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BRIEF REPORT

How does emotion influence different creative performances? The mediating role of cognitive flexibility

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Cognitive flexibility is proposed to be one of the factors underlying how positive emotions can improve creativity. However, previous works have seldom set up or empirically measured an independent index to demonstrate its mediating effect, nor have they investigated its mediating role on different types of creative performances, which involve distinct processes. In this study, 120 participants were randomly assigned to positive, neutral or negative affect conditions. Their levels of cognitive flexibility were then measured by a switch task. Finally, their creative performances were calibrated by either an open-ended divergent thinking test or a closed-ended insight problem-solving task. The results showed that positive emotional states could reduce switch costs and enhance both types of creative performances. However, cognitive flexibility exhibited a full mediating effect only on the relationship between positive emotion and insight problem solving, but not between positive emotion and divergent thinking. Divergent thinking was instead more associated with arousal level. These results suggest that emotions might influence different creative performances through distinct mechanisms.

Keywords: Emotional state; Cognitive flexibility; Divergent thinking; Insight problem solving.

The relationship between emotion and cognition has been ardently investigated in the past few decades. Among cognitive functions, creativity is the highest human mental activity (Guilford, 1967). Mumford (2003) called the influence of emotion one of the most important topics in the...
field of creativity. This study was conducted to inspect the mechanism of how affect could influence creativity. More specifically, this study investigated the mediating role of cognitive flexibility.

Previous studies have generally shown that positive affect can inspire more creativity than neutral or negative affect (for a review, see Hirt, Devers, & McCrea, 2008). For example, research has shown that induced positive affect can enhance remote-association performance (Isen, Daubman, & Nowicki, 1987), facilitate the correct solving of insight problems (Isen et al., 1987) and promote performance in divergent thinking (Hirt, Levine, McDonald, Melton, & Martin, 1997; Hirt et al., 2008).

In response, researchers have proposed several possible mechanisms to explain this phenomenon (for a review, see Hirt et al., 2008). Some believe that positive affect enhances cognitive flexibility and, hence, promotes creativity (De Dreu, Baas, & Nijstad, 2008; Fredrickson, 2001, 2003; Hirt et al., 2008; Isen, 2008). Cognitive flexibility refers to the elasticity of strategies or ability to switch among stimuli, operations and mental sets when responding to demands (Isen, 2008; Miyake, Friedman, Emerson, Witzki, & Howerter, 2000; Vartanian, 2009). Empirical evidence shows that positive affect can help individuals employ flexible strategies in the formation and testing of hypotheses (De Dreu et al., 2008; Hirt et al., 2008; Vartanian, 2009), switch between aspects of information, decrease anchoring in a diagnosis (Estrada, Isen, & Young, 1997) and in a decision (Djamasbi, 2007), improve cognitive organisation as reflected in flexible word association (Isen, Johnson, Mertz, & Robinson, 1985) and categorisation (Isen & Daubman, 1984), enable flexible deployment of attention in a global–local task (Baumann & Kuhl, 2005), improve executive functions (Yang, Yang, & Isen, 2013), broaden momentary thought–action repertoires, and ensure the flexible exploration of new ideas (broaden-and-build theory: see Fredrickson, 2001, 2003).

However, after reviewing previous studies, two issues must still be clarified. First, although many researchers claim that positive affect enhances cognitive flexibility and, hence, facilitates creativity, previous studies generally conflate the measures of cognitive flexibility and creativity. For example, some have adopted flexibility indices in divergent thinking tests (Hirt et al., 2008) or category inclusion in classification tasks (De Dreu et al., 2008) as measures of cognitive flexibility while also making these indicators dependent variables for creativity. The better way to explore the mechanisms of how emotions could influence creativity is to set up measures of cognitive flexibility independently and then conduct mediation analyses. To our knowledge, few studies have adopted this approach. The only study we reviewed found no significant mediating effect of cognitive flexibility (Hsu, 2009). However, Hsu (2009) used only open-ended creativity measure as a creativity index, which might have created an additional problem; this will be discussed next.

Second, past studies have seldom distinguished different types of creative performances; however, accumulating evidence indicates that different creative tasks exhibit distinct properties (Wakefield, 1989) and involve different processes (Isen, 2008; Lin, Hsu, Chen, & Wang, 2012; Lin & Lien, 2013). It is therefore important to differentiate how positive emotion affects different creative performances. Researchers have usually used either open-ended (such as divergent thinking tests) or closed-ended creativity tasks (such as insight problem-solving tasks), but not both, to measure creative potential. In a divergent thinking question (e.g., “What are the uses of a brick?”), respondents have to answer in as many diverse ideas as possible (so it is open-ended), to make novel output more likely (Guilford, 1956). On the other hand, an insight problem-solving task has a specific solution goal (in other words, it is closed-ended). The respondents have to escape from the obstacles of familiar frames or existing rules under task constraints (Weisberg, 1995) to find the correct answer. In this case, successful solutions require not only expansive thinking but also constrained thinking in a reciprocal process to construct a novel and appropriate final solution (Isen, 2008).

Researchers have recently developed the “dual process account of creativity” from dual process...
theories (e.g., Stanovich & West, 2000) to differentiate open- and closed-ended creative tasks (Lin et al., 2012; Lin & Lien, 2013). It is proposed that open-ended thinking mainly relies on intuitive, associative System 1 processing to obtain numerous and unique responses, while closed-ended thinking involves a reciprocal process between System 1 and the analytical, evaluative System 2 processing to find a creative correct answer. Empirical evidence supports this differentiation (Lin et al., 2012; Lin & Lien, 2013). For example, studies have shown that the individual performances of the two tasks have no correlation (e.g., Lin, Lien, & Jen, 2005). Furthermore, the two measures have exhibited different relationships among certain cognitive factors and personal variables, such as working memory (Lin & Lien, 2013), personality traits and gender (Lin et al., 2012). Our recent studies have also demonstrated that different types of induced affects have their respective impacts on the two measures of creativity. Divergent thinking performances can be enhanced by both positive and negative affects, while insight problem-solving performances can only be improved by positive affect (Tsai, Lin, & Lin, 2013). Accordingly, the question of whether emotions influence divergent thinking and insight problem solving through different mechanisms is worth further investigation.

With respect to the issues addressed above, the present study aimed to use an independent measurement of cognitive flexibility in the field of attention research (the switch task, Dreisbach & Goschke, 2004) to test whether there are different mediating effects following the different influences of emotions on creativity. Divergent thinking performances can be enhanced by both positive and negative affects, while insight problem-solving performances can only be improved by positive affect (Tsai, Lin, & Lin, 2013). Accordingly, the question of whether emotions influence divergent thinking and insight problem solving through different mechanisms is worth further investigation.

METHODS
Participants, design and general procedures
A total of 120 college students from Fo Guang University participated in this study (64% women, mean age 20.6 years). Participants were randomly assigned to 3 (affect induction: positive/neutral/negative) × 2 (creativity type: insight problem/divergent thinking) conditions for a total of six conditions with 20 participants in each condition. All the participants received individual tests. To disguise the purposes of this study, we told participants that they were going to proceed with three independent tasks. The first was to rate a film as teaching materials for next semester. The participants then watched a film to induce a certain emotional state. They then filled out a checklist about their emotional state after the film. Next, they carried out a switch task to show their cognitive flexibility, and, finally, completed either the insight problem task or the divergent thinking test. After having completed the three tasks, every
participant was debriefed and received appropriate compensation.

Materials and procedures

Affect-inducing films and assessments

Three films adopted from a past study (Tsai et al., 2013) induced positive, neutral and negative affects; each lasted for about four minutes. After the film, participants rated their current emotional states from very unpleasant (100 points) to very pleasant (100) and their arousal state from calm (0) to aroused (100). One of the main purposes of measuring arousal level in this study was to control and purify the effect of emotional valence (e.g., Russell & Carroll, 1999).

Switch task

Miyake et al. (2000) have conducted meta-analysis on various tasks designed to inspect human executive functions. Switching (or shifting) between multiple tasks, operations or mental sets is one of the fundamental executive functions, and a switch task is considered as one of the representative tasks with which to inspect this function. In switch tasks, participants must respond according to a certain rule, which will change during the task. The general findings of this task show that, when the rule changes, participants’ reaction times lengthen. The extra time spent switching rules (switch cost) indicates the perseveration of the prior rule or, conversely, cognitive flexibility (e.g., Smillie, Cooper, Tharp, & Pelling, 2009). The present study modified a switch task from Dreisbach and Goschke (2004) to measure cognitive flexibility because it was found that positive affect could effectively reduce the switch cost in this task.

Participants used the e-prime computer programme to perform the task. In each trial, the screen first showed the fixation point for 250 ms, followed by a blank screen for 250 ms, and then presented two numbers (ranging from 2 to 9) simultaneously in Times New Roman, with a length of 2.4°, and a width of 1.4°, but in different colours. Participants had to judge whether the certain coloured number that appeared was odd or even. After they responded, the next trial proceeded after a wait of 1000 ms. The position of relevant and irrelevant digits changed randomly from trial to trial.

For the first 40 trials, participants had to judge the green number and ignore the purple one. After this, instructions changed—participants needed to judge the grey number and ignore the green one. There were 20 trials for the new rule. Before the formal trials, a 12-trial practice (eight trials for the first rule and four trials for the second rule) acquainted participants with the procedures.

We also adopted the calculation of cognitive flexibility from Dreisbach and Goschke (2004); that is, we calculated two 5-trial average reaction times for correct responses (excluding the error trials) after the switch (from the 42nd to the 46th trial) and before the switch (from the 36th to the 40th trial). The difference between these two (after/before) was the switch cost. The lower the switch cost, the higher the cognitive flexibility. This indicates the ease of preventing interruption of the old rule and adapting a new one (Dreisbach & Goschke, 2004).

Insight problem task

The insight problem task, adopted from Lin et al. (2012), measured participants’ closed-ended creative potentials. This task consists of 10 pure insight problems (Weisberg, 1995), five verbal and five figural and is reasonably reliable (Cronbach’s $\alpha = .68$). Participants proceeded with this task within a 20-minute limit and had to indicate for each problem whether they already knew the answer. The index of closed-ended creativity was the revised number of correct items = (correct items of unknown problems)/(total items of unknown problems) $\times$ 10 (total number of items).

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1The contents of each affect induction film are positive (a mischievous monkey plays tricks on a tiger), neutral (the fabrication process of Michelin tires) and negative (conflict on a football field).
Divergent thinking test
We adopted the Chinese version of the Creative Thinking Test (Wu, 1998) to measure participants’ open-ended creative potentials. This test was designed from subtests of the Torrance Test of Creative Thinking with culturally familiar materials; it has developed a large sample norm in Taiwan, as well as stable reliability and validity results (Wu, 1998). It consists of a verbal and a figural subtest. The participants had to write down or complete as many unusual uses or drawings as possible in the verbal and figural subtests, respectively. They were allowed 10 minutes for each subtest. Two independent raters then scored the results for fluency, flexibility, originality and (for the figural subtest) elaboration. The inter-rater reliabilities of each score were above .94. We also computed the standardised total scores (T scores) for verbal and figural subtests.

RESULTS
Manipulation check of affect induction
The results indicated the effectiveness of affect manipulation: \( F(2, 117) = 63.36, p < .001, \eta^2 = .52 \). Further least significant difference (LSD) comparisons (\( p's < .001 \)) showed that participants’ self-assessments in the positive affect condition (M = 55.13, SD = 25.53) were significantly more positive than those in the neutral affect condition (M = 15.42, SD = 24.54), and the assessments in the neutral affect condition were significantly more positive than those in the negative affect condition (M = 14.18, SD = 32.18).

Arousal also showed significant differences: \( F(2, 117) = 13.35, p < .001, \eta^2 = .19 \). The participants’ arousal levels in the positive affect condition (M = 38.50, SD = 23.43) and negative affect condition (M = 42.38, SD = 25.55) were both significantly higher than those in the neutral affect condition (M = 18.85, SD = 15.10), \( ps < .001 \). There was no difference between positive and negative affect conditions, \( p = .43 \).

Emotional states and switch task
Participants’ error rate on the sampled trials (36th–40th, 42nd–46th) in switch task was 2.9%. After excluding error trials, we also compared participants’ mean response times (RTs) between correct trials immediately following an error with mean RTs of their other correct trials (if they did make an error). The results showed that, before the switch, RTs were not different, \( t(10) = 1.67, p = .13, d = .22 \). However, the mean RTs for correct trials right after an error were significantly longer than the other correct trials after the switch, \( t(14) = 2.15, p = .049, d = .25 \). We therefore omitted RTs immediately following an error after the switch for further analyses.

We conducted a two-factor mixed design analysis of variance (ANOVA) with affect induction (positive/neutral/negative) and rule switch (before switch/after switch) as independent variables and five-trial average RTs as the dependent variable.\(^2\) The results showed no significant main effect of affect induction: \( F(2, 117) = .35, p = .71, \eta^2 = .006 \). However, rule switching did have a significant main effect: \( F(1, 117) = 46.38, p < .001, \eta^2 = .28 \). This indicated a stable switch cost

\(^2\) According to Dreisbach and Goschke (2004), results of the switch task demonstrate a compatibility effect in which RTs in incompatible (incongruent) trials, where targets and distracters map to different response keys, are longer than in compatible trials. We conducted a three (affect induction: positive/neutral/negative) × 2 (rule switch: before switch/after switch) × 2 (response compatibility: compatible/incompatible) three-way ANOVA to inspect compatibility effects. Neither the main effect of compatibility nor interactions between compatibility and other variables were significant. We therefore combined RTs of compatible and incompatible trials for later analyses. Possible reasons for the lack of compatibility effect in our study are that our participants had fewer blocks of trials than in the previous study in order to preserve their emotional states for further creativity tests. Another possibility is that our participants followed instructions well and focused on the targets, which would also explain their lower error rate. Our study collecting two blocks of trials from another independent sample also showed no compatibility effect and a lower error rate (1.82%, Li & Lin, 2013).
There was also a significant interaction effect between affect induction and the rule switch: \( F(2,117) = 3.53, p = .03, \eta^2 = .06 \). Simple main effect analyses showed that \( F(1, 40) = 25.13; 22.31, p's < .001 \) and \( \eta^2 = .40; .37 \), for both the neutral and the negative affect conditions, RTs after the switch (neutral: \( M = 788.64, SD = 155.44 \); negative: \( M = 799.84, SD = 135.20 \)) were significantly slower than those before the switch, (neutral: \( M = 700.11, SD = 126.37 \); negative: \( M = 709.57, SD = 108.81 \)). However, for the positive affect condition, RT difference was only marginally significant before (\( M = 750.94, SD = 139.44 \)) and after (\( M = 782.39, SD = 125.56 \)) the rule switch, \( F(1, 40) = 3.78, p = .07, \eta^2 = .08 \).

For the following mediation analyses, the switch costs (RTs after switch minus RTs before switch, the cognitive flexibility index) of the three conditions (see Table 1) were also computed and compared. LSD analyses revealed switch costs for both the neutral affect condition (\( M = 88.52, SD = 111.05 \)) and the negative affect condition (\( M = 90.27, SD = 118.95 \)) were significantly higher (\( p = .025; p = .021 \)) than those for the positive affect condition (\( M = 31.45, SD = 107.87 \)). The above results demonstrated that participants in the positive affect condition could switch rules more quickly, which replicated a previous study (Dreisbach & Goschke, 2004) which demonstrated that a positive emotional state can foster better cognitive flexibility.

### Emotional states and creativity performance

We compared the participants’ performance on the insight problem task and divergent thinking test separately in three induced affect conditions (see also Table 1). There was a significant difference between the conditions in insight problem performance, \( F(2, 57) = 5.45, p = .007, \eta^2 = .16 \). LSD comparisons (\( p = .002; .029 \)) showed that the numbers of correct items were significantly higher in the positive affect condition \( (M = 4.10, SD = 1.71) \) than those in both neutral \( (M = 2.45, SD = 1.32) \) and negative affect conditions \( (M = 2.95, SD = 1.79) \).

As for divergent thinking performance (see also Table 1), there were also significant differences among conditions for the total scores in the verbal subtest, \( F(2, 57) = 6.30, p = .003, \eta^2 = .18 \), and for the total scores in the figural subtest, \( F(2, 57) = 6.02, p = .004, \eta^2 = .17 \). LSD comparisons (\( p = .001; .03 \)) showed that the total score on the verbal subtest in the positive affect condition \( (M = 175.05, SD = 40.75) \) was significantly higher than those in neutral \( (M = 139.60, SD = 20.05) \) and negative affect conditions \( (M = 152.80, SD = 31.52) \). Although total scores in the negative affect condition seemed higher than those in the

### Table 1. Means and SDs of participants’ switch costs and creative performance in three induced-affect conditions

<table>
<thead>
<tr>
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<th>Positive affect</th>
<th>Neutral affect</th>
<th>Negative affect</th>
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<tbody>
<tr>
<td><strong>Cognitive flexibility</strong></td>
<td></td>
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<tr>
<td>Switch cost (ms)</td>
<td>31.45&lt;sup&gt;a&lt;/sup&gt; (107.9)</td>
<td>88.52&lt;sup&gt;b&lt;/sup&gt; (111.1)</td>
<td>90.27&lt;sup&gt;b&lt;/sup&gt; (119.0)</td>
</tr>
<tr>
<td><strong>Creative performance</strong></td>
<td></td>
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<tr>
<td>Insight problem solving (correct items)</td>
<td>4.10&lt;sup&gt;a&lt;/sup&gt; (1.7)</td>
<td>2.43&lt;sup&gt;b&lt;/sup&gt; (1.3)</td>
<td>2.95&lt;sup&gt;b&lt;/sup&gt; (1.8)</td>
</tr>
<tr>
<td>Verbal divergent thinking (standardised total scores)</td>
<td>175.05&lt;sup&gt;a&lt;/sup&gt; (40.8)</td>
<td>139.60&lt;sup&gt;b&lt;/sup&gt; (20.1)</td>
<td>152.80&lt;sup&gt;b&lt;/sup&gt; (31.5)</td>
</tr>
<tr>
<td>Figural divergent thinking (standardised total scores)</td>
<td>163.20&lt;sup&gt;a&lt;/sup&gt; (24.3)</td>
<td>141.00&lt;sup&gt;b&lt;/sup&gt; (22.7)</td>
<td>157.05&lt;sup&gt;b&lt;/sup&gt; (14.4)</td>
</tr>
</tbody>
</table>

*Note: Different superscript alphabets mean that there are significant differences between conditions (\( p < .05 \)).

<sup>3</sup> The two-way ANOVA analysis with affect induction and creativity type as independent variables showed no interaction effects.
neutral condition, the difference did not reach a significant level ($p = .20$). For the figural subtest performance, LSD comparison ($p = .001; .018$) showed that total scores in the positive ($M = 163.20, SD = 24.25$) and negative affect conditions ($M = 157.05, SD = 14.42$) significantly exceeded those in the neutral affect condition ($M = 141.00, SD = 22.66$).

The above results mostly support previous findings that insight problem-solving performance benefits only from a positive emotional state, while both positive and negative affects can improve divergent thinking performance (Tsai et al., 2013).

**Emotional states influence creativity performance through cognitive flexibility**

The results of the analyses above, respectively, showed that positive affect could reduce switch costs (and, hence, increase cognitive flexibility in the switch task) as well as enhance performance in two types of creativity measures. With three indices obtained on emotional states (self-rated affect), cognitive flexibility (switch cost) and creative performances (correct items in insight problem solving/T scores for verbal and figural subtests in divergent thinking), we further investigated the mediating role of cognitive flexibility in the affect-creativity relationships.

Although manipulation checks on self-assessed ratings and creative performances differed significantly between the different affect conditions, participants’ self-assessed rating of emotional states did not strongly correlate with their creative performances. To examine our hypotheses that only positive affect, not affect per se, could improve insight problem solving but not divergent thinking through the mediation of cognitive flexibility, we computed two contrasts (positive vs. neutral and negative vs. neutral) on the two creative performances. In the first contrast, we coded “the positive condition = 1” as an experimental condition and coded “the neutral condition = 0” as a control condition. In the second contrast, we coded “the negative condition = 1” and “the neutral condition = 0”.

To perform mediation analyses on the two contrasts, partial correlations [control for arousal to exclude the possible confounding from the arousal component of emotional states, Russell & Carroll (1999)] were first calculated. When considering the contrast of positive and neutral affect conditions on insight problem performances ($n = 40$), the results showed that there were significant positive correlations between affect condition and insight problem-solving performance ($r = .49, p = .008$), between affect condition and cognitive flexibility ($r = .45, p = .02$), and between cognitive flexibility and insight problem-solving performance ($r = .44, p = .004$). However, when considering the contrast of negative and neutral affect conditions on insight problem performances ($n = 40$), the results did not show any significant correlations. The correlations between affect condition and insight problem-solving performance, affect condition and cognitive flexibility, and cognitive flexibility and insight problem-solving performance were .18 ($p = .32$), .13 ($p = .70$) and .01 ($p = .97$), respectively.

Similar analyses were computed for divergent thinking performances. For the contrast of positive versus neutral affect conditions ($n = 40$), the results showed that the affect condition significantly correlated with both verbal and figural divergent thinking performances ($r = .49, p = .004; r = .50, p = .004$) and that affect condition and cognitive flexibility were marginally correlated ($r = .33, p = .06$), but cognitive flexibility was not correlated with either verbal ($r = .25, p = .13$) or figural ($r = .15, p = .38$) divergent thinking performances. For the contrast of negative versus neutral affect conditions ($n = 40$), the results revealed that affect condition was not correlated with verbal divergent thinking ($r = .07, p = .68$) and cognitive flexibility was not correlated with figural divergent thinking ($r = .18, p = .28$).

According to Baron and Kenny’s (1986) criterion, only the first contrast (positive and neutral

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4The results might be due to a relatively large variance in separated affect conditions.
The above results demonstrated that, after including cognitive flexibility, the direct effect of affect on insight problem-solving performance significantly decreased, indicating the full mediating effect of cognitive flexibility for positive affect compared to neutral affect. Because the variables mentioned above were not correlated under the contrast of negative and neutral affect conditions, the mediation effect of cognitive flexibility could not exist for the contrast between negative and neutral affect conditions on insight problem solving. These results therefore demonstrate that, as we predicted, cognitive flexibility could only mediate the effect of positive affect, but not affect per se, on insight problem performance.

**Divergent thinking and arousal**

As mentioned earlier, the cognitive flexibility index and divergent thinking performances (for both verbal and figural subtests) did not correlate with each other. Cognitive flexibility was also not a mediator between affect (for both positive vs. neutral and negative vs. neutral contrasts) and divergent thinking performance. Previous studies have shown that arousal can effectively predict divergent thinking, no matter whether in positive or negative emotional states (e.g., Tsai et al., 2013). Did arousal mediate the relationships between emotional states and divergent thinking performance? Because divergent thinking scores and arousal were not different in the positive and negative affect conditions and were both higher than the neutral condition, we computed a contrast to code the affect conditions: positive = negative = 1 (n = 40); and neutral = 0 (n = 20). Correlational analyses (n = 60) showed that the affect condition positively correlated with verbal divergent thinking performance (r = .33, p = .005) and with arousal (r = .42, p < .001), and that arousal significantly corresponded to verbal divergent thinking (r = .28, p = .015). There was no

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5The β value of cognitive flexibility for predicting insight problem performance seemed smaller than that of positive affect. However, the t-test showed a significant result for the former and a marginally significant result for the latter, possibly because of different variances.
significant correlation between arousal and figural divergent thinking. Therefore, we conducted a mediation analysis of arousal only on verbal divergent thinking.

The regression analyses of Model 1 (affect condition → arousal) and Model 2 (affect condition → verbal divergent thinking) showed that the affect condition could boost arousal and verbal divergent thinking ($\beta = .42, p = .001, R^2 = .17$; $\beta = .33, p = .009, R^2 = .11$). When both affect condition and arousal were included in Model 3 (affect condition/arousal → verbal divergent thinking), arousal’s power to predict verbal divergent thinking failed to reach significant levels ($\beta = .17, p = .21$); however, affect’s still did ($\beta = .26, p = .05$), $F = 4.47, p = .016, R^2 = .13, \Delta R^2 = .02$. These results indicate that arousal also could not mediate the effect of emotions on divergent thinking.

**DISCUSSION**

The present study independently measured cognitive flexibility with a switch task and distinguished open-ended (divergent thinking) versus closed-ended (insight problem solving) creativity measures in order to investigate cognitive flexibility’s mediating role in the relationships between positive emotional states and different creative performances. The results of this study showed that induced positive affect, but not negative affect, could reduce switch costs—that is, promote cognitive flexibility, and further enhance participants’ insight problem-solving performance. Cognitive flexibility played a full mediating role in the positive affect—closed-ended creativity relationship. On the other hand, although positive affect could also improve divergent thinking, this influence was not mediated by cognitive flexibility.

These results met our expectations. With respect to Isen’s (2008) notions and the dual process account of creativity (Lin et al., 2012; Lin and Lien, 2013), open-ended divergent thinking relies mainly on System 1 processing (expansive thinking), while closed-ended insight problem solving involves a reciprocal process switching between Systems 1 and 2 (constrained thinking) processing modes. Cognitive flexibility is more crucial to successfully solving insight problems than to divergent thinking.

The results also agreed with physiological findings. For example, evidence has shown that positive affect can affect the brain’s flexibility-related anterior cingulate cortex, increasing its activation, raising its dopamine levels and promoting insight problem solving (Ashby, Valentin, & Turken, 2002; Subramaniam, Kounios, Parrish, & Jung-Beeman, 2009). Studies also found that individuals who are better at solving insight problems exhibited more transformations between $\alpha$ and $\beta$ brainwaves when solving closed-ended creativity problems (Tseng, Tsai, Lin, & Huang, 2012) and were better at controlling their own brainwave transformations (Li, Lin, Huang, & Tseng, 2012) which might represent greater mental flexibility; however, individuals with better divergent thinking abilities did not show these patterns (Li et al., 2012; Tseng et al., 2012). These results support our findings that the mechanism of positive affect on insight problem solving is through the function of cognitive flexibility.

Our data did not demonstrate a mediating role for cognitive flexibility between affect and divergent thinking performance. Arousal level did not mediate this relationship either. However, arousal still coincided with verbal divergent thinking performance ($r = .28$). Some researchers have proposed that arousal caused by emotional state may be a possible mechanism through which emotions can influence creativity. For example, Adamant and Blaney (1996) hypothesised that individuals feel uncomfortable with a high arousal level and use participation in creative activities to reduce such tension. Previous studies have also shown that arousal effectively predicts divergent thinking (e.g., Tsai et al., 2013). A possible reason for arousal’s lack of mediating effect between emotions and divergent thinking is that both positive and negative conditions in this study triggered only moderate levels of arousal. More arousing films (see Tsai et al., 2013) may reveal more significant results. In addition, we found a difference between the verbal and figural subtests of divergent thinking in relation to emotional state and arousal level. These results were not
consistent with Tsai et al. (2013). Researchers have found that verbal and figural creativity are separately related to verbal and visual abilities (e.g., Palmiero, Nakatani, Raver, Belardinelli, & Leeuwen, 2010). The issue of domain-general versus domain-specific creativity calls for further debate and exploration.

In summary, although various manipulations of emotional states, measurements of cognitive flexibility and open- and closed-ended creativity can still be further investigated, this study demonstrated that cognitive flexibility only mediated the link between positive emotional states and one type of creative performance: closed-ended insight problem solving. These results suggest that emotions influence different creative performances through distinct mechanisms.

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