

A development of an application for learning English words with using the method of chain reaction of cues

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Abstract. The main topic addressed in this paper is to propose an application of learning English vocabulary. In the learning, it will be needed to provide a mechanism which makes it fun to learn English vocabulary. In this paper, we propose such a mechanism which we call *chain reaction of cues*, and we provide an application for learning English vocabulary with the mechanism.

1. Introduction

In Japan, improvement of English language skills of the individual is being sought with the advent of the global society. As one of the countermeasures, English became a compulsory subject in elementary schools in Japan. For this reason, support to teachers in elementary school is also required [1]. Higgs et al. showed that the learning vocabulary is important in language learning especially early in learning [2]. Against this background, various teaching materials for learning English vocabulary according to the learner's level are being developed in Japan.

On the other hand, there are limits to some extent in improving vocabulary skills due to the temporal memory capacity of the brain. Hayashi et al. calls short-term memory as working memory. It has a high correlation with understanding the foreign language syntax, ability of reading comprehension, and listening ability. Therefore, it was necessary to learn foreign language according to the operational capability of working memory [3]. It has also been reported that the capacity of working memory improves with nonverbal training [4].

From these, improvement the vocabulary skill is important in early of learning. Also, it is important to provide a mechanism which makes it fun to learn English vocabulary. In this paper, we propose such a mechanism which we call *chain reaction of cues*, and we provide an application for learning English vocabulary with the mechanism.

2. Related works

With the popularization of digital devices, studies of learning applications of English vocabulary have increased. Kuwabara et al. developed a learning application that can learn repeatedly in a short time with listening sound material [5]. It reported that the learners' total learning time was increased, and a significant effect of learning was obtained. Kikuchi et al. developed a tool that creating a word

book with daily events [6]. The aim of tool is to improve learner's ability of memorize the English words due to combine word and daily event. Guo has developed a learning content that incorporates a maze game [7]. It reports that the learners feel interest in the mechanism of maze game, and the correct answer rate of the subject improved from 40% to 75%.

3. Chain Reaction of cues

There has been several reports discussing the advantages of mobile applications for language educations (e.g.. [8,9,10]). The report [8] says that "The most important factors that affected the learning process were the ease of use, the gamification of the application and the ubiquity of the device and application. These factors had a stimulating effect on the process of learning and the willingness to continue using it and recommend to others". Also [9] reports that "As a mobile application for smart phones and tablets, the advantages of crossword puzzles are ubiquitous and can be within an arm's length of most students, and running on a device and in an environment for which most students greatly value". Hence, it would be nice if we can produce an enjoyable mobile application for English vocabulary learning.

To develop such an application, *gamification* plays an important role. To incorporate gamification into English vocabulary learning, we incorporate a common feature appearing several popular puzzle games such as Sudoku, Nonogram, minesweeper, crossword puzzle, and jigsaw puzzle in our game application. We call the feature *Chain Reaction of Cues* (CRC).

	<i>o</i>	<i>d</i>	<i>r</i>	<i>m</i>	<i>e</i>
部屋	2	0	1	1	0
扉	2	1	1	0	0
やり方	1	1	0	1	1
命令	1	1	2	0	1

Table 1. Simple example of chain reaction of cues.

To explain what CRC is, let us consider a learner who remembers that the Japanese words "heya (部屋)" and "tobira (扉)" are "room" and "door" in English, respectively, but vaguely remembers for "yarikata (やり方)" and "meirei (命令)". Then, the learner can easily identify the first and third columns' letters as "o" and "r", respectively. Then, the learner can also determine that the second and fourth columns' letters are "d" and "m", respectively. This is because "room" does not have "d" but has "m", alternatively "door" does not have "m" but has "d". Now, the learner has some cues to remember the English words of "yarikata" and "meirei". For example, "yarikata" has the three letters "o", "d", and "m". So, it seems more likely that the learner remember that "yarikata" is "mode" in English. Moreover, the learner might remember the word "meirei" is "order" after having new cue: identifying the last column's letter as "e".

To explain more detail for CRC, we introduce several terms through the above example. Table 1 is referred to as *question*. The column vector (2,2,1,1) appearing in the first column is called *the first column vector* or "*o*" *column vector* when knowing the first column's letter is "o". Similarly, the row vector (2,0,1,1,0) appearing in the first row is called the first row vector or "heya (部屋)" vector. So, two words which are anagram of one another make indistinguishable row vectors. The set of letters {o,d,r,m,e} is called the *alphabet* (of the question).

As seen in the example, initial cues can be obtained from well-remembered words. Then, the cues produce other cues, then the produced cues also produce other new cues, and so on. This phenomena is what we call CRC. The following points should be devised to make CRC work well.

- Combine words that difficult to remember and that already remembered.

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- Prepare at least a word which has a letter appearing twice in the word.
- Avoid generating indistinguishable column vectors.

	1	2	3	4	5	6	7	8	9	10
	a	b	e	i	l	n	o	r	s	v
手に入る	3	1	1	1	2					1
を関与させる			1	1	1	1	1			2
に気づく		1	2				1	1	1	
理由	1		1			1	1	1	1	
気球	1	1			2	1	2			
到着する	1		1	1				2		1

Table 2. Advanced example

Let us give a more advanced example. In the question as shown in Table 2, "手に入る", "を関与させる", "に気づく" can be considered as difficult words to remember. Indeed, these are at the 2nd, 4th, and 5th places in the ranking of words with difficult to remember among the basic words in TOEIC examination [11]. Let us call those words *difficult*. On the other hand, "balloon (気球)", "arrive (到着)", and "reason (理由)" are highly familiar words and appearance frequency words, so we may suppose that most learner already remember such words. Thus, let us call those words *easy*.

Let us focus the three easy words, then we have ten three dimension (3D) column vectors. For example, the first 3D column vector is (1,1,1), the second 3D column vector is (0,1,0), and so on. In those ten 3D column vectors, there is only one pair of indistinguishable column vectors, that is, fourth and tenth 3D column vectors. Hence, if a learner can identify the English words corresponding to the three easy words, then not only the alphabet of the question is determined, but also the letters corresponding to column vectors except for fourth and tenth column vectors can be identified. Thus, the question can be almost solved if the learner can identify the three easy words.

4. Prototype of application

We developed prototype application with CRC described in the previous section, using Unity. Figure 1 is a screen immediately after the start of the question. Figure 2 is a screen just after finishing answer. The positions of the letters to be answered are changed at random each time, it is activated. The correctness of learner's answer is automatically checked, when touching the JUDGE button.

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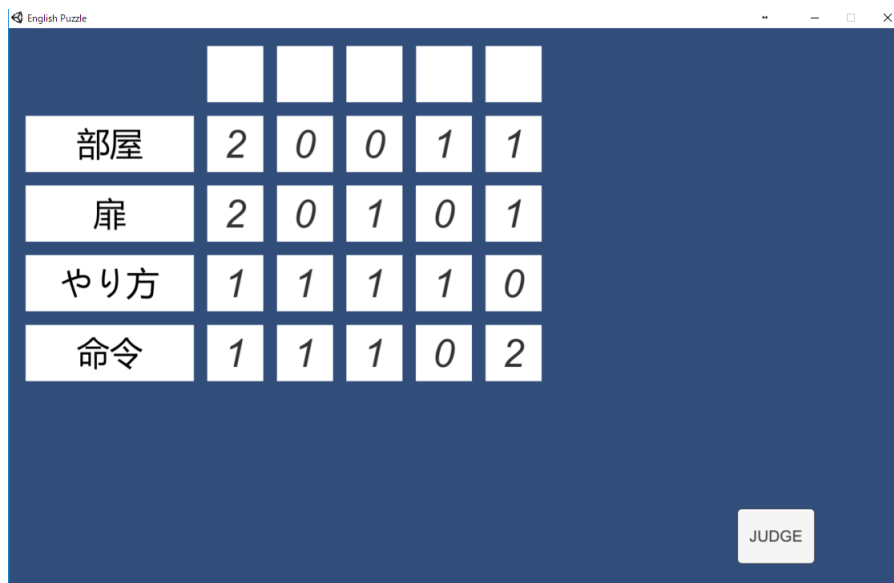


Fig. 1. Initial state of prototype application



Fig. 2. Example answer

5. Conclusion

In this paper, we proposed a mechanism, called chain reaction of cues, which makes it fun to learn English vocabulary. Then, we provided an application for learning English vocabulary with the chain reaction of cues.

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