The Effect of Mood on Problem Finding in Scientific Creativity

ARTICLE · DECEMBER 2014

DOI: 10.1002/jocb.79

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Publication of the Creative Education Foundation ®

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ABSTRACT

This study examined the influence of different mood states on Creative Science Problem Finding (CSPF). CSPF was measured in terms of Fluency, Flexibility, and Originality. Imagery techniques were used to induce positive or negative mood states in participants, with results suggesting that positive mood led to a significant increase in CSPF performance compared with neutral mood, especially for the dimensions of fluency and flexibility. No difference was found between negative mood and neutral mood. Results provide evidence that anger had no impact on CSPF performance compared with neutral mood. However, fear appeared to inhibit the performance of CSPF. The interaction between specific moods and CSPF provide evidence that moods influenced CSPF with open instructions more than with closed instructions.

Keywords: mood, creativity, CSPF, divergent thinking.

A large body of theoretical and empirical work has focused on creativity since Guilford's (1950) address to the American Psychological Association. Creativity research now has its own place within most of the traditional sub-areas in psychology, within which mood has attracted a great deal of research attention as a potential facilitator of creativity (De Dreu, Baas & Nijstad, 2008; Kaufmann, 2003). However, the research on the relationship between mood and creativity has yielded inconsistent results, with existing research focused largely on the effect of induced positive and negative moods on the performance on creative tasks compared to neutral mood (Russ, 1993; Russ, Robins & Christiano, 1999).

Although promotion effects of positive moods are more pervasive, negative moods have also been shown to facilitate creativity (Forgas, 2000; George & Zhou, 2002; Hirt, 1999; Isen, 2000). On one hand, these inconsistent results may be due to focusing only on mood valence, while neglecting the activation and regulatory focus of mood states (De Dreu et al., 2008; To, Fisher, Ashkanasy & Rowe, 2011). On the other hand, there are a large variety of creative tasks to measure creativity, and the effect of mood on creativity may be contingent upon the type of creative task (Davis, 2009).

Most creative tasks focus on creative problem-solving, leaving creative problem finding somewhat overlooked. Creative problem finding is a key element of creativity, and is often a necessary antecedent to creative problem-solving (Chand & Runco, 1993; Csikszentmihalyi, 1999). Problem finding requires both intellectual vision and insight into what is missing (Reiter-Palmon, 2011). The quality and originality of responses exhibited during the problem finding process have been linked to increased creativity; people appear to generate more creative responses to discovered problems than presented problems (Runco & Okuda, 1988). Getzels and Csikszentmihalyi (1976) suggested that the creativity of a solution depends on the creativity of the problem being solved and creative achievements often result from problem finding. Dillon (1982) indicates that problem finding represents a distinct creative act, equal to or more valuable than finding a solution. Problem finding measures were also predictive of artists' success measured 7 and 18 years later (Csikszentmihalyi & Getzels, 1988). Especially in scientific invention, choosing good problems is essential to being a good scientist, and finding a creative problem is often the first step to solve scientific problems (Alon, 2009). To shed some light on the effect of mood on creativity, this study explored the relationship between specific mood states and Creative Science Problem Finding (CSPF).

MOOD AND CREATIVITY

In referring to emotional phenomena, the terms affect, mood, and emotion are often used interchangeably. Affect is the most general term, and mood and emotion are generally seen as subtypes of affect (Frijda, 1993). In contrast to emotions, moods are relatively diffuse, generalized affective states that typically lack a particular object relation that stimulates an action-orientation. Mood is often defined as comprising of two orthogonal dimensions: positive affect and negative affect (Watson, Clark & Tellegen, 1988). Positive affect refers to mood states that increased pleasantness and negative affect increased unpleasantness. However, mood differs on two other dimensions: activation and regulatory focus (Higgins, 1997, 2006). Activation refers to the levels of arousal, some moods are activating with high level of arousal (happy, anger), others are deactivating with low level of arousal (calm, relaxed). Regulatory focus theory distinguishes between promotion focus and prevention focus to describe two self-regulatory or motivational systems. Promotion focus originates from survival need for nurturance; it is concerned with aspirations and accomplishments as desired end states and yields sensitivity to presence or absence of positive outcomes, with behavioral approach as the natural strategy to goal attainment. In contrast, prevention focus originates from survival need for security; it involves responsibilities and safety as desired end states and yields sensitivity to presence or absence of negative outcomes, with behavioral avoidance as the natural strategy to goal attainment. Some moods are promotion focused which reflect an approach orientation (happy, sadness), and others are prevention focused which are linked to avoidance (calm, fearful) (Carver, 2006).

Creativity is generally regarded as the generation of ideas that are original and useful within a specific social context (Plucker, Beghetto & Dow, 2004). Most creativity has been assessed by divergent thinking and idea generation tasks (Kaufman, Plucker & Baer, 2008), with the most common scores being fluency, flexibility, and originality. With regard to creativity, a large body of experimental research supports the claim that positive mood enhances creative thinking (Isen, 2008). Isen, Daubman, and Nowicki (1987), for instance, found that inducing momentary positive mood led to enhanced creative problem-solving and to the production of more unusual word associations (Isen, Johnson, Mertz & Robinson, 1985). Abele (1992) induced positive, negative, and neutral mood by way of autobiographical recall, and demonstrated that positive mood resulted in superior performance on ideational fluency tasks. Vosburg (1998) recorded mood through an adjective checklist immediately prior to task performance and found that positive mood facilitated and negative mood inhibited fluency of idea production. According to Isen (2000), positive mood promotes creativity through two mechanisms. First, positive mood increases cognitive flexibility and makes individuals consider a wider variety of options. Second, positive mood increases the efficiency with which information is processed, avoiding irrelevant and extraneous information. The dopaminergic theory of positive affect proposes that increased dopamine levels in the brain mediate many of the cognitive effects of positive affect (Ashby, Valentin, & Turken, 2002).

However, research on the effects of negative mood on creativity is mixed, with some studies suggesting negative mood promotes creative performance (Carlsson, 2002; Clapham, 2001), yet others suggesting a negative (Vosburg, 1998) or null effect (Goritz & Moser, 2003; Verhaeghen, Joorman & Khan, 2005). The mood as input model (Martin, 2001) ascribes an informational function to moods. Positive moods signal a satisfactory and safe state of affairs, which promotes the use of simplifying heuristics and "loose" processing (Fiedler, 2000) as well as the willingness to explore novel procedures and alternatives. Negative moods, in contrast, signal a problematic state, which requires a careful assessment of environment (Ambaby & Gray, 2002). The problem signal elicited by negative moods motivates one to seek out and solve problems or to invest more effort in order to meet performance standards. Friedman et al. (2007) found evidence that positive moods enhanced creativity on tasks construed as fun and silly, whereas negative moods increased creative performance on tasks construed as serious and important.

Baas, DeDreu, and Nijstad (2008) conducted a meta-analysis of research on mood effects on creativity, concluding that positive mood enhances creative thinking. The meta-analysis also pointed out that creativity is enhanced most by positive mood states that are activating and associated with an approach motivation (e.g., happiness), rather than those that are a deactivating mood (e.g., relaxed). Another meta-analysis (Davis, 2009) suggested that the inconsistent results of the relations between mood and creativity may be due to the type of creative task considered. Positive emotions seem to enhance performance on tasks that mostly require generation skills (i.e., coming up with as many solutions as possible), whereas negative mood may help with tasks that mostly require evaluation skills (i.e., determining which ideas are best).

CREATIVITY AND CREATIVE SCIENTIFIC PROBLEM FINDING

Even though most studies regard creativity as a domain-general ability (Kaufman, Beghetto & Baer, 2010), research on creativity across multiple domains suggests that creativity most probably has both domain-general and domain-specific characteristics (e.g., Kaufman et al., 2010; Plucker, 2004, 2005; Plucker & Beghetto, 2004). There are many instances of research about scientific creativity, most of which are about the creativity of professional scientists (e.g., Chambers, 1964). Hu and Adey (2002) proposed a three-dimensional Scientific Structure Creativity Model, defining scientific creativity as an intellectual trait or ability producing or potentially producing a certain scientific product that is original and has social or personal value, designed with a certain purpose in mind using given information. It is concerned with creative science experiments, creative scientific problem finding and solving, and creative science activity. They developed a scientific creativity test for secondary school students which included tasks related to unusual uses, creative product improvement, scientific imagination, creative problem finding, creative problem-solving, creative experiment design, and creative product design. In a subsequent study, they explored the development of scientific creativity between English and Chinese adolescents, with evidence that the developmental trend of problem finding was different from the overall trend of scientific creativity (Hu, Adey, Shen & Lin, 2004).

In a similar vein, Ochse (1990) has argued that sensitivity to problems is an important feature of the creative process, and Hoover (1994) demonstrated a significant correlation between measures of creativity and scientific problem finding ability for a group of fifth-grade, gifted students. In another study, CSPF was defined as the ability of creative problem finding in science (Hu, Shi, Han, Wang & Adey, 2010). The development of CSPF in Chinese adolescents was explored in terms of fluency, flexibility, and originality. Fluency refers to the number of unique ideas or answers generated; flexibility is the number of distinct categories in which responses were distributed (Kaufman et al., 2008). The categories were predetermined by pooling all responses together and categorizing them based on the nature of all questions. Originality refers to the statistical infrequency of a response. The CSPF was measured by two items with different instruction types. The results suggest that CSPF ability has a developmental trend characterized by a significant leap in the fifth grade, followed by a steady advance until it peaks in the eighth grade, and then declines and stabilizes in the high school years. The type of instruction showed significant differential influence on CSPF and its development.

MOOD AND CREATIVE PROBLEM FINDING

Few studies have examined the relationship between mood and problem finding. Mraz and Runco (1994) reported that an indicator of strongly negative mood (frequency of suicidal thoughts) was positively related to problem finding ability, and also was indicative of an ability to imagine new and interesting problems. Schwarz (1990) suggested different mood states may elicit different kinds of information processing strategies: positive moods indicate a state of well-being and are therefore accompanied by a relaxed, playful approach to tasks. Negative moods, on the other hand, indicate the presence of danger and call forth systematic, detail-oriented thinking strategies that may help with finding and defining problems. In a creative context, people may use their mood state to infer whether a different strategy is needed. Consequently, individuals with positive mood would relax on the processing requirements and are more prone to use simplifying heuristics and loose processing. Individuals in a negative mood would turn to analytic and tight modes of processing, where the situation is treated carefully and systematically (Fiedler, 2000).

Runco and Okuda (1991) used three kinds of instructions to explore creativity and found that instruction forms affected the quality of creativity. Open-ended tasks gave participants more freedom to think creatively and allowed individuals to take an active role in problem finding. In contrast, the closed instructions provided participants with a predefined context, which limited the imagery of participants. Unsworth (2001) postulated that open-ended tasks allow for more creativity because they allow the individual responsible for solving the problem to determine the specific domain, parameters, and scope of problem to be solved. In addition, the open instructions would give the individual greater independence in finding problems, allowing the individual to focus on many domains for which they have the knowledge and expertise to generate a sufficient number of problems.

PRESENT STUDY

In previous research on mood and creativity, the creativity measures have focused on outcomes such as creative problem-solving, neglecting the problem finding process. This study explored the effect of mood on creative problem finding in science. The results of previous study suggested that the development of the ability of CSPF showed a steady advance until it peaked in the eighth grade, and the teenagers in the seventh grade appeared a highly emotional fluctuate. So we want to examine the ability of CSPF of the seventh students under the conditions of specific mood states induced by different techniques.

We hypothesized that, compared to neutral mood state, positive mood would increase CSPF performance and negative mood would have null effect. The specific mood states such as happiness, anger, and fear would have differential impacts on CSPF scores. Compared to neutral mood state, happiness and anger mood with activating and promotion focus would enhance creativity performance and fear with prevention focus would decrease the performance. It was also expected that CSPF performance would be better with open-ended rather than closed-ended instructions, and that the effects of mood on CSPF would be moderated by the form of instruction.

METHOD

PARTICIPANTS AND DESIGN

The seventh- and eighth-grade students (N = 175) were randomly selected from a public school in Shanxi province in China. The sample had a mean age of 14.01 years (SD = 1.50), and 91 students (52%) were male. This section used a 3 (mood: positive vs. neutral vs. negative) $\times$ 2 (instructions: open vs. closed) design with mood as a between-subjects variable and instructions as a within-subjects variable. The participants were randomly assigned to a positive (N = 58), neutral (N = 52), or negative (N = 65) mood manipulation. For the investigation of specific mood effects, 105 students selected randomly from another school in Shanxi province participated in the second part of this study. The sample had a mean age of 14.73 years (SD = 0.82), and 73 students (69.5%) were male. This section used a 4 (mood: happiness vs. fear vs. anger vs. neutral) $\times$ 2 (instructions: closed vs. open) design with the mood as a between-subjects variable and instructions as a within-subjects variable. The participants were randomly assigned to groups that induced moods related to happiness (N = 28), fear (N = 25), anger (N = 24), or control (N = 28) conditions.

PROCEDURE AND MATERIALS

Mood manipulation

An imagery technique (Grawitch, Munz, & Kramer, 2003) was used to generate negative, neutral, or positive mood for participants individually, which was completed by two stages of imagery tasks. The first stage served to bring participants to a relatively neutral baseline to decrease both positive and negative mood within participants. The participants were asked to imagine spring scenery for 3 minutes. The second stage intended to prime the desired mood and lasted for an additional 3 minutes. The participants in the positive mood group remembered an event or scenery from their recent past that put them into a good mood state. The participants in the negative mood group remembered an event or scenery from their recent past that put them into a bad mood state. The participants in the neutral mood group remembered a neutral event or scenery a second time. Research has demonstrated imagery is a valid means of altering individual mood states (Sanna, 2000).

In the second part of the study, film clips were shown to induce happiness, anger, anxiety, and neutral mood states individually (Rottenberg, Ray, & Gross, 2007). Also, the first stage served to bring participants to a relatively neutral baseline in order to decrease both positive and negative moods within participants. A brief clip from the film *Mr. Bean*, which described the humorous behaviors of Mr. Bean after losing his shoe, was used to generate happiness. A clip from the film *Vertical Limit*, which described a scene with two mountain climbers in a very dangerous situation, was used to generate fear. A scene from the Chinese film *White Hair Girl*, depicting a rich person bullying a poor person, was used to generate anger. Finally, a generic, animated image of lines moving and changing was used to induce a neutral state. The film clips were chosen based on a pilot study. In the pilot study, according to Philippot (1993) methodology, we selected 10 film clips to induce six mood states (happiness, anger, fear, sadness, neutral state, surprise). We found four film clips used in the present study that successfully elicited happiness, anger, fear, and a neutral state.

Mood manipulation check

To confirm the effectiveness of the mood manipulation, participants completed a mood self-rating scale. The Emotion Report Forms (Fredrickson & Branigan, 2005) were used to indicate how strongly the participants were currently experiencing happiness, fear, anxiety, and anger using a 7-point scale (0 = *no*, 6 = *yes*). By the imagery techniques, negative imagery participants reported a more negative mood (3.58 ± 1.25; $M \pm SD$), positive imagery participants reported a more positive mood (3.92 ± 1.63), and neutral imagery participants reported they had no obvious mood (0.38 ± 0.56). By the film clips inducement, participants induced the intended mood state for happiness (3.97 ± 1.74), fear (3.63 ± 1.88), or anger (4.88 ± 1.66); the fear film clip also induced anxiety (4.26 ± 1.87). Please see Table 1.

Creative scientific problem finding

To measure CSPF (Hu et al., 2010), we asked participants to write as many scientific questions as they could and think as creatively as possible. In addition, two types of instructions were given. The open-ended instructions asked participants to generate scientific questions based on their everyday life experience and observations, and the close-ended instructions asked participants to generate scientific questions related to a picture of an astronaut standing on the moon. After the mood manipulation check, instructions were presented as Power Point slides. The open instructions were presented before the closed instructions to limit a possible response set bias, with participants' completion of each section limited to 8 minutes.[1]

[1] A pilot study provided evidence that administering the closed conditions task before the open conditions task resulted in sharply decreased problem finding for participants under the open condition. Given that finding, and the belief that the open conditions task had little theoretical impact on the closed condition task performance, the decision was made to administer the two CSPF tasks in the order specified.

TABLE 1. Means and Mode of Mood Check

Mood States	Film Clips			
	Mr. Bean	Vertical Limit	Hair Girl	Lines Change
Happiness				
Mode	5.00	0.00	0.00	0.00
Mean	3.97	1.07	0.23	0.38
SD	1.74	1.57	0.99	1.01
Fear				
Mode	0.00	1.00	0.00	0.00
Mean	0.66	3.63	1.42	0.15
SD	1.08	1.88	1.39	0.74
Anxiety				
Mode	0.00	6.00	1.00	0.00
Mean	1.03	4.26	2.58	1.19
SD	1.30	1.87	2.34	1.76
Anger				
Mode	0.00	0.00	6.00	0.00
Mean	1.14	1.59	4.88	0.98
SD	1.66	1.97	1.66	1.05

The CSPF responses were rated for fluency, flexibility, and originality. The Fluency score is simply the number of questions generated. The Flexibility score is the number of categories across which a subject's questions are distributed. The categories are predetermined, before any individual's response is scored, by pooling all responses together and categorizing them based on the nature of all questions. The Originality score is based on the frequency percentage for a given response in the total sample. The student will gain a score of 2 if the response frequency percentage is smaller than 5%; 1 point if response frequency is between 5–10%; and 0 if above 10% (Hu et al., 2010). All responses were rated by two raters based on a sample of 100 students. The inter-rater agreement remained at an acceptable level, the inter-rater reliability estimates (Person product-moment coefficients) were 0.71 for Originality, 0.73 for Flexibility, and 0.82 for Fluency for the open instruction, and 0.72 for Originality, 0.81 for Flexibility, and 0.85 for Fluency for the closed instruction condition.

RESULTS

EFFECTS OF MOOD VALENCE ON CSPF

Means and standard deviations of variables for each condition can be found in Table 2.

Two-way Repeated Measures MANOVA was conducted to determine the effect of mood valence and instruction on the three dependent variables of fluency, flexibility, and originality. MANOVA results indicated that mood states (Wilks'Λ = 0.579, $F[6, 340] = 17.82$, $p < .001$, $\eta^2 = 0.24$), instruction (Wilks'Λ = 0.722, $F[3, 170] = 21.82$,

TABLE 2. Means and Standard Deviations of Dependent Measures

Instruction	Measures	Positive Mood	Neutral Mood	Negative Mood
Open	Fluency	10.81 (5.60)	5.06 (2.24)	6.74 (3.28)
	Flexibility	2.81 (0.87)	3.27 (1.11)	2.15 (0.71)
	Originality	2.62 (1.36)	2.21 (1.61)	3.08 (2.35)
Closed	Fluency	7.36 (3.63)	5.58 (2.60)	4.82 (2.36)
	Flexibility	2.83 (1.09)	2.81 (1.27)	2.65 (1.07)
	Originality	2.02 (1.65)	2.54 (2.19)	1.09 (1.17)

TABLE 3. Variance (ANOVAs) with Mood Valence and Instruction Types

	Fluency		Flexibility		Originality	
	F	η^2	***F***	η^2	***F***	η^2
Mood	25.74***	0.23	9.03***	0.10	0.79	0.01
Instruction	42.03***	0.20	0.031	0.00	18.67***	0.10
Mood × Instruction	20.21***	0.19	9.22***	0.10	15.06***	0.15

Note. $^{**}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

$p < .001$, $\eta^2 = 0.28$), and the factor interaction (Wilks'$\Lambda = 0.548$, $F[6, 340] = 19.87$, $p < .001$, $\eta^2 = 0.26$) significantly affected fluency, flexibility, and originality scores.

A two-way Repeated Measures ANOVA and pairwise comparisons were conducted to exam the effect of variables on the dependent variables. The results presented in Table 3 indicated that the mood state by Instruction interaction was statistically significant for the fluency ($F[2, 172] = 20.21$, $p < .001$, $\eta^2 = 0.19$), flexibility ($F[2, 172] = 9.22$, $p < .001$, $\eta^2 = 0.10$), and originality dependent variables ($F[2, 172] = 15.06$, $p < .001$, $\eta^2 = 0.15$). The main effect of instruction was statistically significant for the fluency ($F[1, 172] = 42.03$, $p < .001$, $\eta^2 = 0.20$) and originality ($F[1, 172] = 18.67$, $p < .001$, $\eta^2 = 0.10$). The main effect of mood state was statistically significant for the fluency ($F[2, 172] = 25.74$, $p < .001$, $\eta^2 = 0.23$) and flexibility ($F[2, 172] = 9.03$, $p < .001$, $\eta^2 = 0.10$). The pairwise comparisons results for fluency indicated that individuals in the positive group performed significantly better than those in negative and neutral groups, and for flexibility the individuals in the negative group significantly differed from those in positive and neutral groups.

Further simple effect analysis suggested that, under the open instruction condition, individuals performed significantly differently in different mood groups for fluency ($F[2, 172] = 31.09$, $p < .001$, $\eta^2 = 0.27$), flexibility ($F[2, 172] = 23.09$, $p < .001$, $\eta^2 = 0.21$), and originality ($F[2, 172] = 3.18$, $p = .044$, $\eta^2 = 0.04$). The pairwise comparisons for fluency indicated that individuals in the positive group performed significantly better than those in negative and neutral groups. For flexibility, individuals in the neutral group performed significantly better than those in positive and negative groups, and those in the positive group performed significantly better than those in the negative group. For originality, individuals in the negative group performed significantly better than those in the neutral group.

While under the closed instruction, participants performed perform significantly differently in different mood group for fluency ($F[2, 172] = 12.19$, $p < .001$, $\eta^2 = 0.12$) and originality ($F[2, 172] = 11.21$, $p < .001$, $\eta^2 = 0.12$). The pairwise comparisons results for fluency indicated that individuals in the positive group significantly differed from those in the negative and neutral groups. For originality, the individuals in positive and neutral groups performed significantly better than those in the negative group. The interaction between mood valence and instruction can be seen in Figure 1.

EFFECT OF SPECIFIC MOOD ON CSPF

The effect of induced specific mood on CSPF was also analyzed. Means and standard deviations of variables for each condition can be found in Table 4.

Two-way Repeated Measures MANOVA was conducted to determine the effect of specific mood and instruction on the three dependent variables of fluency, flexibility, and originality. MANOVA results indicated that mood states (Wilks'$\Lambda = 0.740$, $F[9, 241] = 3.53$, $p < .001$, $\eta^2 = 0.10$), instruction (Wilks'Λ=0.606, $F[3, 99] = 21.48$, $p < .001$, $\eta^2 = 0.40$), and the factor interaction (Wilks'$\Lambda = 0.760$, $F[9, 241] = 3.20$, $p = .001$, $\eta^2 = 0.09$) significantly affected fluency, flexibility, and originality.

Two-way Repeated Measures ANOVA and pairwise comparisons were conducted to exam the effect of variables on the dependent variables. The results presented in Table 5 indicated that the main effect of mood state ($F[3, 101] = 5.19$, $p = .002$, $\eta^2 = 0.13$) and instruction ($F[1, 101] = 9.13$, $p = .003$, $\eta^2 = 0.08$) was statistically significant for fluency. The pairwise comparisons results indicated that individuals in happiness group performed significantly better than those in fear group. The interaction between mood states and instruction forms was statistically significant ($F[3, 101] = 5.39$, $p < .01$, $\eta^2 = 0.14$). Further simple effect analysis suggests that under the open instruction, individuals performed significantly differently in different mood groups ($F[3, 101] = 10.02$, $p < .001$, $\eta^2 = 0.23$). The pairwise comparisons results indicate that under the open instruction the individuals in the fear group performed significantly lower than those in other groups.

For flexibility, the main effect of mood state ($F[3, 101] = 5.09$, $p = .003$, $\eta^2 = 0.08$) and instruction ($F[1, 101] = 11.11$, $p = .001$, $\eta^2 = 0.10$) was statistically significant. The pairwise comparisons results indicated that individuals in happiness and fear groups performed significantly better than those in fear group. The interaction between mood state and instruction form was also significant, with a relatively large effect size ($F[3, 101] = 9.02$, $p < .001$, $\eta^2 = 0.21$). Further simple effect analysis suggested that under the open instruction the individuals performed significantly differently in different mood groups ($F[3, 101] = 11.60$, $p < .001$, $\eta^2 = 0.26$). The pairwise comparisons results indicated that under the open instruction the individuals in fear group performed significantly poorer than those in other groups.

For originality, the mood state and instruction form interaction was neither statistically nor practically significant ($F[3, 101] = 0.54$, $p = .656$, $\eta^2 = 0.02$), but the main effects of mood states and instruction form were statistically significant and associated with moderate to large effects ($F[3, 101] = 6.20$, $p < .01$, $\eta^2 = 0.16$; $F[1, 101] = 20.87$, $p < .001$, $\eta^2 = 0.17$). The pairwise comparisons results indicated that individuals in the happiness group performed significantly better than those in other groups. The interaction between specific mood and instruction can be seen in Figure 2.

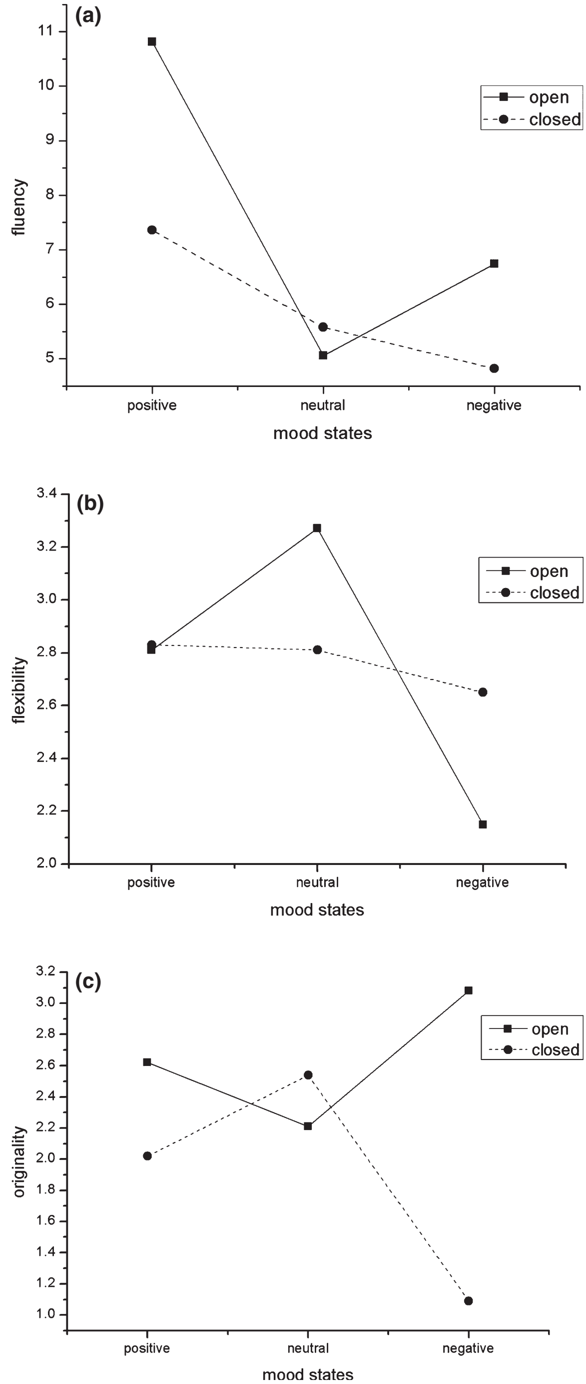

FIGURE 1. Interactions Between Instruction Forms and Mood State with Creative Science Problem Finding.

TABLE 4. Means and Standard Deviations of Dependent Measures

Instruction	Measures	Happiness	Neutral	Fear	Anger
Open	Fluency	9.29 (4.86)	8.00 (4.31)	7.42 (3.69)	6.46 (2.66)
	Flexibility	3.50 (1.53)	2.96 (1.31)	3.04 (1.40)	2.96 (1.31)
	Originality	6.82 (6.33)	4.32 (4.83)	4.13 (4.05)	3.57 (3.11)
Closed	Fluency	7.79 (3.85)	6.52 (2.77)	3.71 (2.65)	7.79 (2.67)
	Flexibility	3.96 (1.35)	3.84 (1.38)	2.29 (1.40)	4.39 (1.29)
	Originality	4.29 (4.07)	1.80 (1.58)	0.92 (1.66)	2.21 (1.83)

TABLE 5. Variance (ANOVAs) with Specific Mood and Instruction Types

	Fluency		Flexibility		Originality	
	F	η^2	*F*	η^2	*F*	η^2
Mood	5.19**	0.13	5.09**	0.13	6.20**	0.16
Instruction	9.13**	0.08	11.11**	0.10	20.87***	0.17
Mood × Instruction	5.39**	0.14	9.02***	0.21	0.54	0.02

Note. $^{**}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

DISCUSSION

This study provides evidence that the impact of mood states on creative scientific problem finding is moderated by the instruction forms. With open instructions, the CSPF scores in the positive mood group were significantly higher than those in the negative mood group, suggesting that the effect of positive mood on creative problem finding in science may be facilitated with open instructions. However, the performances in the anger mood group with the closed instructions were considerably higher. Perhaps anger, with an activating and promotion state, may promote a more systematic and detail-oriented information processing mindset, leading the participant to focus more on concrete information (Forgas, 2002), and the closed instructions provide participants with that concrete information. Also, the effect resulting from the problem itself would have a stronger effect on problem finding (Reiter-Palmon, 2011).

Another interesting result of this study was that the performances of flexibility with closed instructions were better than that with open instructions. Given that flexibility refers to the number of distinct semantic categories, it reflects the capacity to switch approaches and sets across ontological categories. After analyzing the responses of participants, it could be explained that the closed instructions narrowed the problem scope, and the participants maybe used the method of enlarging the scope of semantic categories as the coping strategy to increase their number of responses.

The results also provide evidence that positive mood significantly facilitated the creativity of scientific problem finding compared with negative and neutral moods. In the conditions of the induced specific moods, the performances with a happy mood state were better than the performances with other moods. The performances with a neutral mood were significantly higher than that with a fear mood, but no different with an anger mood. In both conditions, the scores of CSPF with open instructions were better than with closed instructions. For the qualities of CSPF, the results were more

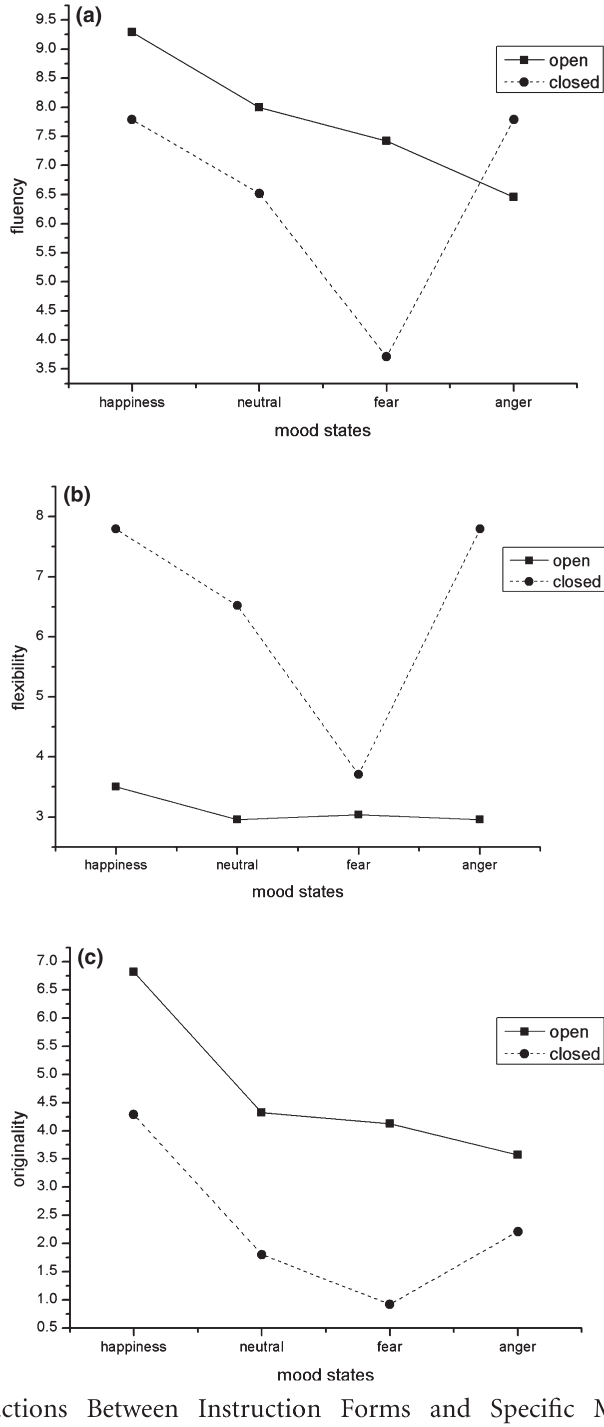

FIGURE 2. Interactions Between Instruction Forms and Specific Mood States with Creative Science Problem Finding.

interesting. For fluency and originality, the results were the same as with the scores of CSPF. However, for flexibility, the scores with closed instructions were better than that with open instructions. In the condition of closed instructions, the performance in the anger mood group was much better.

These results are in accordance with the conclusions from previous studies (Ashby et al., 2002; Isen, 2000; Isen & Daubman, 1984). Ashby et al. suggested positive affect increased dopamine levels in the brain and dopamine improves the selection of or the switching among alternative cognitive sets. Isen et al. thought positive material was more extensively connected and better integrated in memory, which promoted spreading activation and increased the likelihood of making remote associations conducive to creative thought. In addition, positive moods suggested that individuals were in a satisfactory and safe state, which made participants willing to explore novel procedures (Fiedler, 2000; Ruder & Bless, 2003; Russ, 1993). Our study used the tasks of problem finding as the creativity measure. In most situations, problem finding would occur automatically. Like the creative problem-solving process, the creative problem finding process includes both divergent and convergent elements (Reiter-Palmon, 2011). Our results suggest that positive moods could enhance creativity in the task of finding problems about science.

According to a review of literature by Higgins (2006), mood states differ on a number of dimensions; in addition to valence, activation and regulatory focus should also be paid attention to. Friedman and Forster (2008) proposed that the interaction between level of activation and the regulatory focus had an impact on the mood-creativity relationship. In order to test the effect of specific mood states on creativity, we induced three specific mood states in addition to the neutral group. The results showed that performances with the happy and anger groups were better than the neutral and fear groups, although the differences were minor and not statistically significantly, which is consistent with the results of Baas et al. (2008) meta-analysis. Baas et al. (2008) suggested creativity was enhanced most by positive moods that are activating and associated with a promotion focus. Negative, deactivating moods with a promotion focus were not associated with creativity. Negative, activating moods with a prevention focus were associated with lower creativity. Both happy and anger moods are activating states with a promotion focus, while fear mood is an activating state with a prevention focus. The promotion states would engender a global attention scope and facilitate concept access to mental representations, while the prevention states would engender a narrow attention scope (Forster, Friedman, Ozelsel & Denzler, 2006). The process of creative thinking would benefit from a broader attention scope at both the perceptual and conceptual levels (Rowe, Hirsh & Anderson, 2007). So the happy and anger moods with the promotion focus enlarged the attention scope and increased the creative performances.

Further, the results of this study showed that the scores with open instructions were higher than with closed instructions except for flexibility. In this study, the open instructions were defined as asking participants to generate scientific problems in terms of their daily life and their experiences and closed instructions were defined as generating scientific problems in terms of a picture depicting an astronaut standing on the moon. The results showed the participants produced more creative scientific questions in response to the open instructions. Runco and Okuda (1991) conducted a study to explore the relationship between creativity and finding and solving of real-world problems and found that real-world problem finding was more predictive of creative accomplishments than either standard divergent thinking tasks or real-world problem-solving, which has led to a broader range of applications of so-called "real-world DT tasks" (e.g., Plucker, Runco & Lim, 2006). In our study, the open instructions provided the participants with a real-world problem finding task. Compared with the astronaut, the participants were more familiar with the real-world and had more freedom to generate scientific problems, and thereby increased the creativity of problems generated. In our study, we present the CSPF test by following the open instruction task first. In the pilot study, we found that the closed instructions appear to give the participants a thinking set and limit the responses with the open instructions when the closed conditions task is encountered before the open conditions task, while the open task referred to the everyday life experience and observations which has no impact on the later item when the open conditions task is presented before the closed conditions task.

LIMITATIONS AND FUTURE RESEARCH

Limitations of this study included the inclusion of only middle school students in the sample, relatively small sample sizes, only investigating creative problem finding in science, and a limited number of mood manipulations. Future studies should investigate whether the results also apply to other domains and aspects of creativity, induce other mood states that differ in terms of valence, activation and regulatory focus, and a broader range of participant ages.

Regardless of these limitations, this study found promising results that suggest instruction forms moderate the relationship between mood and creative problem finding in science. The creative problem finding ability performed better with the open instructions in the positive group, the negative mood group with closed instructions showed low performance, and activating moods appeared to play important roles in increasing creativity.

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This research was supported by the National Natural Science Foundation of China (31271110, 31470977), Science and Technology Foundation Project (2013IM030200), as well as The Humanities and Social Sciences project of Ministry of Education (12YJA190007). The authors appreciate the extensive editorial assistance provided by Anna Dilley during the preparation of this manuscript.