A Study on Learning Effects of Marking with Highlighter Pen

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Abstract. For learning students including elementary, junior high school and high school students, improvement of academic performance is one of the most important learning objectives. Types of problems in every subject are versatile and it is essential to find key points and keywords in sentences as well as questions under any situation. In order to find these key points and keywords, information on sentences as well as questions should be organized which can lead to increased attentional capacity as well as cognitive capacity. Various kinds of writing materials are used by the learners, and especially highlighter pens which are used by many learners for marking, when they are used for marking as means of organizing information, can have effects on the improvement of academic performance by the visual effects as well as through marking works.

Therefore, the purpose of this study is to clarify the effects of marking with a highlighter pen as a means to recognize necessary information. The Japanese language word problems, arithmetic computation problems and English problems were used and the amount of memory and the number of correct answers were measured to verify the effects.

Keywords: Highlighter pen · Memory · Attentional capacity · Academic performance

1 Introduction

Recently, there are many kinds of writing materials used by learners (elementary school students, junior high school students, high school students, university students) such as pencils, mechanical pencils, and ball-point pens. Presently, highlighter pens are produced and sold to color letters for highlighting which are widely used by students such as elementary school students, junior high school students, high school students, and university students when studying various subjects to enhance learning effects. Marking with highlighter pens is especially used to highlight important points in textbooks or study guides and has become a general learning means.

Purposes of learning for learners are various, but one of the major purposes is to acquire high scores in daily or regularly done written examinations, improve own academic performance level and acquire high scores to pass entrance examinations of preferred high schools or universities.

Currently, test types presented to the learners are often written tests and questions are given in various forms such as cloze test, multiple-choice, or narrative.

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However, in any form, it is essential to accurately recognize necessary words, keywords and important points to get right answers.

There have been studies dealing with visually favorable fluorescent colors or simple memory tests to examine the effect of marking with a highlighter pen. Reference [1] Also studies have been done about the effects of silent reading upon memory prose or understanding and memory of arithmetic word problems. References [2, 3] However, it has been unknown how specific marking methods in various subjects would influence attentional capacity, cognitive capacity or memory ability or calculating ability as well as contribute to improve academic performance.

Therefore, in this study, learning effects given to learners by marking key words and important points with a highlighter pen were verified by experiments using tests of story reading in the Japanese language, four-function computation in arithmetic and third person singular present S in English.

2 Experimental

2.1 Test Subjects

Tables 1, 2 and 3 show the number of subjects and data in each experiment. The subjects were from 4th grade of elementary school students to 3rd grade junior high school students who went to a cram school. In experiment I (marking experiment of the Japanese language), the number of subjects was in total 50, among them who used markings was 28 and the number of subjects who did not use markings was 22.

In experiment II (marking experiment of arithmetic), the number of subjects was 45.

In experiment III (marking experiment of English), the total number of subjects was 54. The number of subjects in group A was 28 and the number of subjects of group B was 26. In each experiment, subject sex and grade were selected in random order.

Table 1. Experiment I marking experiment of the Japanese language (attribute)

Marking Experiment of the Japanese Language (attribute)					
With marking			Without marking		
Grade	The number of subjects	Ratio of male students and female students	Grade	The number of subjects	Ratio of male students and female students
The fifth grade at an elementary school	1	male:18	The fifth grade at an elementary school	0	male:8
The sixth grade at an elementary school	2		The sixth grade at an elementary school	8	
The first grade at a junior high school	9		The first grade at a junior high school	6	
The second grade at a junior high school	8	female :10	The second grade at a junior high school	5	female :14
The third grade at a junior high school	8		The third grade at a junior high school	3	
Total	28		Total	22	

Table 2. Markings experiment of arithmetic (attribute)

Markings Experiment of Arithmetic (attribute)		
Grade	The number of subjects	Ratio of male students and female students
The fourth grade at an elementary school	1	
The fifth grade at an elementary school	5	male:26
The sixth grade at an elementary school	3	
The first grade at a junior high school	19	
The second grade at a junior high school	15	female:19
The third grade at a junior high school	2	
Total	45	

Table 3. Experiment III marking experiment of English (attribute)

Marking Experiment of English (attribute)					
Group A Marking (without marking + with marking)			Group B Marking (without marking + without marking)		
Grade	The number of subjects	Ratio of male students and female students	Grade	The number of subjects	Ratio of male students and female students
The first grade at a junior high school	4	male17	The first grade at a junior high school	7	male : 10
The second grade at a junior high school	11		The second grade at a junior high school	9	
The third grade at a junior high school	13	female : 11	The third grade at a junior high school	10	female : 16
Total	28		Total	26	

2.2 Highlighter Pens Used for Experiments

Figure 1 shows highlighter pens (Sugata Co. Ltd.) used by the subjects for experiments.

Pens are packaged in a 6-piece set. The subjects used a fixed color or colors to mark necessary sections when needed. Kinds of highlighter pens were not specifically selected. A set affordable by the subjects of elementary school students, junior high school students, and high school students was chosen. The 6-piece set can be purchased at ¥108.

Fig. 1. Highlighter pen

2.3 Experimental Method

Experiment I Marking Experiment of the Japanese Language.

In experiment I, an experiment of memory ability after silently reading the Japanese language sentences (1744 letters) was carried out. The subjects were students who went to the cram school and the usual study rooms of the cram school were used for the experiment. The subjects were separated in a group who used highlighter pens for marking while silently reading and a group who did not use highlighter pens for marking while silently reading. Time of the silent reading was 5 min for each group and the reading could be repeated as many as possible. Marking method used for the group who used highlighter pens for marking was to mark out letters with the pens. Characters, places and times were set as keywords and the subjects were requested to mark them.

Also, the marking color to be used for characters was set as orange, for places as purple and for times as green.

After finishing the silent reading time, a memory test for characters (8 sections), places (5 sections), and time (4 sections) which appeared in the sentences was carried out. Then differences between the group who used highlighter pens and the group who did not use highlighter pens were verified. Figure 2 shows the sentences without marking. Figure 3 shows the marking actually given by the subjects.

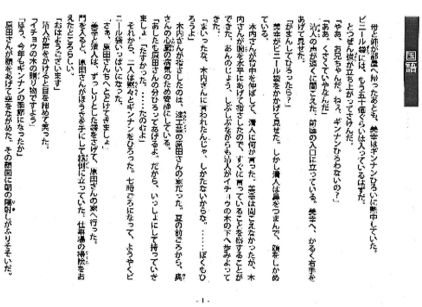

Fig. 2. Sentences in the Japanese language without marking

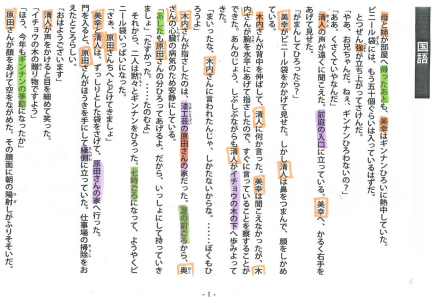

Fig. 3. Sentences in the Japanese language marked by a subject

2.4 Investigation of Memory Amount

Figure 4 shows results of the test which was conducted for each group after the silent reading. The test was in narrative form where the subjects wrote characters, places and times (sections to know time) that they memorized. The number of appearances of keywords in the sentences was 8, 5 and 4 respectively.

2.5 Experimental Method

Experiment II Marking Experiment of Arithmetic.

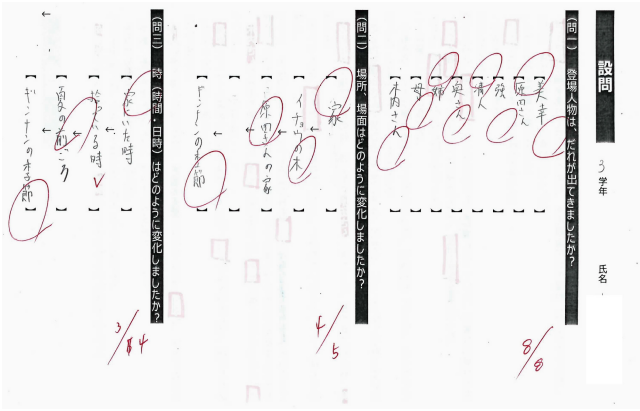

Fig. 4. Memory amount test

Experiment II was carried out to find whether there was difference in the number of right answers in arithmetic computation problems (four fundamental rules of arithmetic mixed problems) depending on the use or no use of marking with highlighter pen.

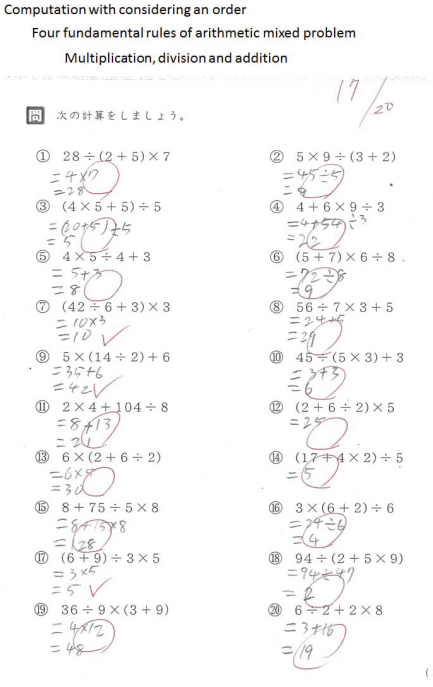

Fig. 5. Computation problems without marking

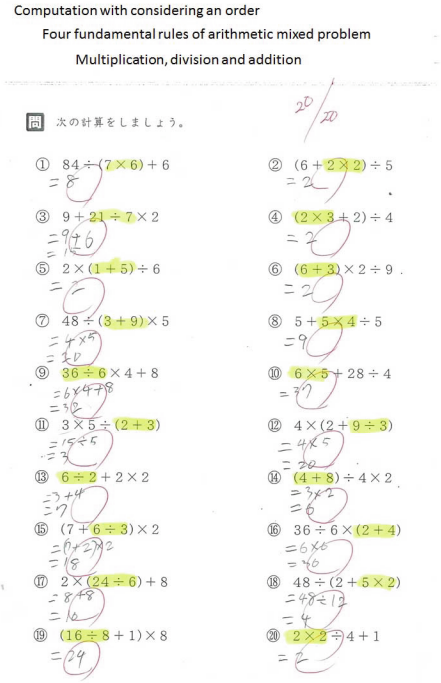

Fig. 6. Computation problems with marking

The subjects were students who went the cram school and the usual study rooms of the cram school were used for the experiment. The number of the subjects was 45.

The subjects solved 20-computation problems. When marking, the subjects were requested first to mark the prioritized computation in each problem, and then start solving. Figure 5 shows the problems without marks. Figure 6 shows the problems with marks.

2.6 Experimental Method

Experiment III Marking Experiment of English.

In experiment III, 50 problems regarding third person singular present S of English were presented. Experiment III was carried out to find whether there was a difference in the number of right answers depending on the use or no use of marking with a highlighter pen. In this experiment, subjects (subject clauses) were marked to accurately recognize whether third person singular present S was necessary or not. The subjects were separated in groups as follow and the test was conducted twice.

Group A: 1st time (without marking) + second time (with marking) 28 subjects.

Group B: 1st time (without marking) + second time (without marking) 26 subjects.

First, grammatical explanations for third person singular present S were given to each group before conducting the test. Then, each group solved problems without marking with highlighter pen. Next without break, group A solved the same problems while marking with highlighter pen and group B solved the same problems without marking. Then difference of the number of right answers between group A and B was investigated.

Marking had to be given to a subject (subject clause) with yellow color.

3 Results

3.1 Experimental Result I Marking Experiment of the Japanese Language

Memory amount for keywords of characters, places, and times (section to know times) in the sentences was confirmed. The memory amount for every keyword was higher when marking was used compared when marking was not used. The result is shown in Fig. 7.

As to characters, the memory amount was 7.25 points out of 8 points when marking was used and 6.14 points when marking was not used. Also as to places, 2.54 points out of 5 points when marking was used and 1.36 points when marking was not used. As to times, 2.46 points when marking was used and 0.64 points when marking was not used.

The total score of three keywords scores was 12.25 points out of 17 points when marking was used and 8.14 points when marking was not used. The total score when marking was used was relatively high.

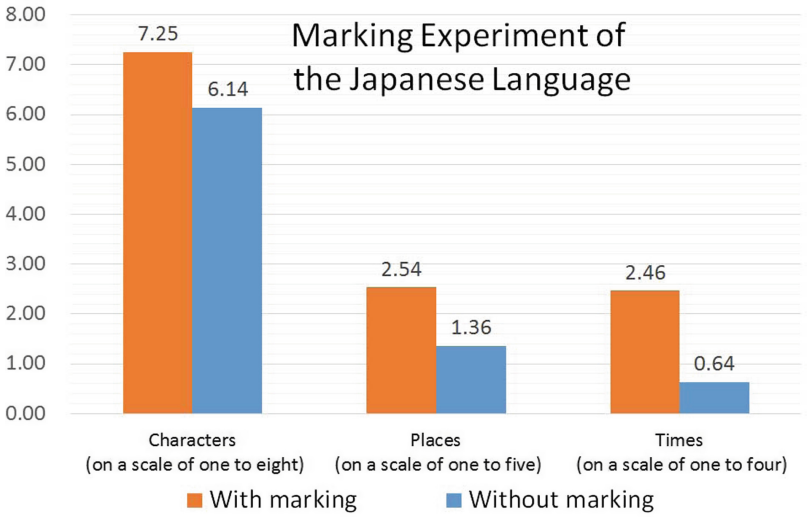

Fig. 7. Results of the memory amount of each keyword in marking experiment of the Japanese language.

It was confirmed that there was difference in the memory amount but the difference was not so remarkable when one keyword memory was measured but there was a large difference when several keywords memories were measured (Figs. 8, 9 and Table 4).

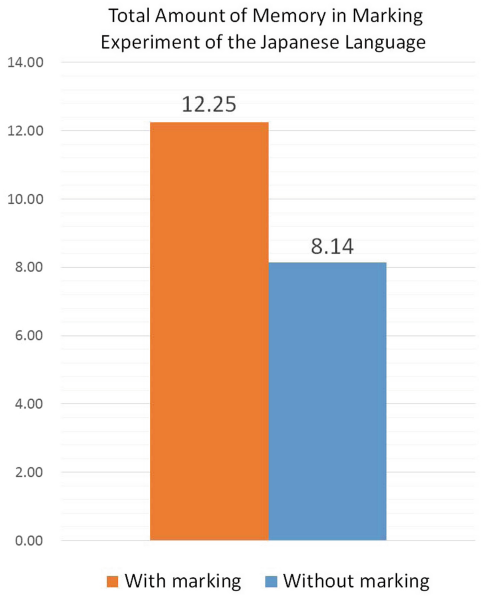

Fig. 8. Total amount of memory in marking experiment of the Japanese language

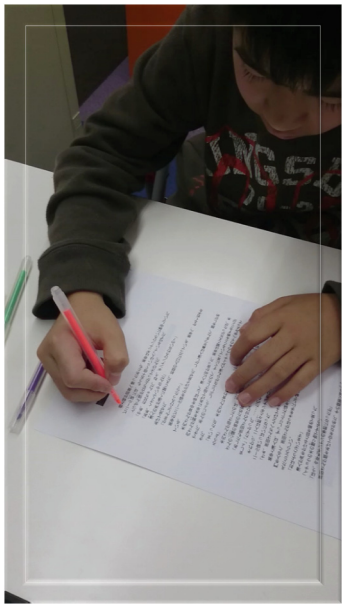

Fig. 9. Subject at the time of marking experiment

Table 4. Comparison of Subjects scores and average scores depending on the use of marking

with marking						without marking					
Grade	Name	Characters (on a scale of one to eight)	Places (on a scale of one to five)	Times (on a scale of one to four)	Total	Grade	Name	Characters (on a scale of one to eight)	Places (on a scale of one to five)	Times (on a scale of one to four)	Total
The third grade at a junior high school	K.D	8	0	1	9	The third grade at a junior high school	I.H	7	2	1	10
The third grade at a junior high school	N.A	7	4	2	13	The third grade at a junior high school	K.Y	7	4	1	12
The third grade at a junior high school	T.M	7	2	2	11	The third grade at a junior high school	M.S	7	0	2	9
The second grade at a junior high school	Y.A	7	0	2	9	The third grade at a junior high school	S.M	8	1	1	10
The third grade at a junior high school	Y.M	6	3	1	10	The third grade at a junior high school	T.D	7	2	2	11
The third grade at a junior high school	H.A	8	5	4	17	The sixth grade at a elementary school	T.A	6	0	1	7
The third grade at a junior high school	S.T	8	4	3	15	The sixth grade at a elementary school	I.R	5	3	1	9
The third grade at a junior high school	T.M	6	2	0	8	The sixth grade at a elementary school	K.R	6	2	2	10
The third grade at a junior high school	A.T	6	3	1	10	The sixth grade at a elementary school	K.U	6	1	1	8
The second grade at a junior high school	K.A	6	2	2	10	The sixth grade at a elementary school	B.M	4	0	0	4
The fifth grade at a elementary school	T.H	8	4	4	16	The sixth grade at a elementary school	S.K	6	3	1	10
The sixth grade at a elementary school	K.E	6	2	4	12	The sixth grade at a elementary school	S.R	8	2	0	10
The second grade at a junior high school	Y.T	8	1	2	11	The sixth grade at a elementary school	Y.A	5	1	0	6
The second grade at a junior high school	K.Y	8	4	4	16	The second grade at a junior high school	M.Y	5	0	0	5
The second grade at a junior high school	T.E	8	4	1	13	The second grade at a junior high school	K.A	6	2	0	8
The second grade at a junior high school	M.D	7	2	4	13	The second grade at a junior high school	M.M	5	0	0	5
The second grade at a junior high school	S.M	8	0	4	12	The second grade at a junior high school	N.R	1	0	0	1
The sixth grade at a elementary school	O.Y	8	3	3	14	The second grade at a junior high school	K.A	7	1	0	8
The second grade at a junior high school	T.T	6	1	0	7	The second grade at a junior high school	K.R	7	0	0	7
The first grade at a junior high school	O.T	8	1	4	13	The third grade at a high school	S.N	8	1	0	9
The first grade at a junior high school	N.S	8	3	3	14	The third grade at a high school	N.K	8	2	1	11
The first grade at a junior high school	K.J	8	3	3	14	The third grade at a high school	N.M	6	3	0	9
The first grade at a junior high school	K.F	6	4	3	13						
The first grade at a junior high school	Y.H	8	4	0	12						
The first grade at a junior high school	F.K	8	2	4	14						
The first grade at a junior high school	I.H	7	3	4	14						
The first grade at a junior high school	O.M	7	2	3	12						
The first grade at a junior high school	M.Y	7	3	1	11						
Total		203	71	69	343	Total		135	30	14	179
Average		7.25	2.54	2.46	12.25	Average		6.14	1.36	0.64	8.14

3.2 Experimental Results II Marking Experiment of Arithmetic

Differences in the number of right answers were confirmed depending on the use of marking. When marking was used, average score was 18.76 points and when marking was not used, average score was 17.53 points. The average score when marking was used clearly showed higher value (Fig. 10).

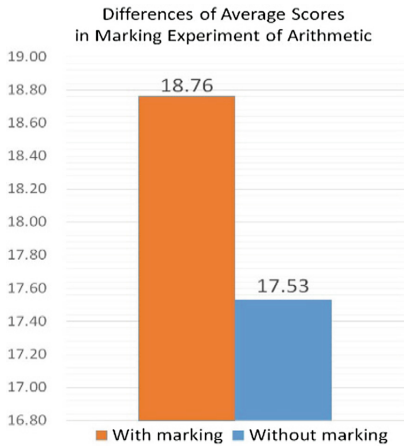

Fig. 10. Differences of average scores in marking experiment of arithmetic

3.3 Experiment Results III

Marking Experiment of English.

In third person singular present S judgment test, differences of the number of right answers in the second test depending on the use of marking were confirmed.

In the case of Group A (1st time without marking, second time with marking), average score increased remarkably from 27.82 to 43.

In group B (1st time without marking, second time without marking), average score decreased from 38.19 points to 37.46 points. Therefore, it is considered that marking tends to increase attentional capacity by enhanced recognition of important points. In group B, the average score was decreased. This can be because of the decreased attentional capacity due to increased level of fatigue (Fig. 11).

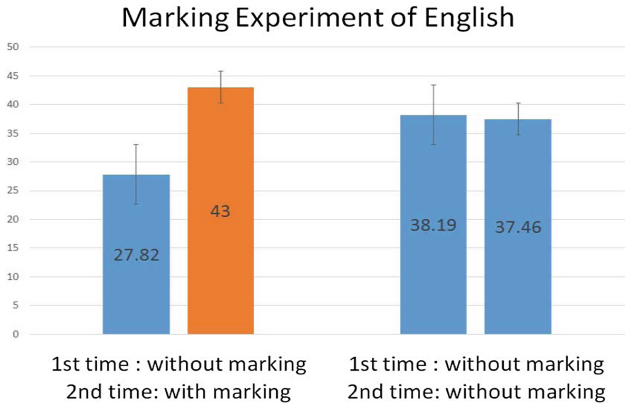

Fig. 11. Results of marking experiment of english

4 Impression Evaluation

Impression evaluation in five stages using SD method was carried out to find what kind of impression would be given to the subjects by marking with a highlighter pen. Evaluation Items is shown in Table 5. Also the subjects were requested to select a suitable writing material for marking important points or sections from choices of pencils, mechanical pencils and highlighter pens. Also, a test which showed two rows consisting of same several letters on paper was presented to the subjects. The letters in rows seemed to be arranged in a random manner but included the same word. The letters which formed the word was marked with highlighter pen in one row and marked with pencil (underline) in the other row. The subjects were requested to describe their impression of easiness to find the word in each row. Their impression was confirmed. The question is shown in Fig. 12.

According to the evaluation by SD method, 82 % (41 out of 50) answered very impressive/impressive to a certain degree for a question as to an impression and 76 % (38 out of 50) answered very effective and effective to a certain degree for a question as to learning effects.

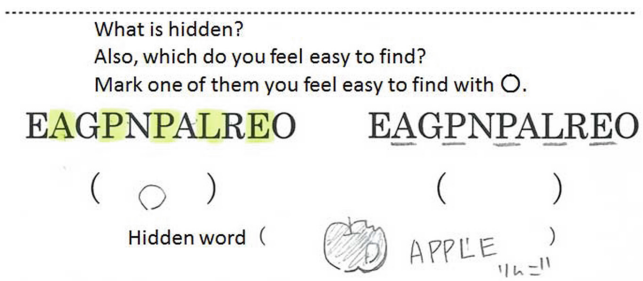

Fig. 12. Question with marking and question with underline

As to suitable writing material for marking, 45 subjects out of 50 (90 %) selected highlighter pen. The result is shown in Table 6.

As to the impression evaluation of easiness of finding the hidden word depending on marking with pencil and marking with highlighter pen, 50 subjects out of 50 answered that the word marked with highlighter pen was easy to find.

The result is shown in Table 7.

In free description, they wrote reasons why highlighter pens were good as follow:

1. Easy to see and easy to understand,
2. Firstly see,
3. As letters are often written in black, marked sections are highlighted and easy to see and so on. It was suggested that marking with a highlighter pen promoted feeling of easy understanding compared to marking with pencils because highlighter pens accentuated and emphasized marked sections.

Table 5. Evaluation items

Feel bright	Feel dark
Joyful	Not joyful
Can concentrate	Can not concentrate
Impressive	Unimpressive
Easy to use	Difficult to use
Effective on leaning	Ineffective on leaning

Table 6. Suitable writing material for marking

Pencil	Mechanical pencil	Highlighter pen
1	4	45

Table 7. Comparison of Impression between highlighter pen marking and underline marking

Marking with highlighter pen	Marking with underline
50	0

5 Conclusion

In this study, it was verified that marking keywords or important points in questions with highlighter pen could have learning effects and contribute to necessary memory ability, attentional capacity and cognitive capacity of learners (elementary school students, junior high school students, and high school students) by experiments using the story test in the Japanese language, arithmetic computation problems and third person singular present S judgment problems in English.

The results show clear differences by marking with highlighter pen, that is, increased memorized keywords of the story in the Japanese language, the higher number of right answers in arithmetic computation and the increased number of right answer in the English test.

Therefore, it appears that marking with highlighter pen can improve academic performance of learners. This can meet one of the major objectives of the learners and marking with a highlighter pen can be expected to enable enhanced leaning effects in fields of memory ability, attentional capacity, cognitive capacity or computational ability.

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