Changes in Affective Experiences in Convergent and Divergent Creative Group Works

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Abstract— Background. Divergent and convergent creative tasks have reciprocal relationships with the affective experience of the individuals participating in the tasks. Previous studies have affirmed that divergent thinking tends to increase positive affect and convergent thinking tends to increase negative affect. However, creative projects often involve both divergent and convergent thinking tasks interspersed in a particular. This study is aimed at investigating how the ordering of divergent and convergent tasks during the creative process influences changes in the affective experience. The authors of the current study hypothesized that change in affect is influenced by both the type of task and the order of the task types.

Methods. Twenty-two students taking a graduate-level class in "Design Thinking" at an engineering school participated as subjects. Four groups of students were each assigned to classes with different pairings of divergent and convergent tasks: either convergent tasks in a series, a divergent task followed by a convergent task, a convergent task followed by a divergent task, or two divergent tasks performed in a series. The subjects' affective states were measured using the Self-Assessment Manikin technique before and after each task, and valence and arousal levels were compared to derive changes in affect.

Results. Generally, after conducting the convergent tasks, affect remained neutral. Affect shifted in a positive direction after divergent tasks and became more negative after two consecutive convergent tasks. The valence became significantly more positive for all divergent tasks. The valence of the tasks became more negative only in the convergent–convergent task combination. Likewise, arousal levels significantly increased after almost all the divergent tasks.

Conclusions. The participants' affective states were raised most significantly in the divergent process. However, the convergent task did not necessarily decrease the valence and arousal levels. Only in the case of the class assigned two convergent tasks was the affect made more negative. Thus, the current study revealed that divergent processing strongly influences affect. This illustrates the importance of the order and combination of divergent and convergent tasks in a creative group work and therefore, how to design creative tasks in terms of optimal affective experiences for participants.

Keywords: affect changes, creative process, divergent thinking, convergent thinking

Introduction

The creative process produces novel and useful ideas in relationship to affective experience (Amabile, Barsade, Mueller, &. Staw, 2005). Individuals use divergent thinking to generate ideas, and convergent thinking to select the most promising ideas and plans to perform a task successfully (Lewis & Lovatt, 2013). How creativity through divergent and convergent thinking is influenced by affective experience has been explored extensively, and the concept that positive affect supports divergent thinking and creativity has been widely accepted (Amabile et al., 2005; Politis & Houtz, 2015). Subsequently, some studies have investigated the converse of this relationship, looking at whether the creative thinking process itself influences affective experience (Amabile et al., 2005). Akbari, Chermahini, and Hommel (2012) have revealed that divergent thinking influences the valence of a task positively, and convergent thinking negatively influences valence. Moreover, a divergent task increases positive affect regardless of the performance level (Lewis & Lovatt, 2013). Insight about how the thinking process influences affect would help individuals and organizations determine how to maintain a creative atmosphere that facilitates the well-being of individuals within work groups. However, most research conducted in a laboratory setting has used only single-set individual tasks. In fact, a creative project possessed complexity, which is evoked by, such as, sequential tasks and group work. Since creative tasks performed in a group might expand the affective experience, and creative task performance often involves interspersing divergent and convergent thinking tasks in a specific order (Jaarsveld & Lachmann, 2017). The combination and order of the divergent and convergent tasks that go into a creative project may evoke positive or negative affect according to the way they intertwine. Likewise, this study is aimed at investigating how the order of divergent and convergent tasks as part of the creative process influences changes in the affective experiences of workgroup participants.

Hypotheses

The authors of the study assumed that affective experience would be influenced by the type of creative task and the order in which the tasks are performed. The group-related factors will be discussed as well.

A. *Influence of types of creative task on affective experiences*

Amabile et al. (2005) proposed ideas on how creativity influences affect. Because creativity is a work event, it could evoke affect in a way similar to other work events. For instance, a person might feel excited when discovering a unique idea and this would elevate a positive effect. Conversely, they might become overwhelmed by trying to decide on one of several proposals for implementing their idea, which may lead to having a negative effect. Divergent thinking is characterized by the ability to be flexible (Lewis & Lovatt, 2013), broad (Ashton-James & Chartrand, 2009), and holistic (DeYoung, Flanders, & Peterson, 2008) in one's thinking. It deals with ambiguity, and thus it draws on intuition and heuristic processing (DeYoung et al., 2008; Knörzer, Brünken, & Park, 2016). Likewise, a positive effect, which indicates a high level of pleasure/valence shows people's interest in a task (Knörzer, et al., 2016; Newton, 2013). It helps to generate new ideas by promoting flexible thinking (Yamada & Nagai, 2015). Accordingly, divergent thinking is aligned with the positive affect. Conversely, characteristics of convergent thinking are logical thinking, analytical, performing on a well-defined problem, and facilitating collaboration (Lewis & Lovatt, 2013; Ashton-James & Chartrand, 2009). This type of thinking is associated with negative affect and a narrowing attention focus (Knörzer et al., 2016; Newton, 2013).

Although the positive affect generally supports divergent thinking and the negative affect promotes convergent thinking, Akbari et al. (2012) noted that these patterns also work inversely. They argued that the human cognitive system has a self-optimizing system to handle tasks. Keeping a focused control state arise negative affect while defocusing control state is followed by positive affect. We assume that this control ability occurs in the interlace of divergent–convergent thinking as well, and thus will change affect level accordingly. Hence, we derive the following hypotheses:

- **H1a**. Divergent tasks change valence to positive while convergent tasks change valence to negative.

Furthermore, affective experience has another element related to urgency, namely, arousal (Zadra, & Clore, 2011). Chermahini and Hommel (2012) did not find any evidence to support that the different task types influence arousal. However, the concept of valence and thinking type mentioned earlier are mostly related to an individual task. Meanwhile, group work might behave differently in terms of the relationship between affect and cognitive processes. Arousal helps people to express their ideas especially when they are working as a team (Tsai, Chi, Grandey, & Fung, 2011). Imbir (2016) argued that arousal influences the heuristic cognition, which is associated with divergent thinking. Accordingly, we derived the following hypotheses:

- **H1b.** Divergent tasks increase arousal while convergent tasks decrease arousal.

B. *Influences of task order on affective experiences*

The changes in affects would not only be influenced by the types of tasks but also by the predecessor process. A former task might influence the control for conducting a later task. The earlier task may become a reference to change behavior to gain better performance (Håkonsson, Eskildsen, Argote, Mønster, Burton, & Obel, 2015). In other conditions, people may continue the former action they had known well regardless of the effect of the behavior on the further task (Albarracín, & Wyer Jr, 2000). Consequently, an affective state in the second process might be attached by the first process. Assuming that the first task was exempted from another cognitive task, we propose the following hypothesis:

- **H2.** Affect change after the first task is greater than affect change after the second task.

Methods

Participants

Twenty-two undergraduate and graduate students, (7 females, 15 males) enrolled in a design project-based course, participated as subjects. They had an average age of 24.23 years (SD = 2.91, range 21–35). The majority of the subjects identified themselves as Japanese (45%). Others were German (23%), Non-Japanese Asian (23%), and African (9%). Twenty of the subjects were master’s students, and two others were an exchange student and a research student. Sixty-eight percent of the subjects belonged to the Industrial Engineering department.

All students were assigned to one of four groups by the researchers based on their backgrounds and gender to create similar groups.

Research design (Class Context/ outline)

The course used intertwined divergent and convergent tasks as processes to create an innovative solution to a real-world problem. There were four classes that had a 2 x 4 combination of divergent and convergent tasks selected for the study. This composition allowed the researchers to conduct comparative studies between the type of task (divergent and convergent) as well as the task order (first and second). Fig. 1 illustrates the task combinations in each class.

The four classes conducted creative tasks with fixed group members. Likewise, each of the class meetings was preceded by a lecture class in a previous week to explain related concepts and practices.

In Class 1, students performed a synthesis task and a prioritizing theme task consecutively. In the synthesis task, students produced themes by combining similar information from the previous week's class. This task was followed by the prioritizing theme task in which students reviewed the themes they had produced in the previous task, and then they selected two or three of the most exciting themes to be prioritized. As the combining, organizing, and choosing in these tasks were convergent processes, these two tasks, for this class, were categorized as convergent.

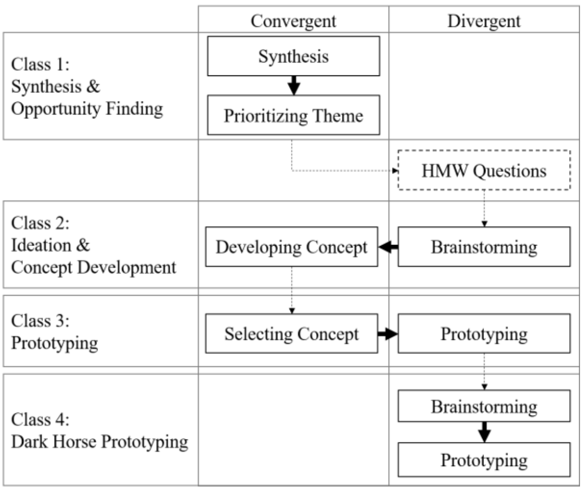

Fig. 1. Flow of creative tasks in design thinking.

Class 2 started with a brainstorming task. In this task, students elaborated ideas on the themes they had chosen in the previous class. Thus, this task was considered a divergent task. The second task of Class 2 was developing a concept starting with the three to five most interesting ideas from their brainstorming process. Each idea was described in a more detailed concept including the idea's definition, features, unique points, and its potential benefits. This process was demarcated as the convergent task.

Class 3 used the combination of a convergent task followed by a divergent task. It started with selecting one concept among three to five concepts students made in the previous class. Then it proceeded with creating a prototype to visualize the selected concept. Students were encouraged to develop the prototype quickly and spontaneously. This prototyping task was considered to be a divergent task.

Class 4 was assigned to change the concepts discussed in the previous class. Students were asked to create a new and fresh idea to produce an innovative solution. This class started with brainstorming, followed by dark-horse prototyping. The two tasks were regarded as divergent tasks.

Measurement

Affective states of the subjects in terms of valence and arousal were measured with the Self-Assessment Manikin scale (Bradley & Lang, 1994). The set of questionnaires consisted of two 9-point scales (valence:1 = negative, 9 = positive; arousal: 1 = low, 9 = high) using five pictures to represent level of valence and arousal.

Procedure

Subjects were asked to fill in the questionnaire three times in each of the four classes. In order to identify the subject while keeping the responses anonymous, participants were asked to write a unique trace code on the cover page of the questionnaire every time it was used throughout the study.

Subjects were asked to respond to the questionnaire just before the first task to get the initial affect data (Time 1). Then, students were instructed about their first task. It took less than 5 minutes to initiate the class and collect the data before the students moved on to the first task.

After performing the first task, which took 30 to 45 minutes, the students were asked to fill out the second questionnaire to measure their affect (Time 2). Then they listened to instructions about the second task. After students performed the second task, which took about 30 minutes, they were asked to complete the last questionnaire (Time 3).

Data Analysis

The comparison analysis using a series of paired t-tests identified the effect of task types and order on the subjects' affective experience. The affect level and change were used to determine the impact of task types. The order of affect was analyzed by using the affective distance data.

Results

Descriptive Statistics of Affect Scores

Table 1 summarizes the means and standard deviations of valence and arousal levels at three measurement times for each of the four classes. In Time 1, the affective levels were near neutral in almost all groups. Class 1 possessed the highest average valence score ($M = 6.05$)

and Class 3 had the lowest (M = 5.14). The highest average arousal score belonged to Class 4 (M = 4.91), and the lowest was for Class 3 (M = 4.00). The average valence and arousal scores were increasing in the second measurement time except for the average valence of Class 1 (M = 5.77) Both scores coincided with a convergent task. The highest average valence and arousal scores for Time 2 were in Class 2 (M = 6.05) and Class 4 (M = 6.00), respectively. Both scores coincided with a divergent task. The lowest average affective score for Time 2 was in Class 3 (valence = 5.33; arousal = 4.70) which coincided with a convergent task. In Time 3, the average affect scores increased in Class 1 (valence = 5.50; arousal = 4.95) where both tasks were convergent. Fig. 2 and Fig. 3 illustrate the average valence and arousal levels, respectively.

Fig. 4 shows the plots of average scores of valence and arousal. It illustrates the changes in affect over three measurement times in each class. Generally, after conducting the convergent process (i.e., Times 2 and 3 in Class 1, Time 2 in Class 3), affects remained around the neutral level. However, the subjects' affects shifted to more positive after the divergent tasks (e.g., Time 2 in Class 2). After performing the two consecutive convergent tasks in Class 1, the subjects' affect scores became more negative. The other three class meetings showed similar patterns.

Affective Level

Hypothesis 1 assumed that a divergent task would change the valence to positive and increase arousal levels while convergent works contrarily. Accordingly, the authors predicted that valence and arousal levels would be higher after a divergent task than after a convergent task. The affect levels for Time 2 and Time 3 were compared separately to avoid order bias.

TABLE I. COMPARISON OF AFFECTIVE LEVEL IN TIME 1, TIME 2, AND TIME 3 – PAIRED SAMPLE T-TEST

Class	**Affect State**	***n***	**Time 1**		**Time 2**		**Time 3**		**Comparison Time 2 vs. 1**		**Comparison Time 3 vs. 2**	
			Mean	***SD***	***Mean***	***SD***	***Mean***	***SD***	***t***	***p***	***t***	***p***
Class 1	Valence	22	6.05	1.40	5.77	1.60	5.50	1.87	-0.709	0.486	-1.142	0.266
	Arousal	22	4.77	1.69	5.36	1.79	4.95	2.10	1.846	0.079	-2.001	0.059
Class 2	Valence	21	5.57	1.54	6.05	1.47	6.43	1.54	1.173	0.255	1.504	0.148
	Arousal	21	4.14	1.65	5.38	1.83	5.76	1.64	2.994	**0.007**	1.321	0.202
Class 3	Valence	21	5.14	1.42	5.33	1.49	6.38	1.32	0.698	0.493	4.481	**0.000**
	Arousal	20	3.90	1.25	4.70	1.69	6.10	1.68	3.238	**0.004**	4.765	**0.000**
Class 4	Valence	22	5.73	1.24	5.95	1.43	6.27	1.61	0.738	0.469	1.322	0.200
	Arousal	22	4.91	2.14	6.00	1.54	6.36	1.56	2.982	**0.007**	1.789	0.088

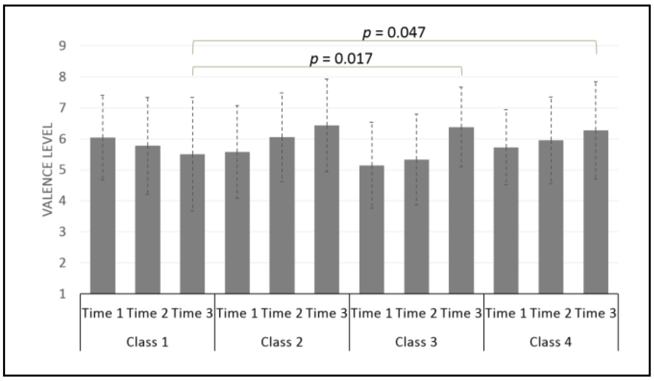

Fig. 2. Valence score and divergent-convergent task comparison

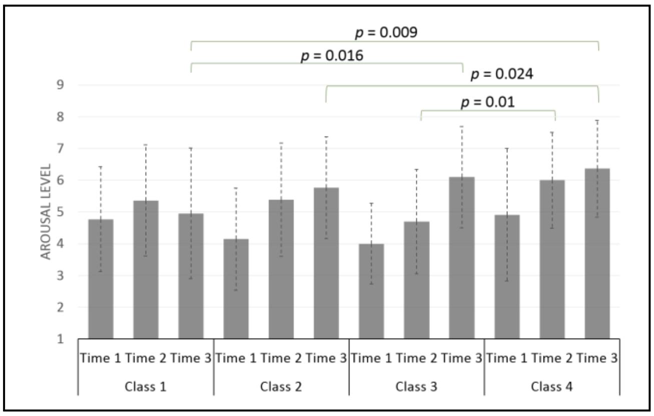

Fig. 3. Arousal score and divergent-convergent task comparison

A series of paired t-test for the second measurement time did not show any significant differences in affect levels between the divergent and convergent tasks except in the arousal level of Class 3 and Class 4. Fig. 3 shows that the arousal level after performing the convergent task in Class 3 (M = 4.70, SD = 1.69) was significantly lower than after performing the divergent task in Class 4(M = 5.90, SD =1.59; t (19) = -2.854, p < 0.01). Hence, this result supported H1b partially.

For the third measurement time, the paired t-test showed some significant differences in the affect levels between the convergent and divergent tasks. The valence level on the convergent task in Class 1 (M = 5.38, SD = 1.83) was significantly lower than the valence on the divergent task in Class 3 (M = 6.38, SD = 1.32; t (20) = 2.603, p < 0.05) and Class 4 (M = 6.27, SD = 1.61; t (21) = -2.112, p < 0.05). The arousal level on the convergent task in Class 1 (M = 4.81, SD = 2.04) was significantly lower than the arousal level on the divergent task in Class 3 (M = 6.10, SD = 1.64; t (20) = -2.63, p < 0.05) as well as in Class 4 (M = 6.36, SD = 1.56; t (21) = -2.87, p < 0.01). Likewise, the arousal level on the convergent task in Class 2 (M = 5.76, SD = 1.64) was lower than on the divergent task in class 4 (M = 6.38, SD = 1.60; t (20) = -2.444, p < 0.05). Thus, these results supported H1a and H1b partially, as shown in Fig. 2 and Fig. 3.

Affective Level Change

The affect level change was defined as the difference in the subjects' affective levels before and after a task, specifically between the first and second measurement for the first task, and between the second and third measurements for the second task. Referring to hypothesis 1, the authors assumed that the valence and arousal levels would change positively in the divergent task so that the level after the task would be higher than before the task. Conversely, the valence and arousal levels would change negatively in the convergent task. Thus, the levels after the task would be lower than before the task.

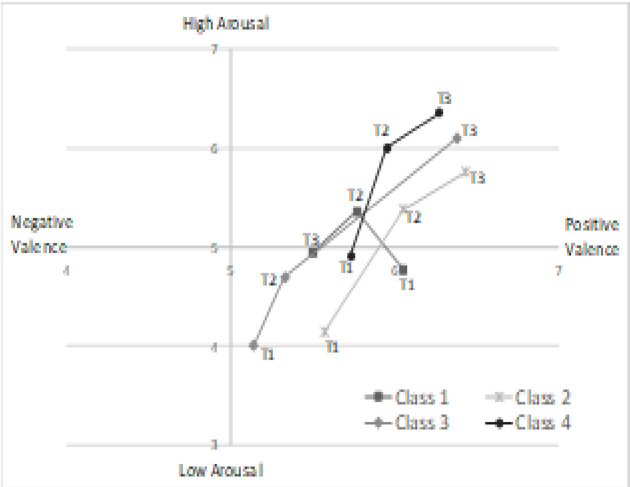

Fig. 4. Affect movement in valence-arousal plane

Table 1 summarizes the results of comparisons of the valence scores and arousal scores between measurements Time 2 and Time 1, as well as between measurements Time 3 and Time 2. As shown in Table 1, valence scores increased in all divergent tasks. A series of paired t-tests showed a significant change in valence in the divergent task in Class 3. In Class 3, the valence level after the divergent task (M = 6.38, SD = 1.32) was higher than before the divergent task (M = 5.33, SD = 1.49; t (20) = 4.48, p < 0.001). Moreover, even Class 2 contained the convergent task in the second process, the valence level after the second task (M = 6.43, SD = 1.54) was significantly higher than before the first task (M = 5.57, SD = 1.54; t (20) = 2.42, p < 0.05). The decrease of valence was observed only in the convergent–convergent combinations in the first class; however, the change was not statistically significant. Hence, these results partially supported H1a.

Likewise, paired t-tests revealed that arousal levels increased significantly after all divergent tasks. In class 2, the arousal level after the divergent task (M = 5.38, SD = 1.83) was higher than before the divergent task (M = 4.14, SD = 1.65; t (20) = 2.99, p < 0.01). In Class 3, the arousal level after the divergent task (M = 6.10, SD = 1.68) was higher than before the divergent task (M = 4.70, SD = 1.69; t (19) = 4.77, p < 0.001). In Class 4, where two divergent tasks were performed in sequence, the arousal level in Time 2 (M = 6.00, SD = 1.54) was higher than Time 1 (M = 4.91, SD = 2.14; t (21) = 2.982, p < 0.01). Meanwhile, even though not significantly higher than the arousal level in Time 2, the arousal level in Time 3 (M = 6.36, SD = 1.56) was significantly higher than in Time 1 (t (21) = 3.016, p < 0.01). Conversely, the decrease of the arousal level appeared in the second process of the convergent task in Class 1 was not statistically significant. Even Class 2 and 3 showed an increase in arousal level after the convergent task. Accordingly, H1b was partially supported.

Affect Distance Change

In order to quantify the extent of the change in the affective experiences, the concept of Euclidean distances was introduced. Change in individual affect was measured across a distance on the valence–arousal plane. As an example, Fig. depicts the scores for a student on the valance–arousal plane as Time 1 (valence = 7; arousal = 7), Time 2 (valence = 6; arousal = 5), and Time 3 (valence = 4; arousal = 3). The first Euclidean distance between Time 1 and Time 2 is calculated as 2.24 and the second distance between Time 3 and Time 2 is 2.83. The individual distance scores were averaged and compared as shown in Table 2.

Table 2 also summarizes the results in the paired t-tests comparing the affect distance between the first and second tasks. In Class 1, Class 2, and Class 4, the distances were significantly larger in the first task than in the second task. In Class 1, the first affect distance (M = 2.05, SD = 1.25) was larger than the second distance (M = 1.20, SD = 0.96; t (21) = 2.653, $p < 0.05$). In class 2, subjects’ affect distance for the first task (M = 2.61, SD = 1.31) was larger than for the second task (M = 1.46, SD = 1.09; t (20) = 2.70, $p < 0.05$). In Class 4, the first affect distance (M = 1.91, SD = 1.59) was larger than the second distance (M = 1.28, SD = 0.84; t (21) = 2.10, $p < 0.05$). These results support H2. Conversely, the convergent–divergent task combination in Class 3 showed the opposite, and the second distance appeared to be larger than the first, though the difference was not significant.

Additionally, we investigated the convergent–divergent intertwined task in Class 2 and Class 3. The distance of the first task in Class 2 was significantly greater than the distance of the first task in Class 3 (t (19) = 3.342, $p < 0.01$). The distances in the second task were not significantly different between Class 2 and Class 3. This result is supported hypothesis 1.

Discussion

The influence of task types on affective experience

This study revealed salient evidence that taking part in divergent thinking tasks tends to have positive valence for participants. Average valence scores were all higher after performing the divergent tasks in the study than they were before performing the task. The affect change was statistically significant after prototyping task in Class 3. Even though the change level of the positive affect in Class 4 was disguised, the dark-horse prototype ended with a higher valence level than the prioritizing theme and the prototyping task in Class 3. These results demonstrated the generality of a positive affect upswing (Akbari et al., 2012). Similarly, Håkonsson et al. (2015) argued that the positive affect was coincident with divergent thinking. However, their findings might indicate that people's satisfaction with the performance of their group will influence their affective experience during a creative task. Further research is needed to affirm this notion.

The influence of divergent tasks on affective experience includes increased arousal levels. Arousal was positively significant in all divergent task types except the dark-horse prototype. In addition, the arousal level after the dark-horse prototype was the highest for all the tasks, and it was significantly higher than after the prioritizing theme task. The project-based creative design activities invited more movement, which likely led to a rise in the arousal levels. Moreover, group work likely encouraged the subjects to communicate their thoughts.

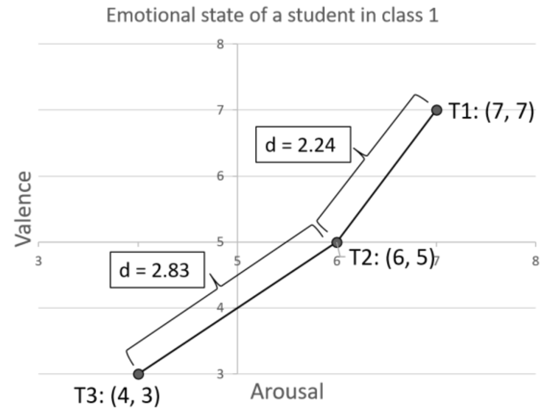

Fig. 5. Arousal score and divergent-convergent task comparison

TABLE II. COMPARISON OF AFFECT DISTANCE IN PROCESS 1 AND PROCESS 2– PAIRED SAMPLE T-TEST

Class	***n***	**First Process (Time 1 to Time 2)**		**Second Process (Time 2 to Time 3)**			
		Mean	***SD***	***Mean***	***SD***	***t***	***p***
Class 1	22	2.05	1.25	1.20	0.96	2.65	**0.015**
Class 2	21	2.61	1.32	1.46	1.09	2.70	**0.014**
Class 3	20	1.70	0.74	2.16	1.13	-1.66	0.113
Class 4	22	1.91	1.59	1.28	0.84	2.10	**0.048**

No correlation between the convergent tasks and affective experience appeared in this study. In Class 1, the average valence level gradually decreased after the subjects performed the two convergent tasks (i.e., synthesis and prioritizing theme). The average of the arousal level was increased slightly after the synthesis task, and then decreased after the prioritizing theme task. Meanwhile, in the classes that included divergent task types (i.e., Class 2 and Class 3), affect levels were increased evenly. While there were no significant negative affective experiences developed during the convergent tasks, the results showed that the affect changes during convergent tasks were not as significant as during the divergent tasks. This result is consistent with the findings of Amabile et al. (2005) that creativity, in general, evokes a positive effect. The incubation phase of creative output, defined as “a process of unconscious recombination of thought elements that were stimulated through conscious work at one point in time, resulting in novel and useful ideas at some later point in time,” might influence the positive affect even weeks after a creative project (Amabile et al., 2005).

Albarracín and Wyer (2000) addressed that the impact of previous cognitive activity would be reduced by interfering in this activity. It would suggest us to arrange the intercede method to shift one task into another in the creative flow. This should be further studied in future researches.

One interesting result was that the performance of the Class 3 divergent task (i.e., prototyping) yielded increased levels of both valence and arousal consistently. The consistency of a positive affect escalation may be due to the activity performed in this task. Subjects were equipped with various materials and working with all these materials might have fostered a sense of as well as fun. Moreover, the initial convergent task may have encouraged the subjects to perform the divergent task in a heightened state of arousal and appreciation because engaging in a selecting concept task helped to clarify what they were going to build in the prototype task. It is recommended that these phenomena be further investigated in future studies.

The influence of task order on affective experience

Subjects in the study exhibited greater affect change during their first task than during their second task. The difference was statistically significant in the convergent–convergent (Class 1), divergent–convergent (Class 2), and divergent–divergent (Class 4) task combinations. This result was consistent with the notion that the initial task made an impression on the completion of the second task. However, the convergent–divergent task set (Class 3) showed the opposite result. One possible explanation for this might be that the cognitive style of the second task (i.e., the divergent task) had a stronger influence on the affective experience than the cognitive style in the former task (i.e., the convergent task). This speculation offers a further point of inquiry for future investigations.

Conclusion

The current study presented two factors that may influence the affective experience in a group creative activity: the task type and the task order. The study results confirmed Akbari et al. (2012) assertion that divergent tasks swing affect to a positive level. This concept was proven not only in an ideation-like task (e.g., brainstorming), but also in prototyping tasks. Moreover, arousal emerged as one of the affective elements that increased by divergent thinking in group works. The changes in arousal were more evident than in valence. Meanwhile, this study showed less affect change in convergent tasks.

The first task influenced affective experience more than the second task in most of the classes. This finding might indicate that the first process in a sequential creative task is the most potent time to awaken affective experience. It gives us a high opportunity to set affect to what extent we plan to. Nevertheless, divergent thinking has more flexibility to enhance the affective experience.

We come to a better understanding of how sequential creative tasks influences affect. Having this knowledge might help us to arrange a work process or event (e.g., learning, training) to evoke people’s well-being.

We admit that conducting a real-case study might prevent us from uncovering the causality; thus, the vivid reason behind some phenomena could not be revealed. Hence, further research is needed to assist us in designing the affective creative flow.

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