ORIGINAL ARTICLE

Can "Semi-relevant Images" Vitalize Brainstorming?

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Abstract: A lot of supporting tools for vitalizing brainstorming sessions have been proposed. Some of them show the participants hints for discussions, e.g. keywords and images. The author's research group also has proposed a supporting system for vitalizing brainstorming sessions. In the system, "semi-relevant images," which are relevant images of the relevant words of words used in created ideas, are shown for participants of a brainstorming as hints. Despite the system works well for vitalizing discussions, the effects of this type of hint had not been investigated. Thus, experiments were conducted to show the effects. In the experiments, effects of three types of hints, (1) relevant keywords; relevant words of the words used in ideas presented in the discussion, (2) relevant images; images retrieved by using words used in ideas presented in the discussion as keywords, and (3) semi-relevant images; images retrieved by using relevant words of the words used in ideas presented in the discussion as keywords, were compared. The results show that the third type of hints can increase number of utterances and diversity of the subjects in discussions.

Keywords: *KJ-method, Idea creation, Group discussion*

1. INTRODUCTION

Brainstorming methods are widely used in group meetings for divergent thinking processes in companies, educational institutions, communities, etc. because of the facile introduction [1]. KJ-method is one of the most popular methods used in brainstorming sessions [2]. In KJ-method sessions, each idea provided by the participants is written on a small card. By organizing and grouping the cards, participants can find relationships between submitted ideas during the discussion, and it helps them submit more ideas and conclude the discussion.

Although KJ-method is a powerful tool, several weak points also have been pointed out. Osborn emphasized the importance of quantity of ideas for brainstorming [3]. This basic principle is well-known as "quantity yield quality." Under the principle, participants have to generate their ideas as much as they can. However, generating many ideas is not so easy for ordinal participants of KJ-method sessions. Osborn also pointed up the importance of "Deferment-of-judgement." It means innovative ideas are created based on diverse ideas. In other words, we should better to expand the variety of ideas even if asinine ideas are included in them. However, it is also hard for ordinal participants because they tend to be affected from the others' ideas, and similar ideas account for most of all.

To solve such problems, many supporting systems have been proposed. Some of them show the participants some hints for discussions, e.g. keywords and images. The author's research group also has proposed a supporting system for vitalizing brainstorming sessions that shows relevant images about ideas presented in the discussion as hits [4]. However, the effects of these hints had not been investigated. Thus, in order to compare the effects of the following three types of hints, experiments were conducted.

(1) **Relevant keywords:** related words of the words used in ideas presented in the discussion
(2) **Relevant images:** images retrieved by using words used in ideas presented in the discussion as keywords
(3) **Semi-relevant images:** images retrieved by using related words of the words used in ideas presented in the discussion

Figure 1 illustrates generating processes of the three types of hints.

In this paper, the results are analyzed and discussed with statistic methods. In the next section, some related studies are shown as backgrounds. The experimental design and the results are shown in the section 3 followed by discussions in the section 4 and conclusions in the section 5.

2. BACKGROUND

In the history, many studies have done for supporting idea creation. Showing some hints to help create now idea is an approach of these studies.
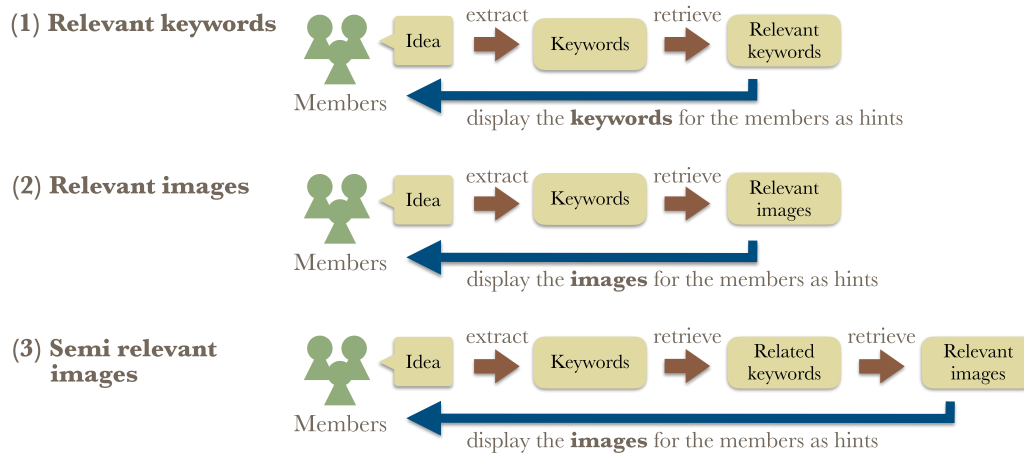
(1) Relevant keywords

Members — Idea —extract→ Keywords —retrieve→ Relevant keywords

display the **keywords** for the members as hints

(2) Relevant images

Members — Idea —extract→ Keywords —retrieve→ Relevant images

display the **images** for the members as hints

(3) Semi relevant images

Members — Idea —extract→ Keywords —retrieve→ Related keywords —retrieve→ Relevant images

display the **images** for the members as hints

Figure 1: Outline of generating processes of three types of hints

Watanabe et al. proposed a tool to help the users meet various informations which the users could be interested in [5]. Users of the tool can take notes on cards on their PC screen as same way as taking notes on sticky notes. When a user take a note, a card in which the note is displayed appears on the screen. Then the card moves slowly for a direction on the screen. As two cards touch together on the screen, a new card appears on the screen. In the new card, a new information that is retrieved by using two keywords on each of the original cards is displayed. This system shows the users relevant information of the users' note for activating the users' imaginations, which means that words described in cards are used as keywords for retrieving hints.

Kang et al. have developed an application for mobile devices, called "Category Camera," for supporting to create new ideas in group discussions after fieldworks [6, 7]. This application is designed as camera used in fieldworks. The user can take photographs and can put prepared labels, each label has a keyword on it, on the photographs easily. The labels help users classify the photographs in the discussion phases, and the users can find common factors underlying them. In this system, keywords associated with images are used as hints for creating new ideas.

It is known that visual stimulus is one of the important types of hint for idea creating [8]. The author's group also has proposed a supporting system for vitalizing brainstorming sessions by using relevant images of ideas provided in the session [3]. This system is designed for activating discussions with KJ-method. Participants of a discussion describe their ideas on cards on the screen. Then, images retrieved by using relevant words of important words used in the ideas as keywords appear on the screen. We call these images as "semi-relevant

images." Here, it must be emphasized that not the words used in the ideas but relevant words of them are used as keywords for retrieving images. As a result, diverse kinds of images are obtained and they can extend users' imaginations.

All of these three systems use relevant keywords for providing hints for the users. The first two systems use keywords whereas the last system uses relevant images as hints for discussions. Thus, we discuss types of hints for idea creation from two stand-points; keywords vs. images, and keywords used in ideas vs. relevant keywords of words used in ideas. In the previous research, the author has conducted some experiments to investigate the effects of the hits [9]. However, the results have not analyzed in rigorous ways yet. Especially, differences of characters of participants and differences of difficulty of topics were not considered. Thus, analyzing them with statistic methods is required.

3. EXPERIMENTS

3.1 Outline

Experiments have been conducted in order to investigate the effects of hints displayed during group discussions.

The following three types of hints were given for the participants:

Type 1: Relevant keywords; relevant words of the words used in ideas presented in the discussion

Type 2: Relevant images; images retrieved by using words used in ideas presented in the discussion as keywords

Type 3: Semi-relevant images; images retrieved by using relevant words of the words used in ideas presented in the discussion

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Numbers of utterances and created ideas in the discussions were counted to evaluate the activation levels of the discussions.

The participants are 16 students from an engineering course of a Japanese national university. 12 of them are the 1st grade of graduate school students and the others are 4th grade of under graduate school students (average 22.18 years old, SD 0.79). They have experiences of discussions with KJ-method, and they have similar abilities for group discussions. The 16 participants were divided into 4 groups, Group A, B, C and D equally, thus each group consists of 3 graduate students and 1 undergraduate student.

Each group was asked to conduct discussions under two conditions, which is shown in Section 3.2, with a system developed for the experiment. In the discussions, the participants input ideas they created into the system by using a keyboard. The system display three hints for the participants when an idea is input.

In the system, kizAPI [10] is used for generating relevant words, and Bing search [11] is used for obtaining relevant images.

3.2 Procedure of the experiments

The procedure of the experiments is shown below:
1. Instructions of brainstorming method and the experiments for the participants
2. Exercise of the brainstorming method (5 minutes)
3. Break (3 minutes)
4. Discussion 1 (10 minutes)
5. Break (3 minutes)
6. Discussion 2 (10 minutes)

The following two topics were discussed in the experiments:

Topic 1: How to make children who hate vegetables eat them.

Topic 2: If your group has extra income of 5,000 JPY, how to use it?

Table 1 shows the combinations of topics and types of hints shown in the discussions. In order to reduce the effects of order, the orders of topics and types of hints were changed for each group.

3.3 Results

Table 2 shows the number of utterances told in the discussions. The average number of utterances in the discussions with the topic 1 is 177.8, meanwhile the average number of utterances in the discussions with the topic 2 is 216.8. From them, it is assumed that the topic 1 is more difficult than the topic 2 to discuss

Table 1: Combinations of topics and hint types for each discussion

Group	Discussion 1	Discussion 2
A	Topic 1 Hint type 3	Topic 2 Hint type 1
B	Topic 1 Hint type 1	Topic 2 Hint type 3
C	Topic 1 Hint type 2	Topic 2 Hint type 3
D	Topic 2 Hint type 2	Topic 1 Hint type 3

Table 2: The number of utterances in the discussions (each number in parentheses stands for the number of topic)

Group	Type 1	Type 2	Type 3	Average
A	261 (2)		228 (1)	244.5
B	200 (1)		263 (2)	231.5
C		176 (1)	207 (2)	191.5
D		136 (2)	107 (1)	121.5

for the participants. To correct for the difference of difficulty level between the two topics, the number of utterances of topic 1 is multiplied by coefficient $1.22 (=216.8/177.8)$.

As we can see from Table 2, there are big gaps among the average numbers of utterances. It is assumed that the number depends on characters of the group. To correct for the differences, the numbers of utterances of group B, C, and D are multiplied by coefficient $1.04 (=242.5/233.0)$, $1.26 (=242.5/192.5)$ and $2.00 (=242.5/121.5)$, respectively.

Table 3 shows number utterances after the corrections.

Table 4 shows the number of ideas as the results of discussions. It also involves differences among characters of groups and differences between the topics. Thus the numbers are corrected as same way as the numbers of utterances.

The the average number of ideas created in the discussion with the topic 1 is 13.3, meanwhile the average number of ideas created in the discussion with the topic 2 is 10.8. Thus the number of ideas created in the discussion with the topic 2 is multiplied by coeffcient $1.23 (=13.3/10.8)$ to correct for the difference of the difficulty level. Then the number of ideas of group B, C and D are multiplied by coefficient $1.68 (=16.0/9.5)$, $1.52 (=16.0/10.5)$ and $1.33 (=16.0/12.0)$, respectively. Table 5 shows the corrected numbers of ideas.

These corrected numbers in Table 3 and Table 5 are used for the discussions in the next section.

Table 3: Corrected numbers of utterances in the discussions

Group	Type 1	Type 2	Type 3
A	261.0		278.0
B	257.6		277.8
C		274.0	264.3
D		273.7	262.6
Average	259.3	273.9	270.7

Table 4: Numbers of ideas provides in the discussions
(each figure in parentheses stands for the number of topic)

Group	Type 1	Type 2	Type 3	Average
A	17 (2)		15 (1)	16.0
B	9 (1)		10 (2)	9.5
C		14 (1)	7 (2)	10.5
D		9 (2)	15 (1)	12.0

Table 5: Corrected numbers of ideas provides in the discussions

Group	Type 1	Type 2	Type 3
A	21.0		15.0
B	15.2		20.8
C		21.3	13.1
D		14.8	20.0
Average	18.1	18.1	17.2

Table 6: The average numbers of utterances in 6 periods
(60 minutes) after showing hints (each number in
parentheses stands for the number of topic)

Group	Type 1	Type 2	Type 3
A	4.17 (2)		3.73 (1)
B	3.23 (1)		4.28 (2)
C		3.02 (1)	3.43 (2)
D		2.02 (2)	1.79 (1)

4. DISCUSSION

4.1 Number of utterances

For the corrected numbers in Table 3 and Table 5, Kruskal-Wallis one-way analysis of variance was conducted. As the results, there is no significant difference between the corrected number of utterances with each type of hits ($p = 0.135$) and between the corrected number of ides with each type of hints ($p = 0.673$). In these experiments, there are only 2 or 4 samples for each type of hints, and it could make the p-values large. Especially, for the number of utterances, the p-value ($p = 0.135$) could be considered as small enough for an experiment of human behaviors. From the result, it is expected that number of utterances with hints of type 1 is less than number of utterances with the other types of hints.

To investigate the effects of each type of hints on number of utterances in more detail, the numbers of utterances after displaying each hint are counted for each type of hints, and they were compared.

First, each data of utterances in a discussion was divided into 60 periods as each period has 10 seconds. Then number of utterances in six periods from the period in which a hint was displayed were counted, and the average was calculated for each type of hints. Table 6 shows the results.

As a result of Kruskal-Wallis test, marginally significant differences were found among the average numbers of Topic 1 ($p < 0.10$). For the Topic 2, despite significant difference could not be found, the p-value is close to the threshold value ($p = 0.137$).

From the results, it is expected that hints obtained form relevant keywords of submitted ideas (type 1 and 3) is better than hints obtained from words used in presented ideas (type 2) for vitalizing discussions.

4.2 Variety of topics in a discussion

In order to investigate diversity of the discussions, the utterances data were analyzed by using multidimensional scaling method. The process is shown below:

1. Sets of words construct each sentence are obtained by using Japanese morphological analysis tool, ChaSen [12].
2. Words, which do not express the contents of discussions, i.e., articles, numeral and preposition [13], are eliminated from the set of words.
3. N-dimension vectors are created. Here, N stands for the numbers of words used in all of the utterances. If the word is used in a sentence, then the element corresponding the word is 1, otherwise 0.
4. All sentences are projected into a 2-dimensional space by using multidimensional scaling method with Euclidean distance.
5. Utterances on the 2-dimensional space are classified by using ward method as height of dendrogram is below 0.5, and count the number of clusters.

The results are shown in Figure 2. In the figures, each green symbol stands for an utterance, and each red circle with mesh pattern indicates a cluster of utterances. In other words, utterances in a same cluster include many same words. Thus, we can think that more clusters mean wider varieties of topics were discussed in the discussion. Table 7 shows the number of clusters under each condition.

Table 7: Number of clusters in the multidimensional
scaling spaces

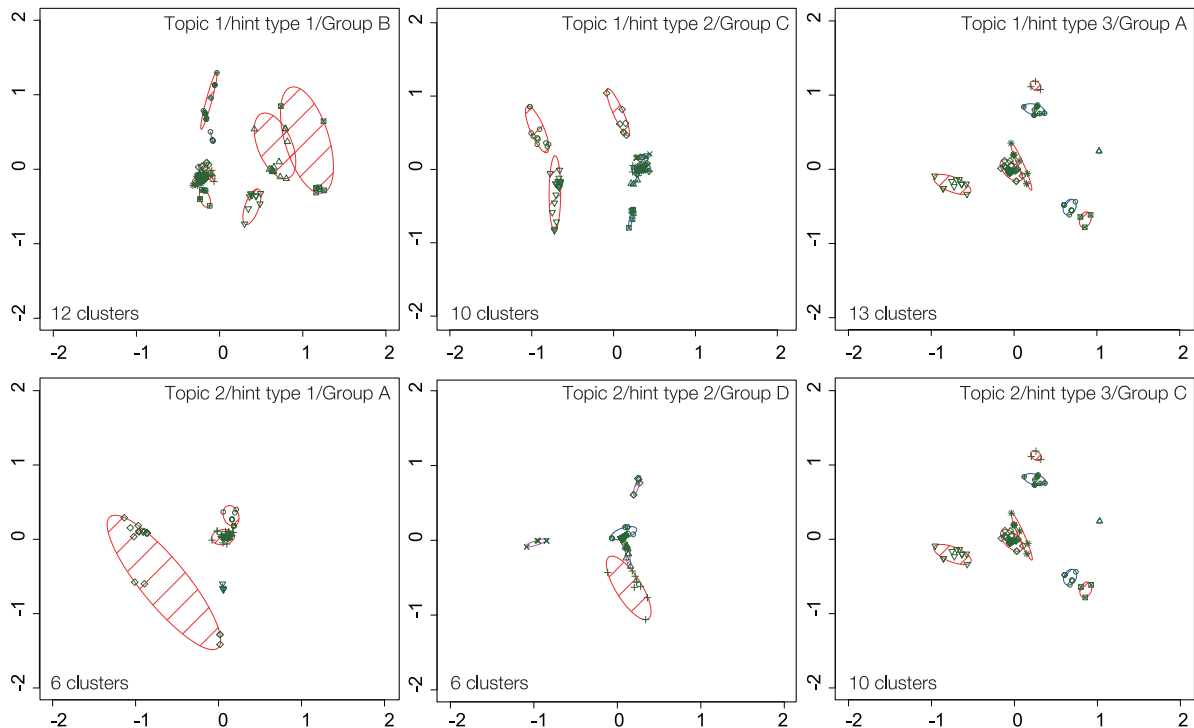|	Type 1	Type 2	Type 3
Topic 1	12	10	13
Topic 2	6	6	10

Figure 2: Results of multidimensional scaling

We can see from Figure 2 and Table 5 that there are most clusters in the results of discussions with the hints of type 3, meanwhile there are least clusters in the results of discussions with hints of type 2. The results mean that the most diversity of topics were discussed under the condition of showing hits of type 3. Thus, it is expected that semi-relevant image is the most useful type of hint for make discussion topics widely.

5. CONCLUSION

In this paper, the effects of hints displayed in brainstorming sessions have been discussed based on the results of experiments.

Three types of hints, (1) relevant words of the words used in ideas presented in the discussion, (2) images retrieved by using words used in ideas presented in the discussion as keywords, and (3) images retrieved by using relevant words of the words used in ideas presented in the discussion as keyword, were compared. As a result, it is revealed that the third type of hints can increase number of utterances and variety of topics in discussions. The followings are considered as the reasons: 1) Images can activate participants imagination more than keyword. 2) Relevant images are too close to the ideas which already shown, and they do not work effectively to expand the variety of ideas.

Although the results shown in this paper can be used for a criteria for designing supporting systems of brainstorming, some future works still remain. In this paper, only the types of hints shown in brainstorming sessions were discussed. However, it is predicted that the timing of giving such hints is also significant for idea creating, so it should be investigated in the future. In the experiments, relevant words and images were obtained by using open APIs. It is also predicted that the effects of hints depends on the retrieving algorisms. The relationship between mechanisms of retrieving them and the activation level of brainstorming sessions also must be investigated in the future.

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