Commonality Search as a Way of Facilitating Creative Thinking: A Comparison with the Alternative Categorization Task

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Abstract

The purpose of this study was to clarify the cognitive processes of commonality search between unrelated objects. Specifically, we investigated the relationship between the performance of the commonality search task and that of the alternative categorization task. We hypothesized that one needs to focus on obscure features of objects to do both tasks well and that there would therefore be a positive correlation between the performances on the two tasks. We also compared the performance of the commonality search task with that of the alternative categorization to investigate exploratorily how each task promotes creative thinking. Thirty-one participants were asked to engage in two tasks: the commonality search task and the alternative categorization task. In the commonality search task, they were asked to list as many commonalities as possible between nine unrelated object pairs within 90 seconds for each pair. In the alternative categorization task, they were asked to list as many categories as possible to which each of the five objects belonged, within 60 seconds for each object. Although There was a significant positive correlation between the numbers of answers on these tasks. The additional results showed that there was no significant difference between the two tasks in terms of average saliency score or the first answer, but the saliency of the commonality search task was significant lower than the alternative categorization task in the second answer. We discussed the similarities and differences between the two tasks and the potential use of the commonality search task as a way to promote creative thinking.

Keywords: Creative thinking, Commonality search, Alternative categorization

Introduction

Many researchers have investigated which cognitive processes underlie creative thinking. Specifically, they have tried to clarify how people generate creative ideas. However, it is still not fully understood how to promote the generation of creative ideas. The purpose of this study is to clarify which cognitive processes are involved in commonality search in order to better understand how to promote creative thinking.

In the following section, we first point out that knowledge association and overcoming functional fixedness are critical for creative thinking. We then introduce a new approach for the generation of creative ideas (i.e., commonality search) and explain our hypotheses based on the relationship between the performance on the commonality search task and that on the alternative categorization task proposed by Chrysikou (2006).

Knowledge Retrieval for Creative Thinking

When people generate ideas, their knowledge is activated. What knowledge is activated determines the quality of the ideas, and the knowledge a person has forms a network structure. The more closely related concepts are, the closer they are located in the network. There are individual differences in the network structure: some people have a network structure in which concepts are located close to each other; others have a network in which they are located far away from each other.

Some researchers have shown that knowledge structure determines creative performance. Mednick (1962) examined the relationship between knowledge association and creativity performance among college design majors. Specifically, they measured participants' knowledge structure using the Remote Associates Task (RAT), in which participants were asked to find a word common to three words that seemed to be unrelated. The researcher also received professional teachers' evaluations of the participants' creativity performance and examined the relationship between their performance on the RAT and their creative performance. The results showed that there was a positive correlation between RAT performance and creativity performance. Kenett, Anaki, and Faust (2014) also examined the relationship between knowledge structure and creativity. They asked participants to engage in the free association task and identified participants' knowledge structures based on their answers. Participants were also asked to engage in a creative task and were divided into high and low creativity groups based on their performance, and the researchers then compared the participants' knowledge structures between the two groups. The results showed that the highly creative group had a knowledge structure that was unusually configured; that is, a knowledge structure in which generally remote concepts were located close to each other. Similarly, Benedek et al. (2017) identified characteristics of knowledge structures using the relevance judgment task. During the task, participants were asked to judge how related two words were. The results showed that performance on a creativity task was higher with a knowledge structure that was organized such that it was easier to access less relevant knowledge.

Fixedness on Creative Thinking

It is difficult for people to use remote knowledge when generating ideas because they usually tend to use only the knowledge that is immediately associated with an object or

concept. Brown, Tumeo, Larey, and Paulus (1998) argue that the activation of knowledge for idea generation occurs separately in each category of knowledge. According to them, knowledge in the category to which the information of interest belongs is activated, and ideas are then generated based on that knowledge. When the activation of knowledge and the generation of ideas in some category are complete, the activation of knowledge in another category occurs. However, since this transition is determined by the strength of association, knowledge activation is likely to occur in categories with strong associations to the first activated category, but is unlikely to occur in categories with weak associations.

Problems are sometimes unable to be solved with only the knowledge that is immediately available and without using more distant knowledge. Duncker (1945) explained people's tendency to focus only on objects' commonly-used functions; this phenomenon is known as "functional fixedness." It has also been found that when an idea is given, it becomes linked to the illustrated information provided as an example; the features included in the example are therefore easily accessible while other features are more difficult to access. For instance, Smith, Ward, and Schumacher (1993) asked participants to design novel toys and fictitious creatures, and the features included in the examples shown in advance were subsequently included more in the participants' designs. Even when participants were explicitly instructed to "create a design different from the example," more features of the example were included compared to when the example was not presented.

Overcoming Functional Fixedness

Some studies have shown that encouraging people to think using inconspicuous knowledge can promote problem solving with new ideas. Chrysikou (2006), for example, developed the alternative categories task as a training to overcome functional fixedness and facilitate creative thinking. In this task, participants were asked to list unusual categories, rather than the most obvious categories to which an object belonged. The results showed that participants' performance on an insight problem-solving was higher after the participants engaged in the alternative categorization task rather than after the word association task. The alternative categorization task consists of listing the general categories of a target, and it is possible to list many categories by focusing not only on features that are immediately apparent but also on features that are less readily identifiable.

Chrysikou (2006) developed interventions for overcoming the functional fixedness of objects, and investigated the effects of the training only on insight problem-solving. However, in the context of idea generation, not only the function of the object is utilized; various categories of knowledge are also activated and used. Recent studies (e.g., Yamakawa & Kiyokawa, 2016) proposed a method to promote the activation of inconspicuous knowledge, focusing not only on overcoming of functional fixedness but also on the activation of knowledge that is not limited to the physical or functional features of the object.

Yamakawa and Kiyokawa (2016) proposed the commonality search task to examine whether searching for commonalities between a pair of unrelated objects is effective in activating less salient knowledge. Participants were randomly assigned to one of two conditions: listing features of each object or searching for commonalities between a pair of unrelated objects. The raters were asked to rate how easily they themselves could associate the participants' answers with the objects. The results showed that the participants in the commonality search condition listed less salient answers than the participants in the feature listing condition. The researchers therefore concluded that a commonality search between unrelated objects is effective for activating less salient knowledge of the objects. Yamakawa, Kiyokawa, and Inohara (2017) also examined how the degree of relevance of between a pair of objects affects the quality of identified commonalities. Participants were randomly assigned to either high or low relevance conditions. The results showed that when the relevance between objects was low, the originality of identified commonalities was higher than when the relevance was high. The results suggest that the commonality search method led leads to the generating generation of creative ideas when a pair of objects is are unrelated.

In the search for commonalities, it is checked whether or not the knowledge associated with each object is common; however, knowledge that can be easily conceived from each object independently is not considered to be common. Therefore, it is necessary to activate obscure (i.e., less salient) knowledge, which is difficult to do when viewing a single object individually. It is thought that an individual who can search for commonalities well (i.e., who can list many commonalities) can better activate obscure (i.e., less salient) knowledge of the subject.

This commonality search method may be effective in activating less salient knowledge without being limited to physical and functional features. The alternative categorization task and the commonality search task are both expected to have an effect on activating less salient knowledge. However, the similarities and differences between the two tasks have not been clarified.

The present study

The purpose of this study was to clarify the cognitive processes of a commonality search between unrelated objects. We examined the relationship between the performance on the commonality search task and the performance on the alternative categorization task (Chrysikou, 2006). We hypothesized that one needs to focus on obscure features of objects to do both tasks well and that there would therefore be a positive correlation between the performances on the two tasks.

We also compared the performance of the commonality search task with that of the alternative categorization to investigate exploratorily how each task promotes creative thinking. Participants' answers were compared between the

commonality search task and the alternative categorization task. This examination revealed the potential of each task in promoting the activation of less salient knowledge.

Method

Participants

Thirty-one Nagoya University students (14 males, 17 females; mean age = 19.84 (*SD* = 1.27) years) participated in this study in exchange for course credit or 750 yen. They granted their informed consent before participation and the Ethical Committees of Nagoya University approved the study.

Procedure

The experiment took place in a room with the experimenter present and up to 10 participants at a time. Each participant used a desktop PC. All materials were presented on a display. The experiment was administered by Qualtrics. Each participant completed both the commonality search and alternative categorization tasks independently. The order of tasks was counterbalanced between participants. After both tasks, the participants were asked to provide demographic information regarding their gender, age, and native language.

Commonality search task. Participants were asked to list as many commonalities as possible (up to 10) between a pair of apparently unrelated objects within 90 seconds. They were told not to consider features of the words such as the number of letters or notation, and to only consider features of the objects. They engaged in a practice trial in which the pair of objects consisted of a pipe and a bottle. Afterwards, they engaged in nine experimental trials. The pairs of objects are shown in Table 1. The pairs were presented in a random order for each participant.

Table 1

The word pairs used in the commonality search task

Ink	-	Killifish
Karuta	-	Lamp
Coin	-	Belt
Tire	-	Puzzle
Bucket	-	Medal
Strawberry	-	Television
Towel	-	Kimchi
Tent	-	Mole
Milk	-	Bench

Alternative categorization task. Participants were presented with an object and the category to which the object is generally assumed to belong. They were then asked to list as many categories as possible (up to 10 and excluding the presented categories). The participants engaged in a practice trial in which the object "spoon" and its category "cutlery" were presented. Afterwards, they engaged in five experimental trials. We used the same procedure as that used by Chrysikou (2006) except for the following points. First, the participants in Chrysikou's (2006) study were required to list six or more categories for an object whereas those in our experiment were asked to list only up to 10 categories. Second, the participants in Chrysikou's (2006) study completed 12 trials for 15 minutes each whereas those in our experiment completed five trials for one minute each. After a minute passed, a button was displayed on the screen that allowed participants to proceed to the next page. The objects and their example categories presented in our experiment are shown in Table 2[1]. The objects/categories were presented in a random order for each participant.

Results

Data from a non-native Japanese participant were excluded from the analyses. We examined the relationship between the performances on the commonality search and alternative categorization tasks.

Relationship between two tasks

We examined the relationship between the performances on the commonality search and alternative categorization tasks. First, we used the mean number of answers per participant as an index of the task performance. The results showed a significant correlation between the mean numbers of answers on the two tasks ($r = .52$, $p < .001$). As Figure 1 illustrates, the participants who listed more categories during the

Table 2

The word pairs used in the alternative categorization task

object	category
table	furniture
pepper	vegetable
strawberry	fruit
shirts	clothing
train	vehicle

[1] We conducted a pilot study to select pairs of an object and their categories used in the alternative categorization task. The procedure in the pilot study was the same as that in Rosch's (1975) experiment. Twenty-nine Nagoya University students were presented with pairs of objects and categories and asked to rate how well each object represented the category on a 7-point Likert scale. We used five categories: furniture, vegetable, fruit, clothing, and vehicle. Each object with the highest rating in each category was selected.

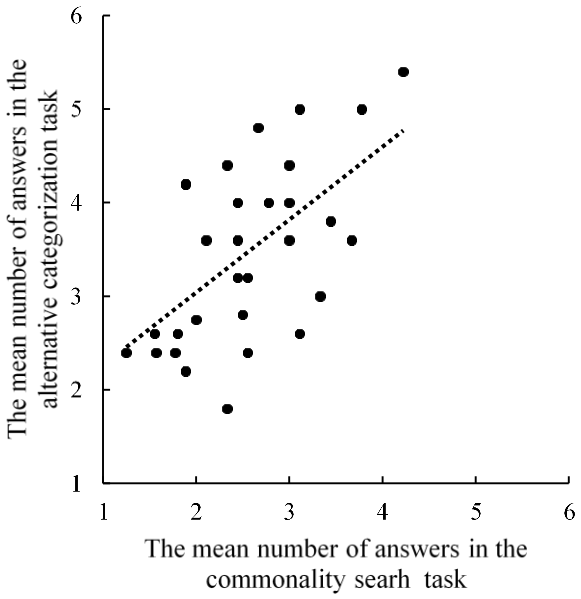

Figure 1: The scatter plot of the mean number of answers in the two tasks and regression line

alternative categorization task also listed more features during the commonality search task.

Comparison between the tasks

We then compared the performances between the two tasks, focusing on the answers to the word “strawberry.” The word “strawberry” was used in both the commonality search and alternative categorization tasks. Table 3 shows the mean number of answers in each task. A paired t-test revealed that the mean number of answers was significantly higher for the alternative categorization task than for the commonality search task ($t(27) = 3.95$, $p < .001$, $d = 0.97$, 95%CI[0.40, 1.54]).

Next, we used saliency ratings of the answers as another index of the task performance. The saliency of an answer was rated higher if more people believed that they could also associate it with an object. The less salient an answer was, the higher performance was expected to be on both tasks. We used each mean saliency rating of answers only to the word “strawberry” per participant.

Four naive raters evaluated the participants' answers to the word "strawberry" on both tasks based on how easily they could associate the participants’ answers with "strawberry" on a 5-point Likert scale (1=I can't associate it with “strawberry” at all; 5=I can associate it with “strawberry” immediately). They were told to evaluate them intuitively and to select the option "I do not understand the meaning of the word" if appropriate. The answers listed by the participants were presented as they were, including typing errors.

Ratings of four answers for which at least one rater chose the option "I do not understand the meaning of the word" were excluded from the analyses. As a result, the data from two participants were excluded from the analyses. Table 3 shows the mean saliency rating of the answers to the word “strawberry” in each task. The results showed that there was no significant difference between the tasks in terms of the mean saliency rating ($t(27) = 0.97$, $p = .34$., $d = 0.30$, 95%CI[-0.24, 0.83]).

Table 3: The mean of the number of answers and the saliency of all answers (*SD* in parentheses)

	Commonality search	Alternative categorization
The number of answers	2.78 (1.07)	4.21 (1.79)
The saliency of all answers	3.54 (0.47)	3.72 (0.73)

Note. $N = 28$

We then examined the relationship between the number of answers and the saliency rating of the answers to the word "strawberry" in each task. We calculated the correlation coefficient between the number of answers to the word "strawberry" and their saliency for each task. The results showed that there were no significant correlations between number of answers and saliency of answers for either task (alternative categorization task: $r = .25$, $p = .21$; commonality search task: $r = -.29$, $p = .13$).

Although the correlation coefficients did not reach the significance level, there seemed to be a difference in the relationships of the number and saliency of answers to the word "strawberry" between the two tasks. Specifically, the saliency ratings were higher when participants listed more answers during the alternative categorization task. On the other hand, saliency ratings were lower when participants listed more answers in the commonality search task. We tested the hypothesis that the number of answers has different effects on the saliency ratings between the alternative categorization and commonality search tasks. Specifically, we compared the mean saliency ratings of the first and second answers to "strawberry" between the tasks.

Data from 23 participants who listed at least two answers were used for analyses because the number of answers differed among the participants. Table 4 shows the mean saliency ratings of the first and second answers to the word “strawberry” in each task. A paired t-test revealed that there was no significant difference between the tasks in terms of the saliency ratings of the first answers ($t(22) = 0.45$, $p = .65$, $d = 0.13$, 95%CI[-0.47, 0.72]). On the other hand, the results showed that there was a significant difference in the saliency ratings of the second answers, indicating that the second answers during the alternative categorization task were significantly more salient on the commonality search task than those on the alternative categorization task ($t(22) = 2.39$, $p < .05$, $d = 0.74$, 95%CI[0.13, 1.36]).

Table 4: The mean of the saliency of first answer and second answer (*SD* in parentheses)

	Commonality search	Alternative categorization
The saliency of first answer	3.86 (0.79)	3.98 (1.09)
The saliency of second answer	3.51 (0.76)	4.17 (1.01)

Note. $N = 23$

Discussion

The purpose of this study was to clarify the cognitive process involved in a commonality search between less relevant subjects. In this study, we examined the relationship with the alternative categorization task (Chrysikou, 2006), which is assumed to have a similar process. We hypothesized that the two tasks involve common processes in which one needs to focus on obscure features of objects, there would therefore be a positive correlation between the performances on the two tasks. The results showed that there was a positive correlation between the number of responses on the commonality search and alternative categorization tasks. Our hypothesis was supported, suggesting that the commonality search and the alternative categorization involve similar processes which facilitate creative thinking.

There is another possible interpretation of the positive correlation between the numbers of responses on the two tasks, which differs from the interpretation that there is a common process involved in the two tasks. The fact that it is good at generating a large number of answers may affect the large number of answers in both tasks. Recent studies have shown that the performance of divergent thinking tasks is associated with verbal fluency (e.g., Beaty & Silvia, 2014; Silvia, Beaty & Nusbaum, 2013). Beaty and Silvia (2014) used the number of answers on a task that involved the enumeration of many words from stimulus words as an index of verbal fluency. The results showed that verbal fluency was significantly related to the number of divergent thinking responses. In other words, verbal fluency as the ability to generate a large number of answers may affect individuals' performance on both tasks.

We also compared the performances of the two tasks. This examination aimed to reveal the potential of each task in promoting the activation of obscure (i.e., less salient) knowledge. The saliency of participants' responses was compared between the commonality search task and the alternative categorization task. The results showed that there was no difference between the two tasks regarding the mean saliency score for the first answer; however, the mean saliency of the commonality search task was lower than that of the alternative categorization task for the second answer. These results suggested that the search process involved in the generation of many answers is different. In the alternative categorization task, the greater the number of answers, the higher the saliency of the answers. On the other hand, in the commonality search task, the more respondents, the lower the saliency of the answers. The more commonalities were provided during the commonality search, the more obscure (i.e., less salient) knowledge was activated. These results suggest that the effects of two tasks may be no different when one generates only one answer, on the other hand, a commonality search may be useful for activating less salient knowledge when one generates multiple answers. Because these results are from the analyses in which only one word ("strawberry") was used as the stimulus word, caution is necessary regarding their generalizability. Further studies need to test the hypothesis with using more various stimuli.

This study had three main limitations. First, there was a smaller sample size; larger samples are needed in future research. Second, other factors that may have affected performance were not accounted for—specifically, the abilities of verbal fluency. Even after controlling for individual differences, it is necessary to examine whether the performances on the two tasks are related or different. Finally, we examine the effect of a commonality search on creative idea generation. The ultimate goal of this study was to establish ways to promote creative idea generation. The present study suggested that a commonality search and an alternative categorization may be effective in activating obscure knowledge. In the future, it is necessary to consider whether performing the commonality search task in advance enhances the creativity of an idea, and whether the effect is more successful than that of other methods such as alternative categorization.

Acknowledgement

This work was supported by JSPS KAKENHI Grant Number 18J11551.

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