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The Impact of Affect and Leadership on Group Creative Design Thinking

Khuria Amila[a] and Hiroyuki Umemuro[b]

[a]*Industrial Engineering and Economics, Tokyo Institute of Technology, Tokyo, Japan;* [b]*Industrial Engineering and Economics, Tokyo Institute of Technology, Tokyo, Japan*

*Corresponding author:
Hiroyuki Umemuro
Industrial Engineering and Economics
Tokyo Institute of Technology
Tokyo, Japan
Email address: umemuro.h.aa@m.titech.ac.jp

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Abstract— The relationship between affect and creative performance in a practical group project environment is poorly understood. The role of leadership in creativity is also often neglected. The present study examines how the affective aspects of group members and emergent leadership influence the creative group performance of tasks. This empirical research engaged the participation of 17 graduate students of a graduate course on design thinking in an engineering school of a university. Data were collected over the course of five class meetings during which the participating students accomplished the performance of seven tasks and shared their perceptions with regard to the affect and leadership aspects of the achievement of the assigned work. The results showed coherence between the performance of diverse tasks and the emotions of participants, especially in terms of the psychological state of arousal. Meanwhile, task-oriented leadership was found to be positively correlated with valence in the storytelling task and with performance in most of the convergent tasks. This study accords a deeper understanding of the ways in which creative group work differs from individual creative effort in relation to affects. It also reveals the importance of leadership in creative group work.

Keywords: valence, arousal, emergent leadership, divergent thinking, convergent thinking

Introduction

Creativity is regarded mandatory in our everyday lives. People are always asking for something fresh and new and seeking joy in every aspect of life. Therefore, the designers who formulate a service or product need creativity not just to win competitions but also to sustain their existence. However, creativity cannot necessarily be stimulated as required; it mandates requires a supportive environment (Brown, 2009).

Within the work system, a designer is often a part of a team that grows innovative ideas (Tsai, Chi, Grandey, & Fung, 2011). Both teamwork and originality are challenges that may confound a designer's emotions. Norros (2014) mentions that the human factor must also be factored into the management of a design process. Understanding the emotional attribute of designing and learning how to drive it can help support creative performance.

The emotional state appropriate for innovation is debatable. Numerous researchers have identified that positive emotions such as happiness and enjoyment serve creativity (e.g., Yamada & Nagai, 2015). However, several researchers have disputed this assertion and have found conflicting results (e.g., Kaufmann, 2003). While positive emotions could be useful in generating ideas (divergent thinking), they may confound decision making (convergent thinking). On the other hand, De Dreu, Baas, and Nijstad (2008) have demonstrated that the activation level is linked to more creativity. The elucidation of the relationship between various emotions and creative processes, especially in a group, requires in-depth investigation. A superior understanding of the affect states that support creative processes may assist in a better organization of a creative environment.

The performance of group work is another measure that can be taken to improve creative output. Brown (2009) has noted that a creative group should not be asked to pursue efficiency as its primary function because the focus on performance may hold back the release of ideas. Therefore, it is unnecessary to assign a team leader to maintain the diversity and equality in a team. However, Williams and Yang (1999) claim that the existence of a good leader is as necessary to foster creativity by providing a free environment. A leader can manage group emotions (Humphrey, 2002) and can help to maintain a cooperative and collaborative climate. The emergent leader who arises unavoidably might be able to promote a creative work atmosphere and may thus increase the group's creative performance. However, the extent to which the emergence of a leader supports (or conversely, prevents) creative performance is not yet clarified.

Research conducted on an actual project may provide insights into the varied processes faced by a designer. The discrete activities of divergent and convergent thinking can be observed. Thus, the relationship between affect, leadership, and creativity may be examined more thoroughly as opposed to the observation of a single conventional creative task such as brainstorming. The present study thus investigated the role of affect and emergent leadership on a creative design project. For every task that was accomplished, a comparison of the performance of the groups was affected along with the affect state and leadership perception of the group members. The results of the comparison were assessed to ascertain how affect and leadership influenced creativity.

Theoretical Background and Hypotheses

Divergent-Convergent Thinking in Creativity

Two primary processes are conducted in creative design. Although these may work separately, they interlace in the creative process. The first is divergent thinking, a necessary process for an ill-defined condition (Jaarsveld & Lachmann, 2017). Divergent thinking involves the ability to search broadly for information problems (Sternberg & O'Hara; Ashton-James, & Chartrand, 2009; Lee & Therriault, 2013) and it is aligned with defocused thought, the default mode of a brain network. Therefore, it yields spontaneous and self-generated cognition (Jaarsveld & Lachmann, 2017) with minimum effort)Runco, 2010). Divergent thinking is characterized through flexible (Lewis & Lovatt, 2013), intuitive, fluent, and holistic expressions (De Young, Flanders, & Peterson, 2008). It is similar to associative thinking (De Young et al., 2008) and heuristic processing (Kno¨rzer, Bru¨nken, & Park, 2016).

The second process is convergent thinking, which is performed for a well-defined problem (De Young et al., 2008). Convergent thinking operates in focused or analytic modes of thought and yields improvement, change, and restriction (Jaarsveld & Lachmann, 2017). The process runs linearly, logically, and systematically, applying rules toward a solution (Lee & Therriault, 2013; De Young et al., 2008). It looks for similarities, patterns, and associations in information (Ashton-James & Chartrand, 2009).

Divergent thinking outcomes become material for the convergent thinking process and vice versa. Thus, distinguishing a task as resulting from either divergent or convergent thinking is involute (Jaarsveld & Lachmann, 2017). Convergent thinking helps in restructuring problems by determining defects and verifying initial or new formulations, while divergent thinking functions to discover the elements and structure of new formulations (De Young et al., 2008). For the purposes of this study, divergent tasks refer to assignments that required more divergent thinking traits, and convergent tasks indicate those that demand a greater involvement of convergent thinking features.

Group Emotion in Creative Process

Focusing on the process of group project design, the current research used group emotions to assert the group's general mental state interchangeably with affect and mood. Group emotion is a combination of the affective states of the team members, which can then re-affect the emotions of individual members (Kelly & Barsade, 2001). Group emotion can be measured by averaging the emotional perceptions of individual members (Bartel & Saavedra, 2000). Forgas (1995) noted that emotions influence judgment mostly in two conditions: in devising solutions, a task associated with convergent thinking; and in dealing with quick, global, and simplified decisions that are assumed to involve divergent thinking. Both conditions are supported by different emotions (Collins, Lawrence, Troth, & Jordan, 2013) and may be influenced by pleasure (valence) or activation (stimulation) levels.

Valence indicates an emotional state that ranges from positive (pleased) to negative (displeased). People with positive emotions have broadened scopes of attention and spend less time fixating on information (Kno¨rzer et al., 2016; Newton, 2013). Positive emotions encourage flexible thinking and thus help generate new, unconventional, and atypical ideas (Yamada & Nagai, 2015). People with positive emotions tend to create many solutions (Newton, 2013; Politis & Houtz, 2015). Therefore, positive emotion is generally associated with divergent thinking.

However, the above notion might not apply consistently to group work. In a group task, an individual is constrained to share something that other people may not understand or appreciate)Runco, 2010). Discrete ideas can lead to the minimizing of mimicry and threaten group harmony (Ashton-James & Chartrand, 2009). Also, positive group emotions denote a comfortable atmosphere within which ideas may be developed. Therefore, according to Collins et al. (2013), none of the members hesitate to offer their thoughts.

On the other hand, positive emotions can suppress convergent thinking (Kno¨rzer et al., 2016). When people are in a positive mood, they tend to make rash judgments, are less critical, and commit more errors (Politis & Houtz, 2015). Conversely, negative emotions may facilitate a more profound understanding through narrowed attention (Kno¨rzer et al., 2016). The fact that people spend a longer time on relevant information when they are in a negative emotional state may imply that displeasing affects accompany cognitive activity and analytic processing that is careful, systematic, persistent, and concerned with details to produce a well-contemplated solution (Kno¨rzer et al., 2016; Newton, 2013). Collins et al. (2013) claim that this concept is also applicable to group work. Members who are relatively charged with negative emotions would form a group that is more focused on the best performance of a convergent task.

In psychological terminology, the state of arousal denotes an excited-calm feeling, or an alertness to information with regard to importance or urgency (Zadra & Clore, 2011). The arousal rate ranges from high to low and guides attention so that people tend to be drawn to objects that are stimulating. Since the 1900s, researchers have investigated the role of arousal in learning and motivation. The Yerkes-Dodson law (Teigen, 1994) is a well-known theory that depicts performance as forming a curvilinear line along with the escalation of arousal (Broadhurst, 1959).

The level of arousal has been associated with other variables such as task difficulty, complexity, and novelty (Teigen, 1994). These variables are known to be challenges for creative work. The duality of mind conceptualized by Imbir (2016) assumes that increase in arousal would improve performance in a heuristic cognitive process, while a decrease in arousal would be beneficial for a rational mind, later resulting in the higher performance of the systematic cognitive process. This notion is also supported by Finch, Peacock, Lazdowski, and Hwang (2015). They researched a business course with more convergent tasks and found that better-performing students could regulate their emotions to balance of positive-negative affects with a lower emotional tone. In congruence with the Yerkes-Dodson law, Newton (2013) asserts that the capacity for complex thought increases with the arousal level, but only up to a point, after which the intensification of arousal takes mental resources away from the task. Imbir (2016) proposes that maximum performance is associated with moderate (but rather high) arousal.

Emergent Leadership to Manage Group Emotion

Emergent leaders are one or several group members who influence the initiative of other members and provide value for a team (Pescosolido, 2005). Such leaders have no formal power to punish or reward group members. They tend to persuade and to provide examples rather than to order. Pescosolido (2005) states that emergent leaders often appear in ambiguous situations. They control a group's emotion and influence the interpretations made by group members and direct their reactions to events. Generally, leaders exhibit two approaches in controlling their groups (Northouse, 2016). The first involves setting a group's goal, developing strategies, and giving feedback on performance using their knowledge and experience. This tactic is used by task-oriented leaders (TOLs). TOLs offer ideas, opinions, and information, and manage team progress by questioning, confirming, and collecting suggestions (Schneier, 1978). Therefore, they perform best in highly structured tasks (Pescosolido, 2005). TOLs often neglect the effects of their group members and may even seem harsh in their desire to accomplish their goals, but overall, they are respected by their group members (Fiedler & Chemers, 1984). Hence, TOLs tend to maintain an emotionally neutral (Humphrey, 2002).

The second approach to leadership involves building trust with regard to the feelings of other group members and unifying the group (Pescosolido, 2005). This method is supported by the leader's ability to express emotion, to understand the emotions of others, and to persuade. These traits are witnessed in relationship-oriented leaders (ROLs). They extend support, offer friendly advice, and are cheerful and accepting. They demonstrate emotions, they are domineering, and they offer criticism (Schneier, 1978). Pescosolido (2005) notes that ROLs function best in unstructured tasks. They encourage group members to participate in decision making and to offer new ideas or different methodologies. They like developing good personal relationships with others (Fiedler & Chemers, 1984). The ROL, in general, displays positive emotions (Cogliser, Gardner, Gavin, & Broberg, 2012).

Hypotheses

This study aimed to investigate the associations between group emotions, emergent leadership, and creative design performance. As discussed above, emotions may support the creative process. Researchers have claimed that the attribute of positive emotion is consistent with divergent thinking while the tendency toward negative emotions is suitable for convergent thinking. Since group emotions represent the contagion of the effect of the group's members, a group evincing positive emotions would represent the characteristics of a positive emotion thinker and support divergent tasks. Conversely, negative group emotions would promote deep and systematic thought processes and thus support convergent tasks. Positive group emotions may also represent a pleasurable environment in which ideas can be shared, while negative group emotions would reflect a narrow focus atmosphere which is conducive to problem solving. Therefore, the following hypotheses are derived:

- H1a. A group with positive emotions achieves higher divergent task performance than a group with negative emotions.
- H1b. A group with negative emotions achieves higher convergent task performance than a group with positive emotions.
- Similar assumptions can be applied for the psychological state of arousal. , The following hypotheses are proposed with reference to the Yerkes-Dodson law:
- H1c. A group with moderate-high arousal achieves higher divergent task performance than a group with low arousal.
- H1d. A group with moderate-low arousal achieves higher convergent task performance than a group with high arousal.

Finally, it is assumed that task-oriented and relation-oriented emergent leaders manage group emotions differently in supporting creative performance. According to their character traits, ROLs are more likely to possess the ability to touch the emotions of a group. They support a low-task structure, which is presumed to approximate divergent tasks. On the other hand, TOLs should wield more control over convergent tasks. Therefore, the following hypotheses are posited:

- H2a. The existence of an emergent leader evincing a relationship-oriented style generates more positive group emotions than an emergent leader who displays a task-oriented style.
- H2b. The existence of an emergent leader who exhibits a relationship-oriented style generates higher group arousal than an emergent leader who expresses a task-oriented style.

Method

Study Context and Participants

This study was conducted with graduate majors in Industrial Engineering and Economics enrolled in a design thinking course at the Tokyo Institute of Technology. The course purposed to impart the design thinking concept and to apply it to actual problems. Practical problem solving was executed in groups. This course was deemed to represent creative design at work and was hence considered suitable for the enhancement of the researchers' understanding of group emotions in the real design process.

Seventeen students enrolled in the course (11 males and 6 females, average age = 23) participated voluntarily in this study. Seven of the students were Japanese, while the others belonged to Denmark, Thailand, Switzerland, Iran, Taiwan, Germany, China, Mexico, and India. The students were divided into four groups of 4–5 students each in an effort to maximize diversity in each group. Two students did not consistently respond to the measurement instrument, so they were excluded from all analyses. The participating students worked as a group for one semester (15 weeks). A design topic was announced at the beginning of the semester and the groups were directed to follow the phases of design thinking to the postulation of a solution for their design topic. Fig. 1 illustrates the flow of phases followed in the design thinking course: design research, synthesis and opportunity area, ideation and concept development, prototyping, business design, dark horse prototyping (DHP), and storytelling. Each phase lasted at least two weeks. During each of the two weeks of a particular stage, students learned the concepts and methods in the first week and subsequently applied the theory in group tasks the following week.

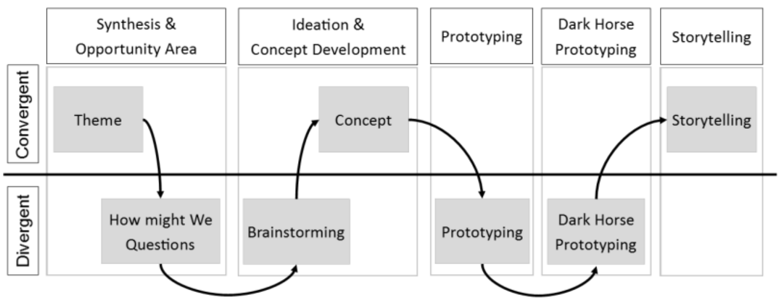

Fig. 1. The flow of the design thinking class.

As stepping stones, each phase mandated the completion of one or two tasks. In the design research phase, students were challenged to uncover interesting insights from people, a service, or an environment. They were asked to collect information through interviews and observation.

The synthesis and opportunity-area stage produced two outcomes: theme, and how-might-we-question (HMWQ). A theme was obtained by synthesizing information similar to the knowledge accrued in design research. HMWQ represented the inference of interesting problems from themes that accorded the opportunity of proposing solutions to design topics.

The period of ideation and the concept development demanded the accomplishment of brainstorming and concept-oriented tasks. Students selected two to three HMWQ and elaborated their ideas as a group. The three most interesting ideas were chosen, and each of the three ideas was developed as a concept.

In the prototyping segment, each concept was visualized as a sample to facilitate the communication of the students with potential users so that their concepts could be improved. The participants were also asked to evaluate the feasibility of their improved concept in the business-design phase. The DHP phase was added to stimulate their ideas to challenge their previous concepts. In the final phase of storytelling, each group prepared a two-minute video to communicate their proposed product or service.

Measurement

1) Group Emotion

The valences and arousal levels of the students were measured using the Self-Assessment Manikin (SAM) (Bradley & Lang, 1994). Students were asked to think of the time they spent performing a task (e.g., one week for ideation and concept development), and to evaluate their emotions at that time on a 9-point scale (valence: 1 = negative, 9 = positive; arousal: 1 = low arousal, 9 = high arousal). Group emotion scores were subsequently obtained as the averages of the valence and arousal scores across members of a group. Internal consistencies, computed for the individual score and the average score, were found to be adequate (valence $\alpha = 0.62$; arousal $\alpha = 0.80$).

2) Task Performance

The measurement of divergent tasks was adopted from Silvia, Beaty, and Nusbaum (2013). The subscales were uncommon, remote, and cleverness. Uncommon indicate work that occurred infrequently in relation to other tasks. Remote implied work that was distantly linked to everyday objects or ideas. Cleverness denoted work in which people were insightful, ironic, humorous, fitting, or smart. Three to five statement items for each subscale were developed and were customized for every assigned task. For example, “This question is similar to other questions” was used to measure uncommon in the synthesis and opportunity-area phase. “This prototype has never existed before” was posited to assess remoteness in prototyping. “This question is challenging” was used to measure cleverness in HMWQ.

Mednick (1962) indicated that creative solutions may be achieved through associative thinking using the features of similarity, serendipity, or mediation. Similarity assumes that work is associative if it has like elements or comparable stimuli that expose the elements. Serendipity considers work to be associative if solutions occur accidentally through contiguous environmental appearance. Mediation regards work to be associative if it is evoked through mediation, connection, or via a linking of common elements. These three associative factors were adopted as subscales to examine convergent tasks. One to five statement items were developed for each subscale adopted in each task. “This concept was derived from some ideas that came up during brainstorming” is an example of a similarity statement in the concept-development phase.

Subjective ratings that have been widely used in assessing creative products were applied (Silvia et al., 2008). Five teaching assistants assessed divergent and convergent task outcomes for all the design thinking phases. They independently evaluated each outcome for each group. Each result was evaluated according to the divergent or convergent subscale item discussed above on a five-point Likert scale (1 = highly disagree, 5 = highly agree). The average scores of the five raters were considered to be the final performance score. The interclass correlation coefficient, which is coincident with Cronbach's alpha, was measured to assess agreement across raters. The alpha of the divergent subscale indicated good internal consistency for uncommonness (.82) and cleverness (.90) and minimally adequate reliability for remoteness (.62). The alpha of the convergent subscale was .76 for similarity and .80 for serendipity, which indicated reasonable internal consistency and reliability. However, the .44 alpha for mediation denoted poor reliability.

3) Leadership style

Northouse’s (2016) leadership behavior questionnaire was adopted to ascertain the behavioral style of leadership as described above through twenty question items: ten odd-numbered items indicated TOL and ten even-numbered items were used to designate ROL. Five-point scales were used for this instrument (1 = never, 2 = seldom, 3 = occasionally, 4 = often, and 5 = always). Internal consistency was $\alpha = 0.939$ for TOL and $\alpha = 0.896$ for ROL.

Procedure

The current study focused on creative tasks conducted in groups. Design research and business-design assignments were excluded from this investigation. Design research was performed individually, and it was thus not representative of group work. The business-design component was only imparted in this class theoretically through a lecture and was taught in more detail in other modules. Therefore, this study encompassed five phases and seven tasks as shown in Fig. 1.

The tasks were categorized according to their nature into either divergent or convergent thinking. The HMWQ, brainstorming, prototyping, and DHP were assumed to be divergent tasks. All these tasks expected uniqueness, reproduction, and multiple outputs to create choices within a limited time. On the other hand, theme, concept, and storytelling involved organizing, analyzing, and choosing how to approach the solution and were thus deemed to be convergent tasks.

At the end of each phase, participants were asked to complete questionnaires to assess the valence and arousal of their own emotions, and to record their subjective evaluation of the emergent leadership in their group. Each student received a form that contained the SAM and leadership questionnaire, along with a group name and user code. The group name was necessary to relate the obtained data to a particular group, while the user code was used to ensure data continuity. Raters evaluated the outcomes of each of the divergent or convergent tasks on rating sheets that were provided to them.

Result

Descriptive Statistics

Table I summarizes the means and standard deviations (in parentheses) of affect in the groups (valence and arousal), their leadership perception (TOL and ROL), and their performances. The overall group valence scores were neutral to positive both for the divergent and the convergent tasks. The valence level changed vigorously. Group 1 and 3 experienced an emotional fluctuations more than the other two groups. The valence level of Group 2 increased over time. Arousal levels in all phases unfolded from low to high. Group 1 and 4 were more aroused than the other two groups. The overall emergence of TOL was moderately low (M = 33.37), while the emergence of ROL was moderately high (M = 37.24). Group 2 and 4 consistently reported higher emergent leader scores. Group 2 exhibited the highest TOL score in all the phases. Finally, all groups showed similar performance scores in both divergent and convergent tasks and no one group was dominant.

Emotion and Performance

Emotions and their relation to the performance of creative tasks were analyzed in three steps: first, grouped data were examined via simple comparison; the subsequent two steps were taken to obtain statistical evidence. Due to the small amount of data, statistical analyses were conducted at the individual level instead of at the group level. The second step examined the correlation between emotions and performance. The last step investigated whether the emotional level significantly differed between high- and low-performance groups.

1) Simple comparison of emotion and performance

As demonstrated in Table I, typical patterns of emotion-divergent and emotion-convergent relationships were unrevealed. Therefore, a simple comparison was conducted in each phase as follows:

The synthesis and opportunity-area stage contained two tasks: it began with the formation of themes, which was considered to be a convergent task, followed by the generation of HMWQs, which was regarded to be a divergent task. The ranking of groups based on the valence level from the most positive to the most negative was: Group 1 (7.00), Group 4 (6.50), Group 2 (6.00), and Group 3 (5.25). This order was congruent to the number of divergent outputs. Group 1 produced the most (6), while Group 3 produced the least (2). However, qualitatively, a contrary relationship was found between this valence order and divergent performance. Group 3 obtained the highest divergent performance score (3.60) while Group 1 earned the lowest score (3.17).

Fig. 2 represents the plotting of the convergent performance scores of the synthesis (theme) phase and the valence scores, while Fig. 3 depicts the plotting of the HMWQ divergent scores and the valence scores. The theme scores increased along with the valence scores while the HMWQ scores decreased. The obtained result was contrary to H1a and H1b, which assumed that a positive emotional state would increase divergent performance while a negative affect would decrease convergent performance. Hence, the findings from this phase did not support these hypotheses.

The ideation and concept-development stage also comprised two tasks. The phase began with the divergent task of brainstorming and ended with the convergent task of developing a concept. Group 3 scored highest for positive emotion (7.33), followed by Group 4 (7.00), Group 1 (6.67), and Group 2 (6.00). This order was contrary to the concept-development score where Group 2 was the highest (3.90), and Group 3 was the lowest (3.22). Fig. 4 displays the plot of the concept-development score vs. valence, where the trend line for scores declines with increasing valence. This result supports H1b, which assumed that a rise in valence would result in a decrease in the convergent score.

The arousal order for this second phase ranked Group 4 (7.33) at the top followed by Group 1 (7.00), Group 3 (4.67), and Group 2 (3.67). This order is aligned with the brainstorming scores: Group 4 (3.69) and Group 1 (3.74) surpassed Group 3 (3.33) and Group 2 (3.27). Fig. 5 shows the plot of the brainstorming score vs. group arousal. The divergent scores are positively related to arousal. This result supports H1c, which assumed increasing arousal would amplify the divergent score.

TABLE I. MEANS AND STANDARD DEVIATIONS (IN PARENTHESES) OF VALANCE, AROUSAL, RELATION-ORIENTED LEADERSHIP (ROL), TASK-ORIENTED LEADERSHIP (TOL), AND PERFORMANCE SCORES BY PHASES AND GROUPS.

Group	*n*	valence	arousal	ROL	TOL	Divergent performance					Convergent performance				
						i	Overall	Uncom-mon	Remote	Clever-ness	*i*	Overall	Similar-ity	Seren-dipity	Media-tion
Phase 1						Opportunity Area (HMWQ)					Synthesis (Theme)				
1	4	7.00 (1.23)	6.00 (0.71)	36.3 (5.9)	26.5 (5.9)	6	3.17 (0.47)	3.44 (0.38)	2.58 (0.48)	3.49 (0.61)	7	3.34 (0.22)	3.75 (0.39)	2.46 (0.42)	3.80 (0.29)
2	3	6.00 (1.41)	3.67 (0.47)	40.3 (2.9)	41.7 (3.1)	4	3.28 (0.28)	3.70 (0.35)	2.68 (0.25)	3.47 (0.32)	5	3.28 (0.06)	3.82 (0.62)	2.20 (0.79)	3.82 (0.31)
3	4	5.25 (1.09)	5.25 (2.49)	33.0 (6.3)	30.6 (9.3)	2	3.60 (0.26)	3.87 (0.20)	3.17 (0.23)	3.76 (0.36)	6	3.03 (0.38)	2.93 (0.58)	2.83 (0.72)	3.32 (0.52)
4	4	6.50 (1.50)	6.75 (0.43)	39.8 (1.5)	36.0 (0.7)	-	-	-	-	-	9	3.34 (0.28)	3.66 (0.78)	2.42 (0.51)	3.93 (0.25)
Phase 2						Ideation (Brainstorming)					Concept Development				
1	3	6.67	7.00	37.7	26.0	3	3.74	3.80	3.50	3.93	1	3.79	3.70	3.4	4.27

		(1.25)	(0.82)	(9.9)	(5.9)		(0.12)	(0.25)	(0.33)	(0.12)				0	
2	3	6.00	3.67	37.0	38.7	3	3.27	2.98	3.07	3.67	2	3.90	4.05	3.53	4.13
		(0.82)	(0.94)	(1.4)	(3.8)		(0.04)	(0.08)	(0.10)	(0.04)		(0.13)	(0.05)	(0.28)	(0.07)
3	3	7.33	4.67	31.7	23.3	3	3.33	3.33	3.33	3.32	1	3.22	3.10	3.35	3.20
4	3	(0.47)	(0.47)	(5.4)	(3.4)	3	(0.13)	(0.43)	(0.13)	(0.16)	1	3.59	3.90	3.3	3.53
		7.00	7.33	42.0	37.7		3.69	3.78	3.38	3.89				5	
		(0.82)	(0.47)	(2.8)	(4.1)		(0.04)	(0.22)	(0.17)	(0.04)					
Phase 3						Prototyping									
1	4	8.00	5.75	35.8	28.3	2	3.94	4.00	3.63	4.20					
2	2	(0.00)	(2.28)	(6.2)	(5.4)	2	(0.05)	(0.07)	(0.03)	(0.12)					
3	4	6.50	4.50	42.0	41.5	1	3.68	3.77	3.40	3.88					
4	3	(1.50)	(1.50)	(2.0)	(2.5)	1	(0.24)	(0.23)	(0.25)	(0.24)					
		5.25	5.50	32.8	28.8		3.47	3.67	2.95	3.80					
		(1.48)	(0.50)	(4.2)	(5.1)										
		6.33	7.00	40.7	38.0		4.04	4.47	3.70	3.96					
		(2.49)	(0.00)	(3.7)	(3.6)										
Phase 4						Dark Horse Prototyping									
1	4	5.75	4.50	34.8	21.0	1	4.22	4.20	4.10	4.36					
2	3	(2.28)	(2.06)	(8.0)	(7.8)	1	3.89	4.13	3.45	4.08					
3	3	6.67	3.67	42.7	41.7	1	4.31	4.73	4.05	4.16					
4	3	(0.94)	(0.47)	(2.6)	(5.8)	1	4.34	4.67	4.00	4.36					
		6.00	3.67	26.7	25.7										
		(1.41)	(0.47)	(7.6)	(4.2)										
		7.33	6.67	41.3	40.3										
		(0.47)	(1.25)	(3.9)	(2.1)										
Phase 5											Storytelling				
1	3	7.67	7.67	39.7	37.3						1	4.04	4.35	3.8	3.96
		(1.25)	(0.94)	(3.9)	(3.4)									0	
2	3	7.67	4.67	43.7	44.7						1	3.76	3.55	3.6	4.12
		(0.47)	(1.25)	(0.9)	(3.3)									0	
3	4	5.25	3.50	28.8	28.8						1	3.97	4.35	3.8	3.76
		(1.09)	(2.18)	(7.2)	(6.5)									0	
4	4	6.75	6.75	44.3	40.8						1	4.09	4.45	3.8	3.96
		(1.48)	(1.64)	(2.9)	(2.1)									7	

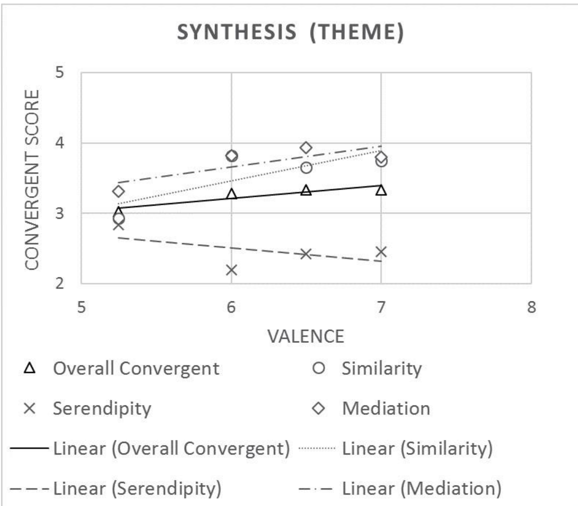

Fig. 2. Group valence and convergent performance in the synthesis phase.

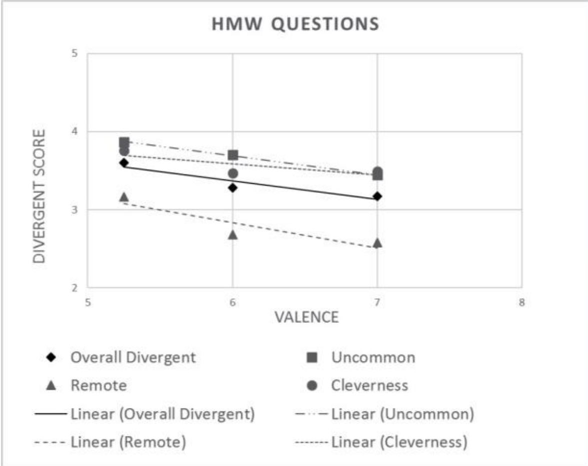

Fig. 3. Group valence and divergent performance in the opportunity-area (HMWQ) phase.

In the prototyping phase, Group 4 obtained the highest overall divergent score (4.04) as well as the highest arousal score (7.00). Group 1, as the second most stimulated group (5.75), earned the second highest overall divergent score (3.94). The overall divergent score was aligned with the uncommonness and remoteness scores. Thus, this result supports H1c. Moreover, Group 1, with the highest valence (8.00), concurrently achieved the highest cleverness score (4.20). The cleverness/valence score relationship confirmed H1a. Fig. 6 shows the plotting of the prototyping score vs. group valence. Fig. 6 illustrates that all divergent subscale scores configure a positive trend line to the valence score.

The arousal order for this phase was aligned with the cleverness score in DHP. The highest cleverness score was accorded to Groups 1 and 4, the two most aroused groups. This result partially supported H1c. The last phase, storytelling, did not evidence any support for H1b and H1d. The data did not reveal that the emotion and convergent scores were negatively linked. Fig. 7 depicts the plot of the storytelling score against group arousal. Fig. 7 displays the slightly positive trend of the convergent score in relation to arousal.

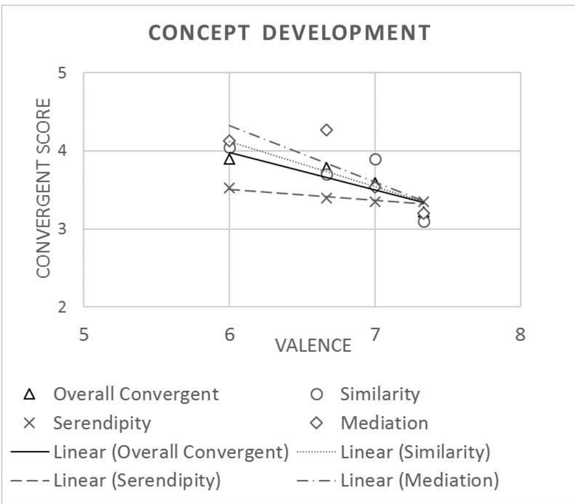

Fig. 4. Group valence and convergent performance in the concept-development phase.

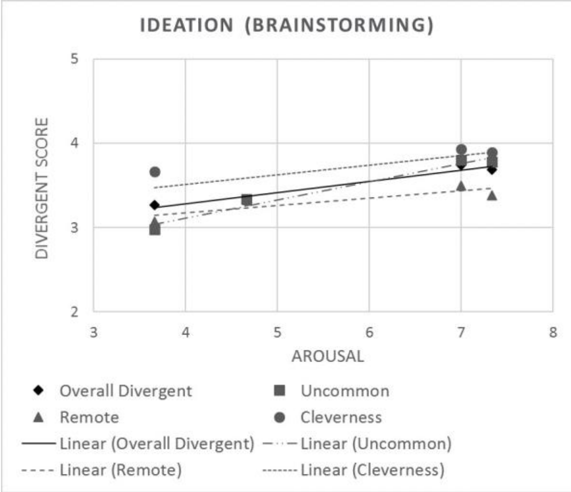

Fig. 5. Group arousal and divergent performance in the ideation phase.

2) Emotion and Performance Correlation:

Individual performance scores were assigned based on group performance scores under the assumption that each member contributed equally to the group. In addition to the mean performance score, the best performance score was also considered for the performance subscales in the subsequent statistical analysis. Skewness statistics indicated that the best mediation violated the normality assumption (−1.013). Even more, this study performed non-parametric correlation analysis taking into consideration the small sample size.

Table II summarizes the Spearman rho correlation results between individual affective scores and divergent performance scores. The positive correlation between valence and cleverness was significant in the prototyping. This result partially supported H1a, which predicted the positive correlation between valence and divergent performance.

H1c envisaged a positive correlation between arousal and divergent scores. Table II demonstrates that arousal scores were significantly correlated with the divergent score in all subscales of brainstorming. Likewise, arousal significantly correlated with uncommonness and mean remoteness at the prototyping stage.

No evidence was found to support H1b and H1d, which expected negative correlation between the convergent and affect scores. The negative correlation between all convergent subscales and valence was not significant for concept development. On the contrary, significant positive correlation was found between valence and mediation at the storytelling stage. Significant positive correlation also existed between the arousal and the best convergent score for synthesis and storytelling.

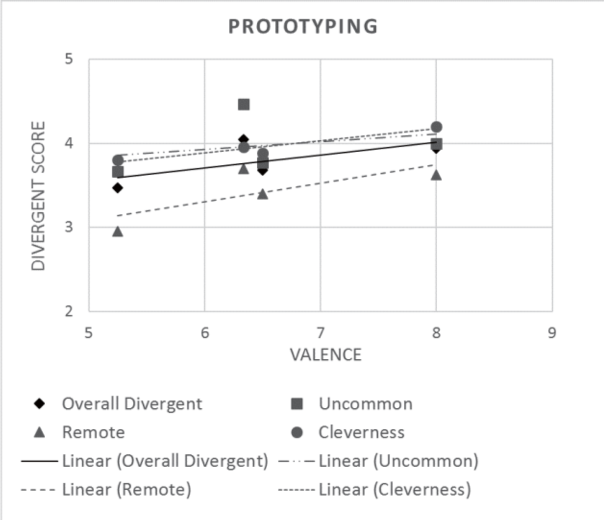

Fig. 6. Group valence and performance at the prototyping phase

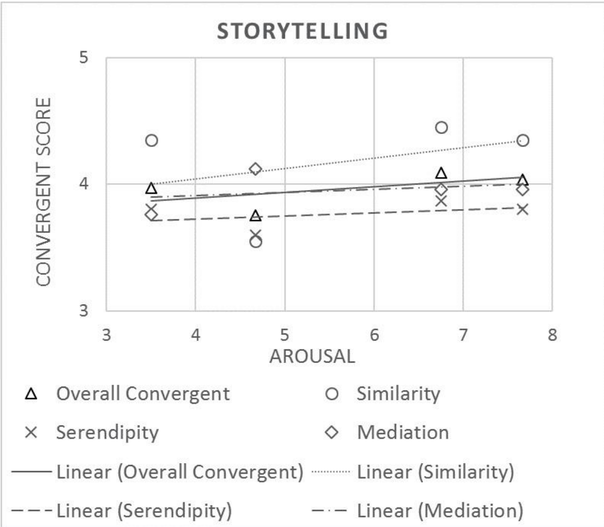

Fig. 7. Group arousal and convergent performance at thestorytelling phase.

3) Emotion and Performance Comparison (Mann-Whitney U Test)

Performance scores between high- and low-scoring groups in terms of affect were compared using a series of Mann-Whitney U tests to examine whether differences in affect scores yielded differences in convergent or divergent performance scores. Samples were divided into high- and low-scoring groups according to the valence and arousal tallies. The split points were adjusted according to the hypothesis. For H1a, where the valence levels compared were more positive and more negative, the mean of valence in the divergent task was used ($\mu = 6.45$). A similar split point was also used for H1b ($\mu = 6.54$). Thus, samples with valence ≥ 7 were compared to those with valence < 7 to test H1a and H1b. Conversely, for H1c, where the arousal levels to be compared were low and moderately high, $\mu - 0.5\sigma = 4.501$ was used as the split point. Thus, samples with arousal ≥ 5 were compared to those with arousal < 5 to test H1c. Meanwhile, for H1d, which warranted the comparison of moderately low and high arousal levels, $\mu + 0.5\sigma = 6.573$ was used as the split point. Thus, samples with arousal ≥ 7 were compared to those with arousal < 7 to test H1d.

The differences in the divergent scores at different valence levels were first examined. H1a expected positive emotions to result in a higher divergent score than negative emotions. The Mann-Whitney U results proved that mean cleverness (p = .034) and best cleverness (p = .049) significantly differed between participant groups with positive and negative valence in prototyping. Participants with more positive valence were more insightful in the accomplishing of their tasks (average mean = 4.05, average best = 4.14) than those who displayed more negative emotion (average mean = 3.85, average best = 3.90). The effect size for mean cleverness and best cleverness in prototyping were r = .59 and r = .55, respectively, which are large-sized effects.

Meanwhile, other divergent scores at the prototyping stage did not differ between participants with positive and negative valence, and the effect sizes were medium. The divergent score for HMWQ, ideation and DHP did not significantly vary between the two valence levels. In HMWQ, the divergent scores of the positive valence group were lower than those of the negative valence group, while the effect size was medium to small. Participants with positive valence in ideation obtained higher uncommonness and remoteness scores than those with negative valence, but the effect sizes were smaller. Similarly, participants with positive valence in DHP earned higher divergent scores for all subscales than participants with negative valence, while the effect sizes were smaller than typical to medium.

The differences in convergent scores between valence levels were also examined. H1b predicted that participants with more negative valence would obtain better divergent scores than those with more positive valence. All average convergent scores in concept development along with similarity and serendipity in storytelling demonstrated results consistent with H1b. However, the results of the Mann-Whitney U tests evinced no statistically significant differences in all convergent task scores between the two valence groups. The effect sizes of the convergent score and the valence were, in general, medium except for the mediation score in the storytelling phase. The average mediation score for participants with negative valence was lower than the score of those with positive valence, and the effect size was larger than typical (r = .51).

Further, the differences in divergent scores between arousal levels were assessed. H1c forecasted that participants with moderate-high arousal would yield better divergent performances than participants with low arousal.

TABLE II. SPEARMAN'S RHO CORRELATION COEFFICIENTS BETWEEN DIVERGENT PERFORMANCE AND AFFECT STATES.

Performance scores	**HMWQ (n = 15)**		**Brainstorming (n = 12)**		**Prototype (n = 13)**		**Dark Horse Prototype (n = 13)**	
	Valence	***Arousal***	***Valence***	***Arousal***	***Valence***	***Arousal***	***Valence***	***Arousal***
Mean Uncommon	−−.543	−.034	.215	.824**	.415	.594*	−.010	.166
Mean Remote	−.543	−.034	.215	.824**	.415	.594*	−.110	−.094
Mean Cleverness	−.228	.467	−.079	.714**	.626*	.400	.134	.402
Mean Divergent	−.543	−.034	.215	.824**	.415	.594*	.148	.470

Score								
Best Uncommon	−.101	−.593	.251	.892**	.415	.594*	−.010	.166
Best Remote	−.228	.467	.215	.824**	.351	.531	−.110	−.094
Best Cleverness	.393	.506	−.079	.714**	.618*	.180	.134	.402
Best Divergent Score	−.228	.467	.215	.824**	.415	.594*	.148	.470

$**p < .01$. $*p < .05$. (2-tailed).

Table III summarizes the results of the Mann-Whitney U tests on the divergent performance scores between individual high-group and low-group arousal scores. Table III outlines supporting results in the best remoteness and cleverness scores with regard to HMWQ, the overall divergent scores pertaining to brainstorming, and the overall divergent scores of DHP. In the interim, the results of prototyping did not yield supporting evidence. The Mann-Whitney U test confirmed that the two groups were significantly different in the highest cleverness score on HMWQ, in uncommonness and remoteness in brainstorming, and in cleverness in DHP. The effect size for those subscales ranged between larger than typical to much larger than the norm. On the contrary, the Mann-Whitney U Test confirmed the opposite result that participants with negative valence were significantly higher in the uncommonness score in HMWQ than those with positive valence and the effect size was much larger than typical.

Finally, the difference in convergent scores across arousal levels was examined. H1d assumed that participants with moderate-low arousal would demonstrate better divergent performance than those with high arousal. The Mann-Whitney U Test confirmed that the two groups were not significantly different.

Emotion and Leadership Correlation

The skewness of the ROL data was lower than −1. Considering this normality violation and the small number of samples, a non-parametric correlation analysis was applied toward affect variables and leadership behavior perception.

The correlation was evaluated both at the group and the individual levels. Leadership behavior and affect scores were not significantly correlated at the group level. At individual level, however, the perception of ROL and valence were significantly correlated (rs = .394, p = 0.01). This result supported H2a which envisaged that ROL and valence would be positively correlated.

A Mann-Whitney comparison test was conducted to investigate whether valence and arousal were different between groups with high ROL and high TOL. A group with higher ROL score exhibited higher arousal than a group with higher TOL (p = .049). The effect size for group arousal was r = .45, a medium-size effect. This outcome supports H2b.

Leadership and Performance Correlation

Further investigation was conducted to reveal the connections between emergent leadership and group affect in different types of creative performance. Additionally, the relationships between emergent leadership and each creative performance were examined.

In overall divergent tasks, ROL significantly correlated with valence ($rs = .42$, $p < 0.01$). Meanwhile, TOL evinced a significant negative correlation with arousal in HMWQ ($rs = -.63$, $p < 0.05$). ROL was not significantly correlated with divergent scores except for the best remoteness in prototyping ($rs = .55$, $p < 0.05$). TOL showed a significantly negative correlation with the best cleverness scores in HMWQ ($rs = -.63$; $p < 0.05$) and for remoteness in DHP ($rs = -.88$; $p < 0.01$). Yet, TOL was positively correlated with best uncommonness in HMWQ ($rs = .61$; $p < 0.05$).

Leadership behavior was significantly correlated with some affect and convergent scores for convergent tasks. No significant correlation was found for ROL with either valence or arousal, while TOL was significantly correlated with valence in storytelling ($rs = .65$, $p < 0.05$).

TOL correlated positively with several convergent scores, specifically mean mediation in overall convergent tasks ($rs = .35$, $p < 0.05$), best serendipity in overall convergent tasks ($rs = .34$, $p < 0.05$), best similarity in theme ($rs = .57$, $p < 0.05$), similarity in concept development ($rs = .78$, $p < 0.01$), and mediation in storytelling ($rs = .80$, $p < 0.01$).

ROL correlated positively with mean mediation in overall convergent tasks ($rs = .42$, $p < 0.01$), storytelling ($rs = .80$, $p < 0.01$), and best similarity in theme ($rs = .52$, $p < 0.05$). However, a negative correlation was found between mean serendipity and emergent leader in theme: TOL ($rs = -.57$, $p < 0.05$) and ROL ($rs = -.52$, $p < 0.05$).

Discussion

Effect of Emotion on Creative Design Performance

This study investigated the varied affective states experienced in the creative design process. The participants perceived a neutral to positive valence and low to high arousal. The affect states differed among groups and fluctuated vigorously in the course of the discrete phases.

1) Divergent Performance Subscales

The relationship between affect and divergent performances differed across the assigned tasks. A conflicting pattern of uncommon and cleverness was found in three divergent phases. The contrary results were found the association of the scores with arousal in HMWQ (see Tables II and III), valence in brainstorming (see Fig. 5), and both valence and arousal in prototyping (see Table II). These results asserted the independence of the subscales. A response could be high in one subscale but low in another (Silvia et al., 2008). This difference affected the generality of the relations between affect and divergent performance. However, Silvia et.al (2008) have asserted that divergent thinking tasks capture the different aspects and dynamics of ideation. Thus, the differences found in the relation between performance and affect do not indicate invalidity.

TABLE III. MANN-WHITNEY U TEST ON DIVERGENT PERFORMANCE SCORES BETWEEN HIGH-GROUP AND LOW-GROUP OF INDIVIDUAL AROUSAL SCORES.

Task	**Subscale**	**Arousal < 5**				**Arousal ≥ 5**				***p***	**effect**
		n	***Mean***	***SD***	***Rank***	***n***	***Mean***	***SD***	***Rank***	**(2-tailed)**	**size *r***
HMWQ	Mean Uncommon	4	3.743	0.085	6.88	7	3.624	0.230	5.50	.483	0.21
	Mean Remote		2.803	0.245	6.88		2.833	0.315	5.50	.483	0.21
	Mean Cleverness		3.543	0.145	3.88		3.606	0.144	7.21	.089	0.51
	Mean Divergent Score		3.360	0.160	6.88		3.354	0.230	5.50	.483	0.21
	Best Uncommon		4.220	0.100	8.63		4.070	0.000	4.50	.010	0.77
	Best Remote		3.048	0.235	3.88		3.211	0.176	7.21	.089	0.51
	Best Cleverness		3.790	0.220	2.88		4.166	0.043	7.79	.012	0.75
	Best Divergent Score		3.673	0.125	3.88		3.780	0.075	7.21	.089	0.51
Brainstorming	Mean Uncommon	3	3.097	0.202	3.00	9	3.598	0.306	7.67	.046	0.58
	Mean Remote		3.157	0.150	3.00		3.374	0.134	7.67	.046	0.58
	Mean Cleverness		3.553	0.202	4.00		3.752	0.258	7.33	.154	0.41
	Mean Divergent Score		3.270	0.052	3.00		3.573	0.208	7.67	.046	0.58
	Best Uncommon		3.357	0.497	3.00		3.928	0.327	7.67	.035	0.61
	Best Remote		3.283	0.144	3.00		3.622	0.243	7.67	.046	0.58
	Best Cleverness		3.653	0.115	4.00		3.849	0.211	7.33	.154	0.41
	Best Divergent Score		3.357	0.098	3.00		3.671	0.208	7.67	.046	0.58
Prototype	Mean Uncommon	2	3.885	0.163	7.00	11	3.987	0.339	7.00	1.000	0.00
	Mean Remote		3.515	0.163	7.00		3.381	0.351	7.00	1.000	0.00
	Mean Cleverness		4.040	0.226	8.50		3.960	0.168	6.73	.539	0.17
	Mean Divergent Score		3.810	0.184	7.00		3.773	0.260	7.00	1.000	0.00
	Best Uncommon		4.035	0.050	7.00		4.027	0.332	7.00	1.000	0.00
	Best Remote		3.650	0.000	7.50		3.409	0.365	6.91	.832	0.06
	Best Cleverness		4.220	0.141	10.00		4.015	0.220	6.45	.220	0.34
	Best Divergent Score		3.960	0.057	7.00		3.811	0.272	7.00	1.000	0.00
DHP	Uncommon	8	4.373	0.297	6.63	5	4.482	0.257	7.60	.651	0.13
	Remote		3.838	0.322	6.63		4.040	0.055	7.60	.651	0.13
	Cleverness		4.180	0.117	5.13		4.360	0.000	10.00	.016	0.67
	Divergent Score		4.130	0.202	5.50		4.292	0.066	9.40	.070	0.50

2) *Valence and Divergent Performance*

Relationships between valence and divergent performance were found to be dissimilar across tasks. Positive associations between valence and divergent performance scores were confirmed in the remoteness and cleverness subscales in brainstorming and in all subscales in prototyping but were uncommon in DHP. However, only the cleverness subscale in prototyping was proven to be statistically significant. In opposition to previous research reporting that positive emotion would facilitate divergent thinking at the individual level (e.g., Yamada & Nagai, 2015), the results obtained in the current study suggest that the implications derived from previous studies may not be directly applicable at the group level.

Tsai et al (2011) proved that the weak relationship between valence and group creative performance might occur because of another factor that, when combined with a certain level of valence, may inhibit creative performance. Their study demonstrated that a group with both high-team trust and high positive group emotion produced fewer creative ideas than a group with either team trust or positive group emotion. Similarly, Collins et al. (2013) have mentioned that groups with a highly positive affective tone and a significant amount of trust among group members were less likely to express diverse opinions. Positive emotion stemming from a sense of reliance on other members to complete the group task might actually hinder creative group performance, especially in the divergent aspects. A further exploration of the trust factor and its effect on different kinds of divergent tasks would be interesting.

3) *Arousal and Divergent Performance*

Groups with higher arousal performed better in most of the divergent tasks, and this result was statistically proven. The arousal correlated positively with divergent scores in brainstorming and prototyping. The groups that evinced higher arousal levels scored better in best remoteness and cleverness subscales of HMWQ, in the overall divergent subscale of brainstorming, and in the cleverness aspect of DHP. These results reveal that arousal was more strongly related to divergent group performance than valence. The findings support the notion that arousal is more critical than valence in influencing heuristic cognition (Imbir, 2016), while heuristic cognition concurs with divergent thinking (Kno¨rzer et al., 2016).

Group work mandates contributions from members in the development of ideas, or the “cross-fertilization of ideas” according to the nomenclature devised by Tsai et al. (2011). The perception of urgency, which is reflected by arousal (Zadra & Clore, 2011), may support the contributory actions of members to the group's work. Sosnowska, Hofmans, and de Fruyt (2017) have shown that people possess high energy, passion, and mental endurance to achieve their work when they are in a state of high arousal. Consequently, the maintenance of positive group emotion is not as important as the preservation of group arousal at the moderate to high level during the accomplishment of divergent tasks. A challenging task combined with the expression of different opinions in a group may lead to a negative state of emotion yet increase arousal, which would be beneficial for the group’s divergent performance.

The results obtained by this study are aligned with the findings of De Dreu et al. (2008) with regard to overall affect states related to divergent performance. De Dreu et al. (2008) revealed that people in a happy and angry state performed well in divergent tasks. Both emotions indicate an activating state. People are likely to be more persistent in a state of anger than while exhibiting any other emotion such as happiness, relaxation, or sadness (De Dreu et.al, 2008). The current research confirmed that novel ideas may be obtained not just through the ability to think in a broad manner but also through strenuous and earnest effort.

4) *Emotion and Convergent Performance*

This study did not find any significant relationship between affect variables and convergent tasks. Although concept development revealed a higher convergent score in the negative emotion group, the relationship was not statistically significant. Similarly, no significant association was revealed between arousal and convergent performance. In congruence with previous research, convergent tasks were found to be more associated with cognitive reasoning (e.g., De Young et al., 2008). This outcome does not imply that emotions do not influence convergent performance. For example, confusion (negative-aroused) is beneficial for focused attention, deep thinking, and judgment (D'Mello, Lehman, Pekrun, & Graesser, 2014). However, further research must deliberate how affects can be categorized to elucidate the general.

Effect of Emergent Leadership on Group Creative Work

Participants perceived more ROL than TOL in this study. The relationship between emergent leadership and group emotion and the manner in which this dynamic affects group creative work are discussed below:

1) Emergent leadership and group emotion

For most of the design thinking task, the participants faced an unknown, ill-defined, and vague situation, also called a low control situation by Fiedler and Chemers (1984). In this uncertain condition, the emergence of ROL would be beneficial in maintaining a pleasant atmosphere. The overall data of this study evidenced the domination of positive emotion and ROL. This investigation revealed that the emergence of ROL is positively associated with group affect. The perception of ROL by group members formed a positive correlation with their valence, particularly in divergent tasks.

Group members who perceived more ROL were more aroused than those who sensed more TOL. Likewise, the existence of TOL tended to decrease arousal levels in HMWQ. These findings were consistent with the researchers' initial idea that ROL might lead to more positive and higher group emotion than TOL.

However, the empirical data demonstrated a significant positive correlation of TOL with valence in storytelling. This finding may indicate that storytelling represents a higher control condition. According to Fiedler and Chemers (1984), in this situation, the emergent TOL can clearly envision how to manage the task. Thus, the leader tends to spend more time socializing with other group members and showing consideration for their feelings. This action might increase the positive emotions of members. After facing conditions of much uncertainty in previous phases, the students gained a better understanding and conducted the storytelling more vividly. Afterward, they produced their proposal for the solution to their challenge. In a way, this result partially supported Pescosolido's (2005) notion that emergent group leaders manage group emotion.

2) Emergent leadership and group performance

This study did not reveal any strong benefit of emergent leadership for the performance of tasks that require divergent thinking. ROL correlated positively only with the best remoteness score in prototype, while TOL correlated negatively with the best cleverness score of HMWQ and the remoteness score of DHP. It was expected that TOL would hinder divergent performance. TOL behavior such as obtaining concrete intention, evaluating prior action, or assuming existent situations (Behrendt, Matz, & Go¨ritz, 2017) may block the flow of ideas.

Meanwhile, ROLs tend to focus indirectly on task completion instead of group engagement. Such leaders foster coordination and promote cooperation (Behrendt et al., 2017), which is not required to generate ideas.

However, the current research proved that an emergent leader partially supports convergent tasks. TOL supported the best similarity score in theme and concept development, best serendipity score in the overall convergent task, and mediation in storytelling. ROL supported the best similarity score in theme and the mediation score in storytelling. However, the reliability of the mediation scale was low and thus, the role of the emergent leaders in mediation needs further careful investigation in the future.

In general, this study implied that even though emergent leadership did not support creative group work through the managing of emotions, it may directly support convergent tasks. Associating a convergent task with a high-task structure appears reasonable. Fiedler and Chemers (1984) have also noted that TOL performs well in such situations. This investigation only found partial evidence of the role of emergent leadership in the creative task, perhaps because creative assignments elicit different behaviors. Hence, further research is required for a more profound understanding of the functioning of emergent leaders in creative group work.

Limitations and Future Research Directions

This study was conducted in a natural setting that imposed several limitations. The investigation depended on a small number of groups and on a limited range of valence conditions. No negative valence conditions such as anxiety or depression existed. The tendency of positive emotions perceived in design thinking tasks may be credited to the work process behavior. Divergent thinking, which was dominant in the design thinking task, may have led to a more positive mood (Akbari, Chermahini, & Hommel, 2012) However, further studies are necessary to prove this notion.

In addition, this study was unable to determine the causality of the affect, leadership, and creative performance relationships. Experimental studies that involve both divergent and convergent tasks and that take into account the task order would be interesting and would yield deeper insights.

Conclusion

The present study confirmed that emotion, especially the state of arousal, was positively related to the performance of divergent tasks. The results implied that medium-high arousal was the optimal state in which to accomplish divergent tasks in a group. A comfortable atmosphere may not be a prerequisite for the devising of fabulous, novel ideas if the group members are actively engaged and if they strive to share their thoughts. This insight may be used by teachers or managers to maintain a creative atmosphere in the classroom or the workplace.

Brown’s (2009) notion that leaders are not necessary for a divergent task was confirmed by this study. It may thus be asserted that the performance of divergent tasks relies on the egalitarian status of members within a group. However, this study also revealed the need for leadership in creative group work. Although the present investigation did not demonstrate a significant relationship between the emergent leader’s function of managing group emotion and group performance, the emergence of leadership nevertheless facilitates the association of ideas in a creative group task. Design managers might control the involvement of TOLs in their group work and may thus be able to increase the group's creative performance.

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