Human-Centered Design and User Experience, Vol. 114, 2023, 642–648
https://doi.org/10.54941/ahfe1004284

Object Combinations for Alternative Uses Test Suitable for 2-Condition Within-Participant Comparisons

Ryunosuke Fukada, Kimi Ueda, Hirotake Ishii, Hiroshi Shimoda, and Fumiaki Obayashi

Department of Socio-Environmental Energy Science, Graduate School of Energy Science, Kyoto University, Kyoto, 606-8501, Japan

ABSTRACT

In recent years, creative thinking has become increasingly important. The Alternative Uses test (AUT) is a method to evaluate divergent thinking, which is one type of creative thinking. The performance of divergent thinking measured by this test is highly dependent on the object presented in AUT, and may not be suitable for 2-condition within-participant comparisons. Therefore, this study aimed to select an appropriate combination of objects, and an experiment was conducted with 32 university students. The results showed that there were significant differences in the AUT quantity of responses, fluency, and flexibility score depending on the object condition. Eight objects were selected based on the mean of each standardized score. Since these combinations do not include pairs of significantly different objects, it is suggested that these objects may be suitable for within-participant comparison in the two conditions.

Keywords: Creativity, Creative thinking, Divergent thinking, Alternative uses test

INTRODUCTION

In recent years, the value of creative thinking in human intellectual work has been increasing with the rapid arrival of the information society. Guilford divided creative thinking into two broad categories: divergent thinking, which generates many diverse ideas from a single concept or problem, and convergent thinking, which derives a single concluding idea from many ideas (Guilford, 1967).

In research on divergent thinking, it is important to evaluate the performance of divergent thinking, and various evaluation tasks for divergent thinking have been proposed, such as TCT-DP (Urban, 2005), the product improvement test, and the incomplete figure test developed by Barron (Barron, 2008). One of the most famous divergent thinking evaluation tasks is the Alternative Uses Test (AUT) developed by Guilford (Guilford, 1956, Guilford, et al., 1978, Torrance, 1972), in which participants are asked to respond to as many ideas as possible about how to use the presented objects differently from how they were originally intended. For example, if a "sponge" is presented as an object, its original use is to be used for cleaning, etc., but alternative uses include "use as a base for fresh flowers" or "use as a

buffer to prevent furniture from damaging the floor". The ideas are evaluated based on indicators such as fluency, flexibility, and originality.

Table 1. Objects presented.

For Practice Task	For Main Task
Plastic shopping bag and Sponge	T-shirt, aluminum foil, washtub, bed sheet, plastic bottle, broom, pillow, chopping board, pencil, desk pad, splitable chopsticks, socks, paper cup, cardboard box, butterfly net, and baseball bat

Because of the short time required to respond to tasks and no special skills required for participants, AUT has been used in many studies. However, the performance of AUT can vary greatly depending on the objects presented. When AUT is conducted under multiple conditions, such as in comparative experiments, differences in objects may have a greater impact on responses than differences between conditions. For this reason, the AUT is not suitable for within-participant comparisons unless an appropriate combination of objects is chosen. Therefore, in this study, experiments were conducted with undergraduate and graduate students to select objects with a focus on flexibility. Based on the experiment on AUT, this study aimed to select a suitable combination of objects for a within-participant comparison of the two conditions.

METHOD

Overview

An experiment was conducted to select an appropriate object combination. In the experiment, the experimental participants performed the AUT as an evaluation task; the AUT consisted of a practice and a main task. Two objects were presented in the practice task and 16 objects in the main task. After the experiment, three evaluators evaluated all AUT responses and calculated the AUT quantity of responses, fluency, and flexibility.

Measure

In this study, the Alternative Uses Test (AUT) developed by Guilford was used as a task to evaluate divergent thinking. The objects presented in the practice and production tasks are shown in Table 1. These objects were selected from a list of 32 objects prepared in advance by the authors and narrowed down to 16 objects by excluding objects with AUT responses in a preliminary experiment with four participants. The example and main task were conducted for 4 minutes for each object. The order in which the objects are given was counterbalanced to reduce order effects with reference to the Latin square design.

In this experiment, the AUT quantity of responses, AUT fluency score, and AUT flexibility score (Torrance, 1988) were calculated from the responses obtained. The following describes the procedure for evaluating the AUT

quantity of responses, AUT fluency, and AUT flexibility. First, we determined whether each idea was valid as an AUT response. image1.pngundergraduate and graduate students at Kyoto University, and the final evaluation was determined by consensus among the three after a discussion of the ideas that were classified differently.

Table 2. Criteria for determining the validity of each idea for the AUT.

Validity Criteria
1. The idea must represent a different use than it was originally intended.
2. The idea must represent how the object will be used, regardless of feasibility
3. The idea must not duplicate other ideas the person has responded to on the object.

Table 3. Perspectives for classifying each idea for the AUT.

Perspective 1	Perspective 2
Either as a material or as is.	How do ideas use object? Choose the most appropriate category from the 13 categories (Wearable items, Toys, Music & Musical Instruments, Furniture, Tools, Outdoor Sports, Kitchenware, Sanitary & Cleaning, Fuel, Vehicles, Stationery, Weapons, Packaging)

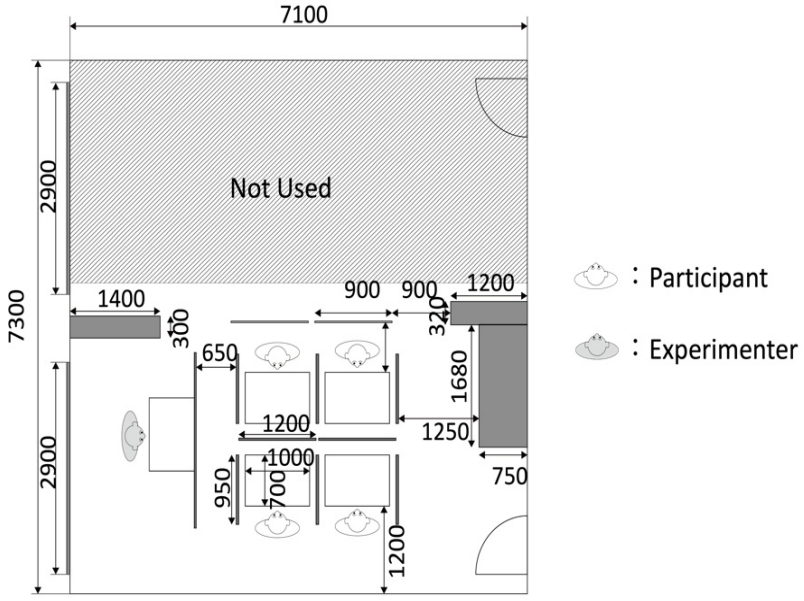

Figure 1: Layout of the experimental room.

Participant

Participants in the experiment were 32 undergraduate and graduate students enrolled at Kyoto University who were at least 18 years old. All participants had Japanese as their native language and were able to type using a keyboard.

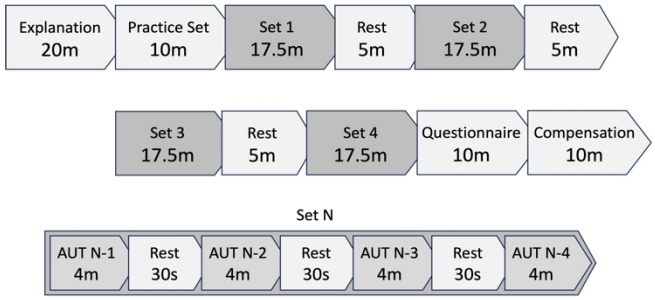

Figure 2: Protocol of the experiment.

Environment

Figure 1 shows the layout of the experimental room. To prevent surrounding items from giving hints to the participant performing the AUT, the participant's work desk was surrounded by 1800 mm partitions. The experimenter was seated at a desk that was out of sight of the participants, and the participants were mentioned using a camera placed on the their desks. The lighting in the experimental environment was set so that the illuminance on the desk surface of the participants' work desks was 200∼250 lx. Figure 2 shows the application screen during the AUT response.

Procedure

The experiment was conducted with four participants in one group. The duration of the experiment was approximately 135 minutes. The experimental protocol is shown in Figure 2.

Analysis

In this experiment, performance was compared using the standardized AUT quantity of responses score (z-quantity), AUT fluency score (z-fluency), and AUT flexibility score (z-flexibility). Each score is calculated according to Equation (1), where x_a is the score in object "a", $\overline{x_n}$ is the mean of the scores of participant "n", and s_n is the standard deviation of the scores of participant "n".

$$z(a,n) = \frac{x_a - \overline{x_n}}{s_n} \tag{1}$$

RESULT & DISCUSSION

Data from all 32 participants were used in the analysis. The means and standard deviations of the AUT quantity of responses (quantity), AUT fluency score (fluency), and AUT flexibility score (flexibility) for each object are shown in Table 4, while the means and standard deviations of the standardized versions of these scores, z-quantity, z-fluency, and z-flexibility, are also shown in Table 5. As shown in Table 6, we conducted a two-factor repeated measures ANOVA on effects. Thus, it cannot be said that the AUTs' performance across the 16 objects was equal. the conditions, and the result showed

a significant difference in the object factor. We did not find any significant differences in the order factor, and the interaction.

Table 4. AUT quantity of responses, fluency and flexibility scores by object.

	Quantity		Fluency		Flexibility	
	Mean	St	Mean	St	Mean	St
T-shirt	4.563	6.125	6.219	1.848	2.379	2.393
aluminium foil	4.563	5.938	6.219	1.722	2.673	2.552
washtub	5.406	7.406	7.469	1.829	2.782	2.758
bed sheet	5.250	7.469	7.469	1.934	3.016	3.016
plastic bottle	6.063	7.750	7.781	1.848	2.599	2.553
broom	4.563	6.688	6.688	1.740	2.375	2.375
pillow	4.500	6.563	6.594	1.606	2.674	2.699
chopping board	4.844	6.531	6.531	1.780	2.851	2.851
pencil	4.594	5.844	5.875	1.456	1.792	1.725
desk pad	5.063	7.031	7.031	1.664	2.117	2.117
chopsticks	5.438	6.656	6.688	1.645	2.361	2.350
socks	4.563	6.438	6.500	1.105	2.449	2.382
paper cup	5.250	7.531	7.531	1.437	2.369	2.369
cardboard box	5.281	7.594	7.875	1.373	2.959	2.861
butterfly net	4.250	6.063	6.063	1.566	2.449	2.449
baseball bat	5.406	6.938	7.063	1.965	2.862	2.687

Table 5. AUT quantity of responses, fluency and flexibility standardized scores by object.

	z-Quantity		z-Fluency		z-Flexibility	
	Mean	*St*	*Mean*	*St*	*Mean*	*St*
T-shirt	−0.406	0.865	−0.412	0.880	−0.341	0.938
aluminium foil	−0.394	0.909	−0.539	0.913	−0.312	0.922
washtub	0.406	0.928	0.410	0.932	0.328	1.027
bed sheet	0.391	1.071	0.437	1.069	0.238	1.085
plastic bottle	0.596	0.816	0.607	0.822	0.824	0.870
broom	−0.099	0.837	−0.053	0.848	−0.371	0.959
pillow	−0.139	0.848	−0.118	0.872	−0.358	0.746
chopping board	−0.213	0.837	−0.169	0.853	−0.151	0.819
pencil	−0.615	0.825	−0.582	0.819	−0.278	0.770
desk pad	0.179	0.998	0.211	0.977	0.085	1.166
chopsticks	−0.053	1.091	−0.051	1.091	0.389	0.972
socks	−0.258	0.819	−0.261	0.811	−0.330	0.745
paper cup	0.465	0.990	0.494	0.978	0.249	0.842
cardboard box	0.580	0.862	0.443	0.923	0.245	0.800
butterfly net	−0.532	0.756	−0.491	0.745	−0.579	0.792
baseball bat	0.091	0.904	0.075	0.836	0.363	0.915

The eight objects with mean absolute values of z-quantity closer to zero are shown in Table 7, and a multiple Turkey test revealed no significant differences between them in Table 7. Therefore, these items can be expected

to perform almost identically in terms of the AUT quantity of responses, making them suitable for within-object comparisons. Similarly for the AUT fluency score and flexibility scores, the eight items in Table 7 do not include any significantly different sets of items. Therefore, the combinations of items in Table 7 are suitable for within-participant comparisons in terms of AUT fluency and flexibility scores. When conducting two-condition within-participant comparisons, these objects can be divided into two object groups which are used as objects of AUT in experimental and control condition, to achieve appropriate within-participant comparisons. Table 6 shows the appropriate combination of objects for each score. The optimal object combination based on which score is selected may be chosen based on the hypothesis of the experiment or other factors.

Table 6. F-value and P-value for each score obtained by analysis of variance.

	z-Quantity		z-Fluency		z-Flexibility	
	F	*P*	*F*	*P*	*F*	*P*
Object	6.188	4.303×10^{-11}	6.020	9.589×10^{-11}	5.820	2.495×10^{-10}
Order	1.182	2.859×10^{-1}	1.300	2.020×10^{-1}	1.228	2.508×10^{-1}
Interaction	0.959	6.271×10^{-1}	0.911	7.624×10^{-1}	0.946	6.648×10^{-1}

Table 7. Candidates for appropriate subject combinations based on each standardized score.

Score	Objects Combination
quantity	T-shirt, pillow, broom, desk pad, splitable chopsticks, chopping board, baseball bat, bed sheet
fluency	T-shirt, pillow, broom, desk pad, washtub, splitable chopsticks, chopping board, baseball bat
flexibility	aluminium foil, desk pad, pencil, paper cup, cardboard box, washtub, chopping board, bed sheet

CONCLUSION

An experiment with 32 students was conducted in this study to select a suitable combination of objects for a two-condition within-participant comparison. The results showed that the analysis of variance indicated that performance varied by object. Therefore, it may not be appropriate to conduct a within-participant comparison of the two conditions without selecting an appropriate object. Therefore, based on each standardized score, eight objects were selected as a combination in order of absolute mean value close to zero. None of these trials were found to contain any pairs with significant differences in performance as indicated by Turkey's multiple test. Thus, these are suitable object combinations for within-participant comparisons in the two conditions. When actually conducting an experiment using these combinations, it is necessary to decide which score-based combination to choose

based on the hypothesis of the experiment or the expected result. It should be noted that the combinations proposed here may not adequately take into account the measurement sensitivity. If the measurement sensitivity is poor and the performance is the same under all conditions, then those object combinations are not suitable for within-participant comparison of the two conditions, since the differences between conditions cannot be observed. Further experimentation and analysis are needed to determine how to account for measurement sensitivity.

ACKNOWLEDGMENT

This work was supported by JSPS KAKENHI Grant-in-Aid for Young Scientists (A) Number JP23K16926.

REFERENCES

Barron F. X. (1958), The Psychology of Imagination, Scientific American, Volume 199, pp. 151–168.

Guilford, J. P. (1956). The Structure of Intellect. Psychological Bulletin, Volume 53 No. 4, pp. 267–293.

Guilford, J. P. (1967) The nature of human intelligence, in McGraw-Hill series in psychology, New York: McGraw-Hill (Ed.).

Guilford, J. P., Christensen, P. R., Merrifield, P. R., & Wilson, R. C. (1978). Alternate uses: Manual of instructions and interpretations. Orange, CA: Sheridan Psychological Services.

Torrance, E. P. (1972). Predictive validity of the Torrance Tests of Creative Thinking. The Journal of Creative Behavior, Volume 6 No. 4., pp. 236–252.

Torrance, E. P. (1988). The nature of creativity as manifest in its testing. In R. J. Sternberg (Ed.), The nature of creativity: Contemporary psychological perspectives, Cambridge University Press, pp. 43–75.

Urban K. K. (2005) "Assessing creativity: The Test for Creative Thinking - Drawing Production (TCT-DP) International Education Journal, Volume 6 No. 2.