

Effects of Color and Serial-Position of Words on L2 Vocabulary Recall and Retention

SoJin Kang
(Seoul National University)
Jin-Hwa Lee
(Chung-Ang University)

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This study investigated the effects of word color, serial-position, and their interaction on L2 learners' recall and retention of words. Adopting a repeated-measure design, this study presented 19 Korean middle school students with low frequency English words and pseudo words under each of the four conditions: [-Order -Color], [-Order +Color], [+Order -Color], and [+Order +Color]. Their vocabulary recall and retention were measured by immediate and delayed free recall tasks, along with written retrospective protocols. Overall the results of this study supported the effects of color, serial-position and their interaction on immediate recall and partly on retention. The participants' immediate recall test scores were higher when some words in the list were marked in color ([+Color] conditions) and the further analyses of individual words showed that those colored words were recalled and retained more frequently and foremost than non-colored ones. It was also found that words in first and last positions resulted in high recall and retention, with stronger primacy effect of the first position than recency effect of the last position. Yet, when color was added, the recency effect turned out to be stronger than primacy effect. Finally, written retrospective protocols confirmed that the participants actually paid attention to color and serial-position of words while processing the presented words.

Keywords: L2 vocabulary, color, serial-position, primacy effect, recency effect

1. Introduction

Knowledge of words plays an important role in comprehending and producing language. McCarthy (1990:viii) states “No matter how well the student learns grammar, no matter how successfully the sounds of L2 are mastered, without words to express a wide range of meanings, communication in an L2 just cannot happen in any meaningful way”. Reflecting the importance of vocabulary in L2 learning, a considerable amount of research has explored effective ways to provide vocabulary instruction to L2 learners. Researchers have found that vocabulary acquisition is affected by various factors, such as frequency, background knowledge, familiarity, relativeness and presentation method (Coady 1997, Graves 1987, Poirier and Saint-Aubin 1996, Pulido 2003). Of them, presentation method is of particular relevance to L2 pedagogy mainly because it is readily subject to manipulation unlike other factors which involve inherent and semantic features of words. For example, frequency or abstractness of words is relatively fixed but font size, color or order of words presented can be easily changed. Furthermore, when words are pre-selected and regulated by the curriculum, as is often the case in EFL settings, manipulation of word presentation would be the most practical and feasible option for pedagogical intervention.

Yet, it is not clear which ways of word presentation are effective in facilitating L2 vocabulary learning. Exploring this question, the present study focused on the effects of color and serial-position of words in presentation. Color and position of items in a series have been known to influence learners’ attention to a significant degree in the field of psychology and linguistics. Recently the effect of colored text has also been investigated in L2 acquisition with related to input enhancement, overall confirming its positive effect (SK Lee and Huang 2008). However, the effect of position and its combined effect with color have not been much explored in L2 vocabulary learning.

To replicate the findings of other fields in L2 learning and provide pedagogical suggestions for L2 vocabulary teaching, this study investigated the effects of color and serial-position of words on Korean middle school students’ memory and retention of English words. Specifically, this study addressed the following research questions:

- 1) Do color and serial-position of words affect L2 learners' immediate free recall in terms of order and frequency of words recalled?
- 2) Do color and serial-position of words affect L2 vocabulary retention in a week-later recall task?

2. Literature Review

2.1. Effects of Color on Attention and Memory

Colors are often used as an effective tool to display information, deliver a certain message, and decorate for art purposes (Dzulkifli and Mustafar 2013). Many researchers have conducted studies to understand this wide use of colors and particularly explore the relationship between color and memory (Pan 2010, Smilek, Dixon, and Merikle 2001, Spence, Wong, Rusan, and Rastegar 2006). Based on the argument that attention is an important early process of memory that is necessary to transfer information from sensory to short-term memory (Atkinson and Shiffrin 1968), these studies have investigated whether colors can contribute to increasing people's attention level and thereby lead to better performance on memory tasks. This question was explored by measuring participants' ability to match colors to objects and comparing obtained reminiscence of colored and non-colored materials. It was expected that if colors capture more attention from people and high level of attention promotes memory retention, colored materials should lead to better recall and retention.

Overall, this hypothesis was born out in empirical studies. Farley and Grant (1976) randomly assigned 52 undergraduate nursing students to either color or black-and-white presentation condition and compared their performances on immediate and seven-day memory retention tasks. Their results demonstrated that color presentation has greater effect than non-color presentation on attention and memory.

Spence et al. (2006) also investigated the recognition of colored natural scene images and gray-scale natural scene images by 120 participants. The two types of presentation resulted in significant differences, with the participants' recognition of colored images approximately 5% higher than that of gray-scaled images.

Smilek et al. (2001) further found that congruent colors are more

effective than incongruent colors in memorizing numbers. When digit numbers were presented in three different conditions, that is, black and white, congruent color, and incongruent color, the participants performed better in recalling numbers presented in congruent colors.

Another interesting study was conducted by Pan (2009), who compared the effect of color with that of shape on recognition by asking participants to identify whether the color or shape of two previously presented objects was the same or not. The results showed that color captured more attention than shape of objects, as evidenced in shorter response time to determine color differences than shape differences.

The study by Miyakoda et al. (2013) was different from the previous studies in that it investigated the effect of color in relation to vocabulary retention. Yet, it again confirmed the color effect by showing that learners obtained higher memory retention rates for vocabulary presented in colored letters.

Overall, previous studies have demonstrated that colors cause a higher level of attention and arousal and thereby lead to better memory performance. The present study attempted to replicate this finding in the context of L2 vocabulary learning and also compared color effect with serial-position effect.

2.2. Effects of Serial-Position on Memory

Many researchers in education, psychology, and linguistic fields have demonstrated interests in what items people tend to remember, and how and why they remember certain items more than others.

Early studies exploring this question investigated the position effect mainly using non-verbal materials such as numbers or nonsense syllables. For instance, Smith (1896) presented lists of 10 nonsense syllables to eight participants and measured their immediate recall of the syllables. The results showed advantages of both first and final positions where first two syllables were recalled first and then the last two syllables followed (as cited in Robinson and Brown 1926). Ebbinghaus (1902) also conducted similar experiments and confirmed strong effectiveness of both beginning and ending positions of the series (as cited in Ebbinghaus 1913). Based on the results, Ebbinghaus (1913) proposed so-called *serial-position effect* to refer to varied recall accuracy depending on an item's position within a study list. The serial-position effect

can be subdivided into primacy effect for the first position and recency effect for the last position.

Somewhat different results, however, were reported by Welch and Burnett (1924). When the experiments did not allow participants to rehearse or review previous items, the data failed to display the primacy effect. These results were interpreted to show that the apparent primacy effect is indeed the effects of participants' practice and word frequency. However, Robinson and Brown's (1926) replicate study not only confirmed both primacy and recency effects but also showed stronger primacy effect than recency effect.

Some researchers extended the setting of their studies to more naturalistic settings. Kurbat, Shevell, and Rips (1998) found that college students have tendency to remember events that happened in the beginning and end of semester better than those happened in the middle of semester. Li (2010) measured participants' recall and recognition of 2006 Super Bowl commercial brands and found that they remembered more brands whose commercials appeared in earlier position of commercial pods, again confirming the strong primacy effect in long term brand memory.

There are studies which investigated serial-position effect in relation to verbal materials, often using randomly selected L1 English words. Deese and Kaufman (1957) provided unstructured lists of words to recall while Murdock (1962) provided different lists of words in length and presentation rate to groups of participants. Both studies suggested that during free recall tasks, last items are recalled first and with the highest accuracy, and earlier items are recalled more frequently than ones in the middle of list. Murdock further discovered that primacy effect appeared for first three or four words and recency effect appeared for last eight words.

More recently, Jones and Oberauer (2013) conducted two experiments on immediate recall of words in relation to serial-position. When both item and relation memory were tested, the results showed primacy and recency effects. Wiswede, Russeler, and Munte (2007) obtained similar results in their study using an event-related brain potentials (ERPs) test to detect serial-position effects in free memory recall of words by 18 female participants. They found better performance on recalling items presented at the beginning and at the end of list than middle ones. Stewart et al. (2004) conducted a more complicated

study where they investigated serial-position and picture-superiority effect on recalling shared and unshared information. After providing partially different 30 words and 30 pictures of common objects, they conducted group recall tasks to their participants. The results showed strong primacy effect with recall of both unshared and shared information and recency effect on recall of shared information.

Put together, previous studies have consistently demonstrated the effect of serial-position on immediate recall, often with primacy effect stronger than recency effect. Yet, given that previous studies are mostly based on non-verbal materials or L1 verbal materials, it is still an open question whether serial-position can also affect recall of L2 words and if so, which of primacy and recency type is stronger.

3. Method

3.1. Participants

Participants in this study were 19 Korean middle school students attending the same middle school in Siheung, Korea. They were all seventh graders with the age of 13~14 years old and there were nine boys and ten girls. They were drawn from an English mentoring program where one of the researchers worked as a volunteer. At the time when the experiment for this study was conducted, they had no prior experiences abroad and had various English proficiency levels.

3.2. Research Design and Materials

This study utilized a repeated-measure design. All the 19 students participated in four different learning conditions in a series. Each learning condition involved different presentation schemes in terms of color and order of words, as follows:

- 1) [-Order -Color] Random order presentation with all words in black
- 2) [-Order +Color] Random order presentation with two out of six words in red
- 3) [+Order -Color] Fixed order presentation with all words in black

- 4) [+Order +Color] Fixed order presentation with first and last words in red

Each learning condition presented six words: three low frequency words and three pseudo words. Therefore, when the participants went through all the four learning conditions, they were exposed to 12 low frequency words and 12 pseudo words in total. The target words used for each condition are presented in Table 1.

Table 1. Target Words and Presentation Schemes for Four Learning Conditions

Condition 1 [-Order -Color] Theme: expert	Condition 2 [-Order +Color] Theme: lover	Condition 3 [+Order -Color] Theme: bell	Condition 4 [+Order +Color] Theme: bottle
maven (LF:260) rutpom (P) pundit (LF: 351) sigbap (P) doyen (LF:60) guplim (P)	binbo (LF:300) bubwim (P) halvah (LF:20) pedcom (P) ardor (LF:399) hulgen (P)	1) jangle (LF:150) 2) lamnop (P) 3) dinger (LF:37) 4) bamfet (P) 5) tocsin (LF:15) 6) napcag (P)	1) cruet (LF:17) 2) lutuin (P) 3) phial (LF:20) 4) rethob (P) 5) flagon (LF:55) 6) tigwob (P)

* LF: numbers = low frequency word: frequency level, P = pseudo word, Boldfaced words were presented in red.

In this study, low frequency words and pseudo words were chosen for two reasons. To measure the genuine effects of color and serial-position on L2 vocabulary learning, it was necessary to control for the participants’ prior vocabulary knowledge by using unknown or unfamiliar words as learning targets. Furthermore, presentation effects investigated in this study can be of greater significance in learning infrequent and difficult words which need more active pedagogical intervention than high frequency words which are more likely to be learned through mere exposure.

Twelve real low-frequency words were selected from online thesaurus dictionaries and went through frequency check with COCA (Corpus of Contemporary American English). Frequency level for the words was lower than 400 frequency level. Twelve pseudo words were invented by the researchers. The length of each word was constrained to five or six alphabet letters with two syllables. Six words for each learning condition were presented as sharing the same theme to re-

lieve the learners' cognitive load to memorize specific meanings of each word.

3.3. Measures

First of all, an immediate free recall test was designed to measure the participants' short-term memory of the words presented during learning sessions. Right after completing vocabulary study under a given learning condition, the participants were asked to recall and write in any order the words that they had been just exposed to. The immediate free recall test was always accompanied by a retrospective question and a prior vocabulary knowledge checkup question. The retrospective question was included to investigate whether the participants were aware of and affected by color and serial-position of words under a given learning condition. Specifically, the participants were asked to provide reasons behind their recall of words. The prior vocabulary knowledge checkup question asked whether the participants had known the presented words before they saw them in learning sessions. The responses to this question were used to validate that the participants' recall performance is not attributable to their prior knowledge but to the effects of presentation methods. The immediate recall test used for [-Order -Color] condition, including the questions on retrospection and prior knowledge on the target words, is presented in Appendix.

Retention of the words was measured by a delayed free recall test which was implemented a week later without notice in advance. The delayed recall test was similar to the immediate free recall test except that this time the participants were asked to recall all the words that they had been exposed to across the four learning conditions and there was no prior vocabulary knowledge checkup question (see Appendix).

3.4. Procedures

The experiment for this study was conducted in two separate sessions. During the first session, the participants first read instructions in Korean which provide information about the upcoming experiment and explain written retrospective protocols. Then the participants were exposed to words under four learning conditions. To counterbalance

the potential sequence effect, the four learning conditions were presented in different orders for different participants.

In a learning condition, each of six words appeared on a Power Point (PPT) slide for 10 seconds along with its meaning in Korean. After the sixth word was presented, a black screen appeared for 10 seconds to give the participants time to rehearse the words. This 70-second-long presentation constituted one round of exposure. Each learning condition was composed of a total of six rounds of exposure so that a word can appear in every possible position from the first to the sixth in the sequence in the case of the random order conditions ([–Order –Color] and [–Order +Color]). When completing six rounds of exposure under a given learning condition, the participants were asked to recall words, retrospect their recall, and report their prior knowledge on the target words in written form. The participants repeated the same procedure for the other three learning conditions. When they completed all the four learning conditions, they were released.

The second session was held one week later. The participants gathered in one classroom and were given 10 minutes to complete a delayed free recall test along with written retrospective protocols.

3.5. Scoring

In order to check the participants' prior knowledge of the target words used in this study, their responses to vocabulary checkup questions in the immediate recall tests were analyzed first. None of the 19 participants reported any knowledge of the target words. Therefore, scores of immediate and delayed free recall tests can be safely interpreted to reflect the effects of presentation.

Immediate recall tests were scored with one point for each word that was correctly recalled in terms of spelling. Scores were calculated for each learning condition with six points as the maximum. In addition, the frequency and order of individual words recalled in immediate and delayed free recall tests were analyzed.

Finally the participants' written retrospective protocols during immediate and delayed free recall tests were analyzed. No scores were given for this measure. Instead the data were used to add supplementary explanations for the participants' performance on recall tests.

4. Results and Discussion

4.1. Performance on Immediate Free Recall Test

Table 2 presents the overall means and standard deviations of the immediate free recall test scores for four different learning conditions.

Table 2. Descriptive Statistics for the Immediate Free Recall Tests in Four Learning Conditions

Order	Color	<i>M</i>	<i>SD</i>
Random order (-Order)	Six words in black (-Color)	2.21	1.40
	Two out of six words in red (+Color)	3.11	1.24
Fixed order (+Order)	Six words in black (-Color)	2.89	1.88
	Two out of six words in red (+Color)	3.37	1.80

The participants showed the highest immediate recall score when they were exposed to [+Order +Color] condition. In this condition where words were presented in a fixed order with two words in red, the participants recalled 3.37 words out of six on average. The second highest recall was obtained under [-Order +Color] condition, which was followed by [+Order -Color] condition and then [-Order -Color] condition.

To test whether the differences in immediate recall tests across the conditions were statistically significant, a 2 (order) \times 2 (color) repeated measures ANOVA was conducted. Only the main effect of color was significant ($F(1, 18) = 11.351, p = .003$, partial eta-squared = .387). No significant effect was found for order ($F(1, 18) = 2.418, p = .137$) and the interaction between color and order ($F(1, 18) = .883, p = .360$). This means that presentation of words in color was effective in facilitating the participants' immediate recall, while whether words are presented randomly or in a fixed order made little influence.

However, given that serial-position effects, particularly primacy and recency effects, are concerned about a specific position of a word in a list rather than the fixedness of the sequence itself, and that only two out of six words were presented in red in [+Color] conditions, it is necessary to analyze the data in terms of individual words. Thus, the

immediate recall test data were further analyzed in terms of 1) whether the participants recalled words that were positioned at the beginning and at the end of a list foremost and/or more frequently and 2) whether the participants recalled words that were presented in red foremost and/or more frequently.

Figure 1 displays the frequency and percentage of words immediately recalled after [-Order -Color] condition, where six words were presented randomly and all in black.

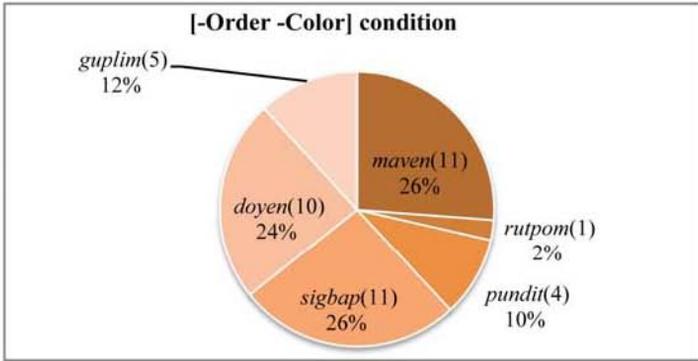


Figure 1. The frequency and percentage of words recalled in [-Order -Color] condition.

The participants recalled ‘maven’, ‘sigbap’, and ‘doyen’ quite frequently, which were followed by ‘guplim’, ‘pundit’, and ‘rutpom’. Noteworthy is that ‘sigbap’ was a pseudo word and nevertheless was well remembered, while the real word ‘pundit’ was recalled much less. This again confirmed that the participants in this study had no prior knowledge on the target English words. However, since this condition does not include any manipulation of presentation, the frequency of the words recalled cannot be attributed to either order or color. Rather the data collected from this condition were used for comparison with the data obtained from the other three conditions.

[-Order +Color] condition was designed to investigate the effect of color. The circle and line graphs in Figure 2 depict the results of [-Order +Color] condition, where six words including two red-colored ones were presented in random orders across six rounds of exposure. In Figure 2(a), the two most frequently recalled words were ‘bimbo’ and ‘bubwim’, both of which were the words presented in red during

learning sessions. The combined frequency of these two words amounted to 51% of the total recall words. Furthermore, the frequency of the most recalled word in this condition ('bimbo': 18) exceeds that in Learning Condition 1 ('maven' or 'sigbap': 11), indicating the effect of color on immediate word recall.

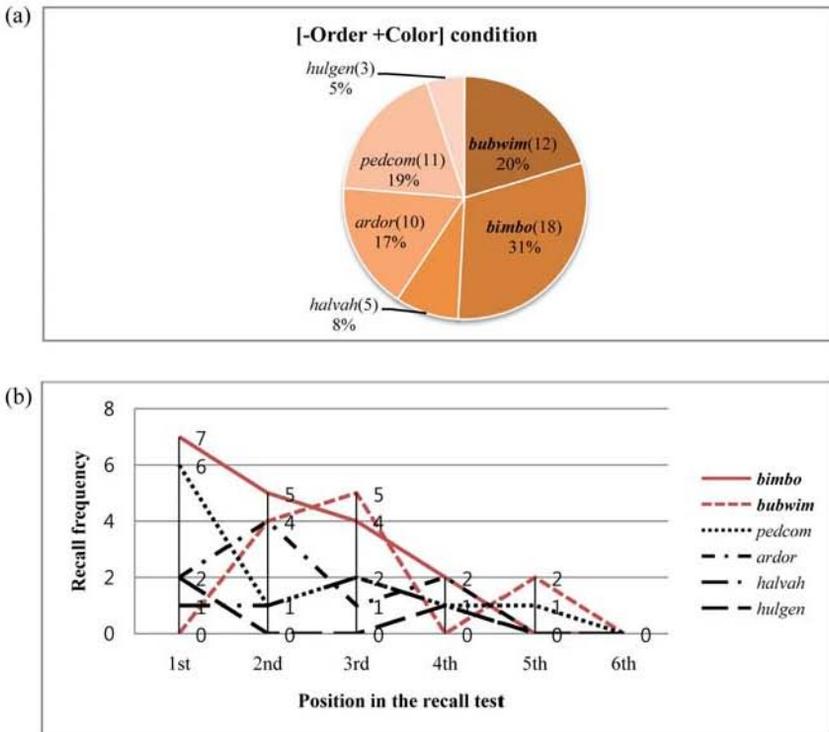


Figure 2. (a) The frequency and percentage of words recalled in [-Order +Color] condition, (b) The position of words in the immediate recall test. * Boldfaced words were presented in red.

Figure 2(b) illustrates the position distribution of the words recalled. For example, 'bimbo' was recalled seven times in the first place, five times in the second, four times in the third, and twice in the fourth in the immediate recall test. Overall, the two red words were recalled earlier than the black words. When the occurrences of the two red words in the first three positions were counted, the frequency was 25 (7+5+4 for 'bimbo', 0+4+5 for 'bubwim'). On the other hand, the total occurrence of the two most frequently recalled black words in the

first three positions was 16 (6+1+2 for ‘pedcom’, 2+4+1 for ‘ardor’). This indicates that the participants tended to recall the red words earlier than the black words.

The effect of color was further supported by written retrospective protocols produced during the immediate recall test. Five participants who recalled colored words first reported that the red color of the words drew their attention and made it easier to memorize them. Put together, the analyses of individual words and written retrospective protocols showed that the color of words contributed to enhancing the participants’ attention as well as immediate recall.

[+Order –Color] condition was designed to examine the serial-position effect, specifically primacy and recency effects, on recall frequency and order. Figure 3 displays the results of [+Order –Color] condition, where six words, all in black, were presented in a fixed order.

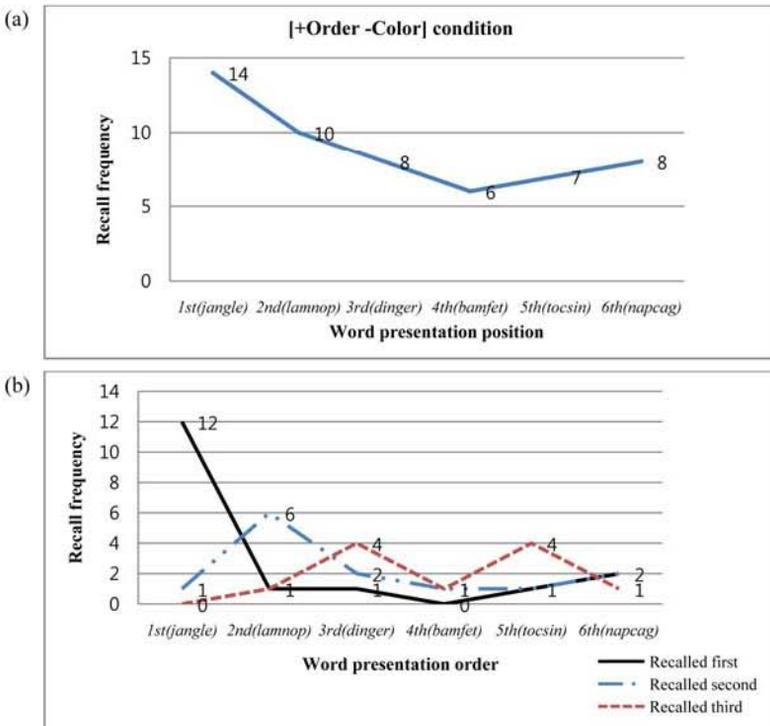


Figure 3. (a) The frequency of recall words by presentation position in [+Order –Color] condition, (b) The relationship between presentation position and recall position.

Figure 3(a) shows a U-shape serial-position curve, where the words presented in the beginning and at the end were recalled more than those presented in the middle. Primacy effect was particularly strong in the immediate recall test, as shown in the highest recall rate of the first positioned word 'jangle' (14 times). Although not as strong as the first position, the second position also led to a high recall rate (10 times), which was even higher than that of the last positioned word (8 times).

Figure 3(b) demonstrates the relationship between presentation position and recall order by analyzing the words that appeared in the first three positions in the recall test. Overall, the participants' recall order of words corresponded to their presentation order. The first presented word ('jangle') was also recalled in the first position 12 times out of 14, while the second positioned word ('lamnop') was recalled in the second position 6 times out of 10. Thus the participants seemed to have paid attention to the order of the words during presentation.

Written retrospective protocols provided additional evidence for the serial-position effect. When asked why they recalled a certain word first and more, they answered that it was because they saw it first or last in the list. All these results from [+Order -Color] condition suggest that early and last positioned words drew more attention from the participants, which, in turn, resulted in high recall rates.

While [-Order +Color] condition and [+Order -Color] condition examined respective effect of color and serial-position, [+Order +Color] condition was implemented to investigate the combined effect of color and serial-position on recall frequency and order. Figure 4 presents the results of [+Order +Color] condition, where six words were presented in a fixed order with first and last words in red.

Figure 4(a) shows that the most frequently recalled word was 'tigwob' (18 times), which was followed by 'cruet' (13 times). Note that these two words were presented in the last and the first positions, respectively, both in red. Overall this condition showed a U-shape serial-position curve as was in [+Order -Color] condition (Figure 3(a)). However, there was also an interesting difference between [+Order -Color] condition and [+Order +Color] condition. While primacy effect was stronger than recency effect in [+Order -Color] condition, [+Order +Color] condition showed the opposite. When color was added, the participants remembered the last word better than the first

word in immediate recall. This shows that color effect particularly enhanced recency effect.

Figure 4(b) demonstrates the relationship between presentation position, color, and recall order by analyzing the words that appeared in the first three positions in the recall test. It depicts that the first and last presented colored words ('cruet' and 'tigwob') were recalled most frequently in the first place (8 times for each). The participants' written retrospective protocols also indicated that their recall was affected by both serial-position and color. Thus, it can be concluded that there was a combined effect of serial-position and color.

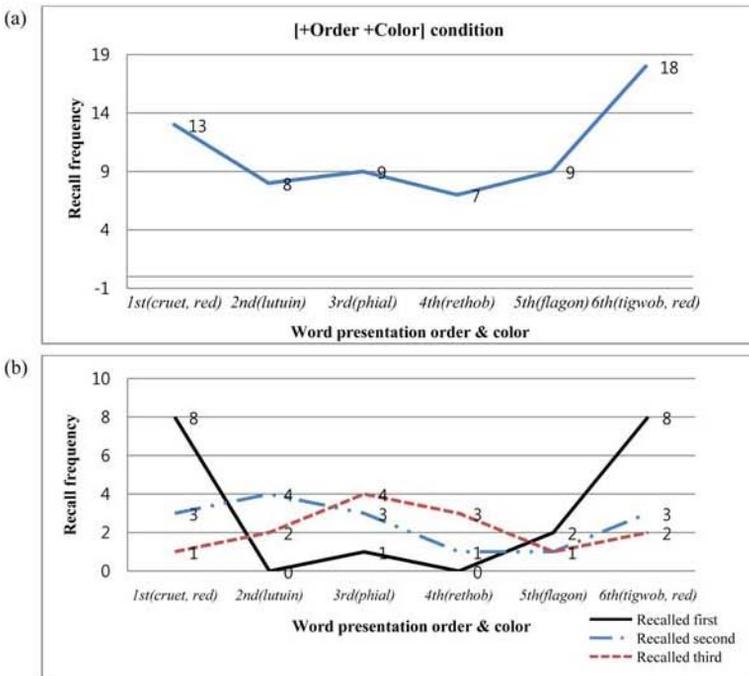


Figure 4. (a) The frequency of recall words by presentation position in [+Order +Color] condition, (b) The relationship between presentation position, color, and recall position.

4.2. Performance on Delayed Free Recall Test

To investigate whether the effects of serial-position and color on memory are retained over a time, a delayed free recall test was im-

plemented to the participants a week later. The results are presented in Table 3.

Table 3. Frequency of the Words Recalled in the Delayed Test

Condition 1 [-Order -Color]	Condition 2 [-Order +Color]	Condition 3 [+Order -Color]	Condition 4 [+Order +Color]
sigbap (2) doyen (1) pundit (1)	bimbo (3) pedcom (2) bubwim (1)	jangle (5)	tigwob (3) flagon (1)

A total of nine words out of 24 were recalled on the delayed test. Three words were recalled from each of [-Order -Color] and [-Order +Color] conditions, two words from [+Order +Color] condition, and one word from [+Order -Color] condition. This appears to suggest that the manipulation of presentation did not have significant effects on the participants' retention of the words over a week. However, it is noteworthy that three most frequently recalled words are the ones that had been presented in the first position ('jangle'), in red ('bimbo'), and in the last position in red ('tigwob'). This indicates that serial-position and color, though not strong as in immediate recall, still exerted an influence on the participants' word retention to some extent.

5. Conclusion

In order to explore the potential of L2 vocabulary acquisition under limited exposure through manipulation of presentation, this study investigated the respective and combined effects of color and serial-position on Korean EFL learners' recall and retention of L2 words. Low frequency English words and pseudo words were presented under four leaning conditions which differ in terms of color and order of the words.

The scores of the immediate recall test showed that the color effect was significant regardless of whether words were presented randomly or in a fixed order. The participants recalled more words when some words in the list were presented in color. The further analysis of individual words in the recall test revealed that it is these colored words that were recalled more frequently and foremost.

The effect of serial-position was also found in the analysis of in-

dividual words recalled. The participants recalled words presented in first and last positions much better than those presented in the middle of the sequence. Primacy effect of early positions was particularly strong in this study, corresponding to the findings of the previous studies (Li 2010, Onifade et al. 2011). Interestingly enough, however, when color was added to the first and last positions, recency effect turned out to be stronger than primacy effect. In other words, color created a synergistic effect with the last position but it did not facilitate the recall of the first positioned word. This is probably because color information of early positions may be diluted or lost with the lapse of time before it exerts any facilitative influence on word recall. In contrast, when the last word is presented in color, both color and recency effects are more likely to be maintained in short-term memory, which leads to better performance in immediate recall tests.

The analysis of written retrospective protocols demonstrated that the participants were actually aware of and affected by color and serial-position of words during presentation. When asked why they recalled certain words before others, they mentioned colors and positions of the words as facilitative factors. These results indicate that color and serial-position indeed served as an effective device to draw the participants' attention to words, which resulted in better performance on the immediate recall test.

However, the participants' retention of the words after a week was only limited. Learning conditions did not make much difference in the number of words retained. Yet, it is noteworthy that the participants recalled the colored and first/last positioned words more frequently. This result seems to reflect the residual of the effects of color and serial-position.

Overall, the present study found the respective and combined effects of color and serial-position on L2 vocabulary recall and retention. These results shed light on L2 vocabulary teaching. When target words have high frequency, they are likely to be subject to incidental learning through mere exposure. However, low frequency words require more active pedagogical intervention which should induce learners' attention to them. L2 researchers have emphasized contextualized vocabulary teaching as a viable instruction approach. Yet, the reality of L2 classroom is that many teachers and materials are still presenting words in a list. In this context, the results of this study suggest

that manipulation of presentation can facilitate L2 vocabulary learning. Specifically it would be effective to present difficult words in color in contrast with less difficult ones. To place difficult words at the very beginning or at the end of vocabulary instruction may be also beneficial by taking advantage of primacy or recency effect. The combination of color and position also needs to be considered as one of the options to amplify the saliency of words.

This study has several limitations in research methodology. The limited number of the participants and the within-group comparison restrict the generalizability and rigorousness of the findings of this study. More studies involving a larger size of participants and a between-group comparison design need to be conducted. In the studies, the unbalanced number of colored versus non-colored words in [+Color] conditions (two versus four) also needs to be rectified.

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SoJin Kang (First author)
Department of Foreign Language Education (English Education)
Seoul National University
1 Gwanak-ro Gwanak-gu, Seoul 151-748, Korea
E-mail: ksojin917@snu.ac.kr

Jin-Hwa Lee (Corresponding author)
Department of English Education
Chung-Ang University
84 Heukseok-ro, Dongjak-gu, Seoul 156-756, Korea
E-mail: jinhlee@cau.ac.kr

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Appendix. Immediate and Delayed Free Recall Tests

A. Immediate Free Recall Test for [-Order -Color] condition (with a Retrospective Question and a Prior Vocabulary Knowledge Checkup)

1. ‘전문가’라는 뜻을 가진 영어단어를 생각나는 순서대로 쓰세요.
_____, _____, _____,
_____, _____, _____
2. 처음 쓴 단어들이 가장 먼저 생각난 이유는 무엇인가요?
3. 앞서 제시된 단어 중 원래 알고 있었던 단어가 있으면 모두 쓰세요.

B. Delayed Free Recall Test (with a Retrospective Question)

1. 여러분들은 지난 주에 여러 단어들을 배웠습니다. 가장 먼저 생각나는 단어들부터 순서대로 모두 쓰고 각 단어의 뜻을 적으세요.
2. 처음 쓴 단어들이 가장 먼저 생각난 이유는 무엇인가요?