefore, to effectively utilize the features of the digital media devices, the learning products need to be associated with the advanced functions. For example, the camera device in smartphones is noteworthy, because everyone has a smartphone with them, especially young people, who enjoy taking pictures in daily life.

Also, in our former research, we came to the conclusion that the feeling of the paper or the turning up of the card could contribute to memory retention. There is a mnemonic from ancient times called the “memory palace,” which enhances memory by putting information in a familiar place in the brain. With this method, people are able to organize and recall information well, so, for that reason, many memory contest champions claim to use this method [7]. We believed that this method could work not only in the brain, but also in the smartphone through taking pictures. When the user takes pictures, the pictures change into vocabulary flash cards, so the user can recall words such as, “in place X there was word A.”

We have developed a new digital system for memorizing words that is connected to the real world for each word. This system is based on taking photos in daily life. The system detects squares in the photo, and the square becomes the space for one word. In this paper, we talk about the design and evaluation using a prototype.

## 2 Überall System

### 2.1 Concept

Previous research has indicated that paper-based materials are better tools than digital-based media for learning and memorizing words. However, the advantage of digital media is that functions can be easily added. We developed a new digital system for memorizing words, which is connected to the real world for each new word. To use this system, users first take a photo. The system then detects squares in the photo, and this square becomes the space for a word. There have been both books and learning systems that use pictures to illustrate new words [8], but in our system, we use pictures from daily life that are not consistent with the meaning of the words (Fig. 2).

We call this system Überall, which means everywhere in German. Any location can be used to create a flash card when a photo is taken. It is speculated that users can memorize more words using this digital media system. Überall is designed to make learning fun. Most language learners these days take photos anytime and anywhere in daily life. This is especially true in Japan, where taking photos is a normal everyday behavior. People take photos of food, information on the street, or classroom shots. Therefore, because taking photos is so common, this system should be easy to use. We have chosen a German word for the name of the system, because the “Ü” from Überall resembles a smiley face.

### 3 Experiment

#### 3.1 Überall Prototype

To evaluate the learning words system, we developed a prototype using POP (Fig. 3), which is an application for simulating the screen transition on smartphones. With POP, we could use many images, and users could also click on a part of the image and move to other pages.

Unfortunately, POP is unable to work with the smartphone's camera device. Because of that, we used pictures that were taken previously, but the users needed to behave as if they had taken these pictures. As Fig. 4 shows, at first the users only see the photo. Then they press the button as if they are taking a picture and the photo changes to a photo with words, which represents the mock-up of the smartphone's camera device.

We developed 81 pages for this prototype. Fourteen photos were taken on the Keio University campus in Shonanda, Japan. The developed pages were based on the 14 photos and contained photos, the same photos with words, a magnification of the words and the main Überall screen.

Until the users looked through all the words once, they were unable to look back at the previous word, so they could only go on the next word. Once all words have been studied, then users can freely browse all other words.

#### 3.2 Experiment

Twenty students from Keio University were selected as participants, with the equal number of males and females. The average age of the subjects was 20.6 years, with the youngest being 18 years and the oldest being 26 years. None of the subjects had eyesight problems. The average duration of smartphone use was 44.1 months, with the shortest being 20 months and the longest being 104 months. The average duration of PC use was 7 years and 4.3 months, with the shortest being 3 years and the longest being 12 years. In Japan, children generally do not study English before 12 years.

#### 3.3 Environment of Experiment

The influence of the application was investigated by testing how the students remembered the words on the following day, three days after and one week after. Therefore the test was conducted several times to verify how well the students learned. We used the iPod touch 4<sup>th</sup> generation, which has a 3.5 in. widescreen multitouch display and a 960 × 640 pixel resolution at 326 pixels/in. We used the font “MS P ゴシック” for Japanese and the font “Calibri” for English.

#### 3.4 Flash Card Contents

In the prototype, the flash card set had 10 words in English and 10 words in Japanese. As the users were Japanese, difficult ideograms were chosen for the test. In Japan, an examination called the Japanese Aptitude Kanji Test is used to check student's knowledge of Japanese Characters. For our test, we used ideograms that had the same level of difficulty as that examination [8]. A phonetic symbol for the Japanese syllabary was

added to ideograms. The English also had the same level of difficulty that a language teaching company in Japan “Alc” gives definitions [9]. The level of the Alc English words in the experiment is the advanced level over upper intermediate.

We developed a list of words with microsoft excel and randomly chose words both in Japanese and English.

### 3.5 Process

In former research, subjects were given 2 min to learn 20 words using two different types of media [5, 6]. However, subjects using Überall were required to do additional activities such as taking pictures, i.e., this additional work depends on the motivation and the interest of the individuals. We fixed the system so that the subjects could decide on the completion time by themselves, and they had to inform us if they thought they had learnt all the words.

On the following day, three days after the initial learning period and a week after, subjects received an email with a vocabulary test, which comprised 10 words; 2 words belonged to the group of 10 that had already been learned in the Überall prototype, with the remainder being new words (Fig. 5).

We set aside one week for the test period. We also tried a one month experiment, but there were only small differences between the results a week after and a month after memorizing the words. Psychologist Hermann Ebbinghaus did an experiment and developed a “forgetting curve.” In the forgetting curve, there was only a 4 % difference between recall after a week and recall after a month.

### 3.6 Questionnaire

After the subjects had used the Überall prototype, they completed a questionnaire. The first part of the questionnaire collected personal data such as age, sex, and eyesight. The second part was a confirmation as to whether the Überall prototype effectively recreated the workings of the camera device. For that we asked two questions: one about whether the subjects had understood where the photos had been taken and the other about their impressions of the quality of the photos. Subjects answered on a scale of 1–7. The third part of the questionnaire asked subjects to give a free description about the use of the system.

When the subjects took the tests, we asked them how they recalled the information, with “Only words,” “Words and some photos which came with the words,” “Words and photos,” “Photos and some words that came with the photos” or “Only photos.”

## 4 Results

### 4.1 Experiment Scores

Each word was given a score of 1 point. The number of subjects was 20 and each subject could have a maximum of 2 points. Therefore, the maximum score overall was 40 points. The graph below presents the results with the average scores (Fig. 6).

The average prototype use time was 5 min 27 s. The shortest was 1 min 42 s and the longest was 12 min 5 s.

We first tested whether subjects chose words that they already learned, and conducted an additional test to check whether they could memorize a phonetic symbol. One ideogram had been allocated an incorrect phonetic symbol, so we asked subjects how they would read the word. The word used was “玲瓏,” which should be read “れいろう (reirou),” but was given as “れいせい (reisei)” in the experiment. 16 subjects answered “れいせい (reisei)” incorrectly as they had learned this using the prototype. The results demonstrated that the subjects could memorize many words using Überall and that they could recall these words well a week after memorizing them. From these results, then, we can say that the Überall learning words system was successful.

## 4.2 Questionnaire Results

### 4.2.1 Recreation of the Memory Palace

People who use the mnemonic memory palace put information in a familiar place in their brain. The subjects could recreate this type of memory system using the Überall prototype on smartphones, and in this experiment, even though the subjects could not take photos themselves, they could behave as if they had taken the photos. Therefore, we needed to confirm whether it was possible to recreate the workings of the camera device. We first asked whether subjects had understood where the photos were taken on a scale of 1–7, where level 1 was “I could understand every place” and level 7 was “I couldn’t understand any of the places.” All subjects answered with a 1 or 2, with the average being 1.3.

### 4.2.2 Connection Between the Photos and the Words

We asked the subject how impressive the photos were on a scale of 1–7, with level 1 being “the Photos were very impressive” and level 7 being “the photos do not give me any impression.” The average level was 2.6, with most answers being between 1 and 5.

When the subjects took the tests on the following day, three days after and a week after memorizing the words, we asked them how they had recalled the information. The following table presents the choices and the responses. Many subjects chose the category “Only words” or “Words and some photos which came with the words,” indicating that they recalled the photos from the words. None of subjects said that they recalled the words from the photos (Table 1).

**Table 1.** Information recall method

	1 Day	3 Days	7 Days
Only words	10	13	16
Words → photos	9	4	3
Words and photos	1	2	1
Photos → words	0	0	0
Only photos	0	1	0

### 4.2.3 Impressions About Überall

This part of the questionnaire was a free description. Some of the opinions given were “I felt like I was putting words in my brain when learning the words, and this system seems to put the words in a familiar place so I feel good about it,” “Mapping words in daily life is interesting,” “The words came up in various ways, so I could learn words enjoyably”, and “I was surprised that I could remember many words after only looking at them once.”

On the other hand, there were some opinions such as “It may be better if the photos were connected to the meaning of words” or “It was hard to remember when there were 2 words on a photo.”

## 5 Discussion

### 5.1 Relation Between Learning Time and Results

When we reviewed the results of those subjects who only got 1 point (max. 2 point and the average point was 1.8 points) when learning Japanese, they were found to have used the prototype for 4 min 2 s on average, which was approximately 1 min shorter than the average use (5 min 27 s). We developed a table that shows the relation between the learning time and the results. Five subjects who had used the prototype for a minimum time were chosen (Table 2).

**Table 2.** Relation between learning time and results

		5 subjects with minimum time	Whole subjects
Japanese	1 day	1.8	1.8
	3 days	1.8	1.9
	7 days	2	1.9
English	1 day	1.6	1.7
	3 days	1.4	1.8
	7 days	1.2	1.5

From this table, it can be seen that there are only a few differences. In short, the learning time did not appear to have a large effect on the results. Firstly, the subjects did not find the learning time very long, and one subject said he could learn easily.

## 5.2 Relation Between Words and Places

A notable result was the way subjects recalled the information. Many subjects answered “Only words” or “Words and some photos which came with the words.” When we checked with the subjects who did not recall the words well, 4 out of 5 of these subjects had chosen “Only words.” On the contrary, when we checked with the subjects who had recalled the words well, almost all had chosen “Words and some photos which came with the words.”

Admittedly there were some problems, for example, we did not ask them what methods they had used to recall the words and photos, but supposed that they recalled the places if they were unable to recall the photos. Nonetheless, the results suggested that those subjects who had good recall had been able to connect the words and photos well.

In addition, although we used pictures that had been taken previously, the users were required to behave as if they had taken the pictures. We believe that if the subjects had taken the photos themselves, the connection between the words and places could have been better.

## 5.3 Comparison with Paper Flash Cards

We compared the Überall results with the results that we had from former research [5, 6]. These two approaches had similar subjects as the subjects came from Keio University. The average age of subjects in this experiment was 20.6 years and the average age of subjects in the former experiment was 20.1 years. Subjects from this experiment had a longer experience in using smartphones, but a shorter experience in using a PC than the subjects from the former research. Consequently, there was only a small difference in experience with digital devices.

In our former research, we compared the use of paper flash cards with digital flash cards. The results demonstrated that the subjects could recall more words in Japanese or English when using the paper flash cards as a learning tool. However, when we compared the results of the English vocabulary one day after, the points scored for digital media were higher. We believe that this could happen if users had many years of experience with digital media. During the following tests, having such an experience did not appear to make any difference as the results demonstrated that the paper flash cards were more effective. We compared the results using the paper flash cards at first.

### 5.3.1 Comparison in Learning English

Figure 7 presents the average score for the results and the standard deviations. The average score was gradually lowered when using the paper flash cards. The differences between using the paper flash cards and using Überall were 0.6 on the following day, 0.75 after three days, and 0.8 points after a week.

We surmise that these results may be due to the additional information. The paper flash cards have additional information such as the feeling of the paper or the turning up a card, which can strengthen fixing the word in memory. However, Überall also has additional information such as places and images of the places.

### 5.3.2 Comparison for Learning Japanese

Figure 8 presents the average score for the results and the standard deviations. The average score increased a week after memorizing the words when using the paper flash cards. However, when using Überall, the average score increased at three days after memorizing the words and this level was maintained after a week.

While it is recognized that the data are insufficient to make sweeping conclusions, it does seem that subjects could remember not only the words itself, but also the phonetic symbols when learning Japanese, because 80 % of the subjects had answered with the wrong phonetic symbol, which they had learned as part of this experiment.

### 5.4 Comparison with Simply Electronic Flash Cards

The results are presented in Fig. 9. In the graph, Überall is compared with simple electronic flash cards. The appearance of the simply electronic flash cards is in Fig. 1 on page 2. This version has a similar appearance to the paper flash cards but users could only swipe the multitouch screen interface to see the next or previous words.



Fig. 1. Paper-based flash cards and its digital equivalent

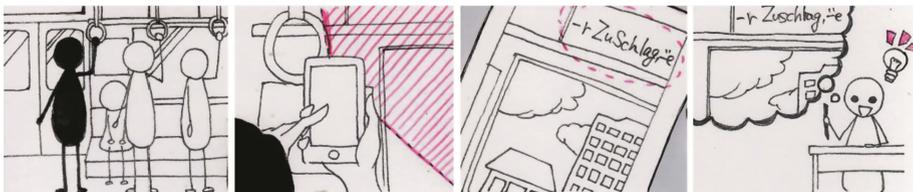


Fig. 2. Scenes from using Überall

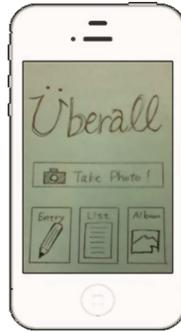


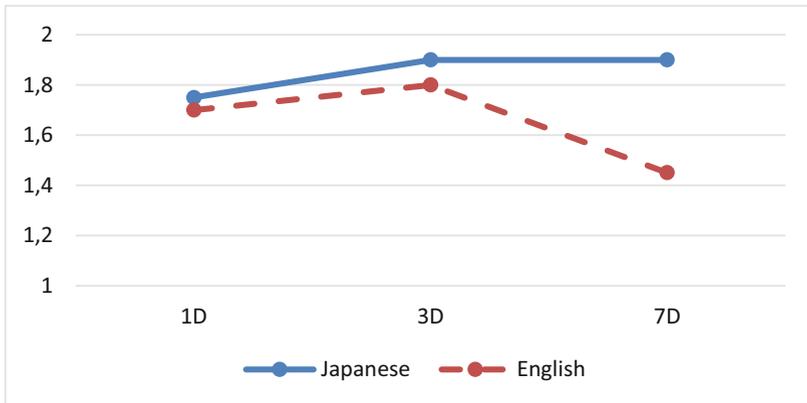
Fig. 3. Überall prototype



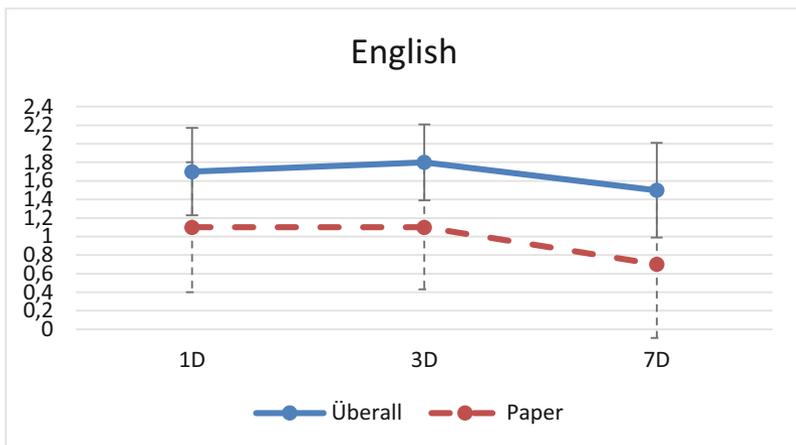
Fig. 4. Representation of the working of the camera device in the prototype



Fig. 5. Test example



**Fig. 6.** Score for Japanese and English by Überall



**Fig. 7.** Comparison for learning English

The difference on the following day was small, but it can be seen that recall three days after and one week after was significantly higher for Überall, indicating that Überall is a more effective vocabulary learning tool than simply electronic flash cards. The simply electronic flash cards have little additional information. As outlined, it appears that additional information makes it easier to recall words.

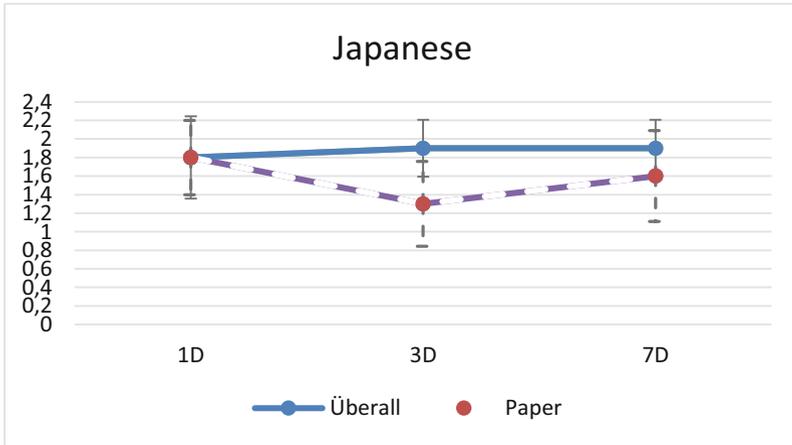


Fig. 8. Comparison for learning Japanese

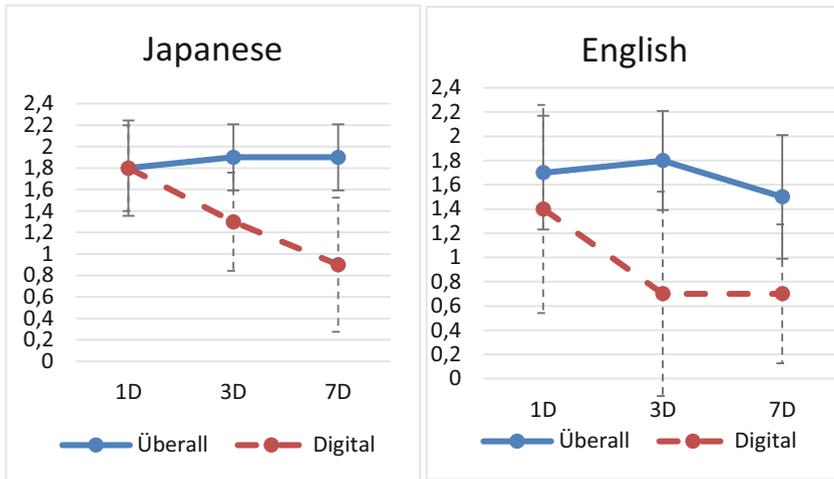


Fig. 9. Comparison with simply electronic flash cards

## 6 Conclusion

In this paper, we propose a new digital system, called *Überall*, to memorize words that are located in the real world and are associated with visual clues from the associated pictures. The prototype of *Überall* had been tested on 20 subjects.

When using *Überall*, users required more time for learning, because they had to take pictures to make the flash cards. Nonetheless, through this experiment, it can be concluded that *Überall* is both effective and enjoyable. The usefulness of *Überall* was found to be better than that of paper flash cards.

The main results and conclusions that can be taken from this experiment:

- Users could memorize and recall words when using Überall irrespective of the time they spent using it.
- When users could connect places and words well, they were found to have an effective recall.
- Überall was found to be a better tool for learning words than paper flash cards.

In the experiment, we only used a prototype of Überall. When we develop the final Überall version on the basis of the same concepts, users would be able to take their own pictures and develop their own vocabulary learning lists. It is reasonable to suppose that this real experience may be even more effective. Future work will focus on the use of the final system to assess this supposition.

Besides our research intention to test the effectiveness of the final system, we also intend to explore the following questions: “Is it better if words are related to pictures?”; “How many words should be on one picture?”; and “What kind of place is effective?”.

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