Different attentional traits, different creativities

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A B S T R A C T

This study examines the relationships between two aspects of “breadth of attention” (orienting sensitivity and effortful control) and two forms of creativity (divergent thinking and insight problem-solving). It suggests that the two forms of creativity relate differently to the two modes of attention. This distinction has not been made in previous studies. Intelligence and other personality traits were also assessed as control variables. Over 300 participants’ responses to the Adult Temperament Questionnaire, the Abbreviated Torrance Test for Adults, insight-problem tasks, the HEXACO Personality Inventory, and Raven’s Advanced Progressive Matrices were collected. The results showed that, after the effects of intelligence scores and personality traits were controlled for, individuals’ performance on insight problem-solving was predicted only by orienting sensitivity, while effortful control could only predicted divergent thinking performance. The relationships between attentional traits and creative performances were discussed.

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1. Introduction

The breadth of attention trait has been proposed as a characteristic of creative individuals. For example, the biographies and personal anecdotes of many eminent creators have revealed that they were sensitive to environmental stimuli such as noise (for a review, see Kasof, 1997). Moreover, research studies have found that highly creative individuals had more intrusion errors on dichotic listening tasks (Dykes & McGhie, 1976), and they tended to describe themselves as more “distractible” (Domino, 1970) than did those with low creativity. It was suggested that this wide breadth of attention enables creative individuals to attend to more concepts at a given time, increasing the likelihood of novel and appropriate combinations (e.g., Martindale, 1999; Mendelsohn, 1976). However, various measures of attentional breadth and creative performance have been adopted, indicating that different constructs or processes might be involved in those measurements and that different relationships might exist between breadth of attention and creative performance in relation to these distinct conceptions. The present study aims to explore this issue by specifying two constructs of attention in the Adult Temperament Questionnaire (ATQ; Evans & Rothbart, 2007) that might contribute to breadth of attention, as well as two measures of creative performance that, it has been suggested, involve different processes (Lin & Lien, in press); subsequently, the study explores how these specific constructs/measures might interact.

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1.1. Constructs of breadth of attention

**Breadth of attention** generally refers to the number and range of stimuli that an individual can attend to at any one time (Kasof, 1997; Mendelssohn, 1976). This construct can be empirically assessed by various measures when investigating its relationship with creativity. Some researchers (Domino, 1970; Kasof, 1997) have used self-reported questionnaires to assess this breadth of attention trait in individuals by using descriptors such as “I am tremendously affected by sudden loud noises” (quoted from Kasof, 1997). It was found that the breadth of attention trait in individuals was positively correlated to their creative performance. Other studies utilized different cognitive tasks. For example, Mendelssohn (1976) used a cue utilization paradigm in which the irrelevant peripheral cues later became the targets to attend to (see also Ansburg & Hill, 2003). Individuals were asked to focus on visually presented items while another list of to-be-ignored items was presented acoustically as background noise. Some words from both lists were the solutions to the anagram tasks presented later. It was found that highly creative individuals utilized both focal and peripheral cues more efficiently and solved more anagrams than individuals with low creativity, indicating that the former may have possessed a wider breadth of attention and larger attentional resources (e.g., Ansburg & Hill, 2003; Mendelssohn, 1976). On the other hand, increased attentional breadth was considered to reflect a decreased inhibitory process in which irrelevant task distractions were not properly filtered or inhibited, enabling participants to attend to more peripheral stimuli (Eysenck, 1995; Friedman & Miyake, 2004). For example, researchers (Rowe, Hirsh, & Anderson, 2007) adopted the flanker task, in which individuals were asked to respond quickly and correctly to central stimuli that were presented coupled with irrelevant peripheral stimuli (e.g., NNHNN). It was found that highly creative individuals could not inhibit peripheral cues properly and responded more slowly to the targets when distractors were incompatible with it.

Given that various measures have been used to assess individuals’ breadth of attention, we consider that different facets of attention should be further distinguished. For examples, one of the key differences between the cognitive tasks described above is whether the performance of the main task is hindered while a participant attends to peripheral stimuli. While some can nicely attend to and process both central and peripheral information, others are attracted to peripheral distractors and process the target less effectively. In the domain of questionnaire assessment, similar differentiations could also be made.

1.1.1. Orienting sensitivity versus effortful control

In the Adult Temperament Questionnaire, Evans and Rothbart (2007) differentiate orienting sensitivity and effortful control as two attentional constructs. Following Rothbart’s framework of temperament (Rothbart, Derryberry, & Posner, 1994), Evans and Rothbart (2007) defined orienting sensitivity as awareness of a neutral or emotional stimulation of low intensity originating from the surroundings, or a spontaneous idea not directly related to an association with the surrounding environment. Further, according to Evans and Rothbart (2007) orienting sensitivity consists of three constructs: (1) general-perceptual sensitivity (for example, “I usually notice visual details in the environment,” p. 885); (2) affective-perceptual sensitivity (for example, “I am always aware of how the weather seems to affect my mood,” p. 884); and (3) associative sensitivity (for example, “When I am resting with my eyes closed, I sometimes see visual images,..,” p. 885). Various researchers (Evans & Rothbart, 2007; Komsi et al., 2010; Wiltink, Vogelsang, & Beutel, 2006) have shown that orienting sensitivity is strongly related to openness/intellect in the five-factor framework. Evans and Rothbart (2007) argued that orienting sensitivity could be the substrate of the openness/intellect in a framework of personality development. However, in the framework of creativity, which concerns this study, orienting sensitivity could include other cognitive characteristics. Based on his review, Feist (1998) differentiated two cognitive traits: open and imaginative and open and flexible. Nusbaum and Silvia (2011) distinguished intellect from openness and found that openness is related to creativity, and intellect is associated with fluid intelligence. Orienting sensitivity reflects individuals’ broadly attending to low intensity and peripheral cues, possibly due to having more resources available, as suggested by the cue utilization paradigm (e.g., Ansburg & Hill, 2003; Mendelssohn, 1976), leading people to be flexible and open to new perspectives or ideas.

Meanwhile, effortful control was defined as a set of regulatory processes to inhibit dominant (but inappropriate) responses, to perform subdominant (but avoidant) behaviors, and to control attention (Evans & Rothbart, 2007). It also consisted of three constructs, according to Evans and Rothbart (2007): activation control (for example, “I hardly ever finish things on time,” coded in reverse); attention control (for example, “When interrupted or distracted, I usually can easily shift my attention back to whatever I was doing before,”); and inhibitory control (for example, “It is easy for me to hold back my laughter in a situation where it is not appropriate,” p. 884). Effortful control is considered to be based on executive attention, which serves the functions of error detection, inhibition, and conflict resolution for emotional and cognitive control (Posner & Rothbart, 2007; Rueda, Posner, & Rothbart, 2005). Some evidence has supported the connection between effortful control and conflict resolution, response inhibition or error detection in different cognitive tasks across different age groups (Jones, Rothbart, & Posner, 2003; Posner & Rothbart, 2010; Zabelina & Robinson, 2010). For example, Kanske and Kotz (2012) found that adults with high effortful control could quickly resolve the conflict in the flanker task and Simon task. In relation to the discussion on attentional breadth mentioned above, the notion that wider breadth of attention is represented by lower inhibition with regard to peripheral stimuli may possibly be reflected by lower effortful control (inhibitory control, in particular), as evident by highly creative individuals’ low inhibition to peripheral cues in the flanker task (Rowe et al., 2007).

Orienting sensitivity and effortful control were proposed in studies of adult temperament only recently. Past researches (Rothbart & Bates, 2006) have investigated effortful control in various domains of child development, but its effects on adult life are little known. The effects of orienting sensitivity as well have been seldom studied. Furthermore, no previous study
has inspected the relationships of these two types of attention with creative performance. The present study aims to assess individuals’ orienting sensitivity and effortful control to empirically investigate the relationships between these two facets of attentional breadth and creativity.

1.2. Different measures of creative performance

Researchers have used either divergent thinking tests or insight problem tasks to measure individuals’ creative potential with respect to the “psychometric approach” and the “cognitive approach” in the creativity literature (Sternberg, Lubart, Kaufman, & Pretz, 2005). Divergent thinking ability was referred to as generating many responses to a given question (Guilford, 1956), measured by fluency, originality, and flexibility indices in a divergent thinking test (e.g., Torrance, 1966; Wallach & Kogan, 1965). An insight problem was one that exhibited those properties with regard to which problem-solvers usually encountered obstacles at first and invent a sudden “aha!” solution later (e.g., Dominowski, 1995; Ohlsson, 1984). This kind of problem was considered a productive problem because it could not be solved using existing rules; rather, a reconstruction of the problem representation was required for success (Weisberg, 1995). The accuracy rates of solving insight problems were used as an index of creative ability.

As Wakefield (1989) pointed out, the divergent thinking test was a well-defined, open-solution problem, and an insight problem was an ill-defined, closed-solution one; researchers (Lin, Lien, & Jen, 2005) have identified the different task demands of these two measures with respect to the requirement of novelty and appropriateness. Empirical evidence also showed that performance on the two tasks was not correlated in the same individuals (e.g., Lin et al., 2005) and that various factors correlated differently to these two measures. For example, intelligence was found to be more positively correlated to insight problem-solving than to divergent thinking performance (for a review, see Sternberg et al., 2005). Individuals with better divergent thinking performance were found to exhibit lower cognitive inhibition ability than controls, while individuals with better insight problem-solving performance did not (Lin, 2006). In addition, some big-five personality traits—for example, openness to experience—correlated positively to divergent thinking performance, while emotionality was found negatively correlated to insight problem-solving (Lin, Hsu, Chen, & Wang, 2012). These results suggest that different processes might be involved in divergent thinking and insight problem-solving performance.

1.3. Relationships between different attentional constructs and creative performance

With respect to the different operational definitions of attentional breadth as well as the different processes involved in divergent thinking and insight problem-solving, we hypothesized that orienting sensitivity and effortful control exhibit different relationships with the two creativity measures. If orienting sensitivity could reflect both individuals’ broadly attending to peripheral cues and freely associating different ideas, it was predicted to correlate with individuals’ insight problem-solving performance and divergent thinking. However, given the relationships between orienting sensitivity and openness as well as between openness and divergent thinking, the effects of orienting sensitivity on the performance of divergent thinking should vanish when the effects of openness on divergent thinking are predicted in advance. On the other hand, if effortful control (inhibitory control in particular) reflected cognitive inhibition abilities, individuals with good divergent thinking performance might exhibit lower effortful control, considering that previous studies suggesting negative correlations between cognitive inhibition and creativity have used mostly divergent thinking measurements (e.g., Eysenck, 1995; Lin, 2006).1

In the present study, we thus use ATQ to measure participants’ orienting sensitivity to examine our hypotheses. We also measured personality traits and intelligence as control variables. As mentioned previously, research has revealed overlaps between constructs of attentional temperament and personality variables. For example, orienting sensitivity is found to be related to openness/intellect in the five-factor framework (Evans & Rothbart, 2007; Komsí et al., 2010; Wiltink et al., 2006). In addition, personality traits (e.g., Lin et al., 2012; Runco, 2007) and intelligence (e.g., Batey, Chamorro-Premuzic, & Furnham, 2009; Nusbaum & Silvia, 2011; Sternberg et al., 2005) are also correlated differently to different creativity measures. Controlling for these variables allows us to clarify the relationships among two kinds of attention constructs and two types of creative performance. In addition, due to the fact that effortful control and orienting sensitivity have not been used before and the distinction between insight problem-solving and divergent thinking has been less investigated for Taiwanese adults, we inspected the factor structure of attentional traits and creativities.

2. Methods

2.1. Participants and general procedures

A total of 320 undergraduate students from five universities in Taiwan participated in this study (57.8% female; mean age = 19.45, SD = 1.89). Each participant gave informed consent and participated in some or all subtests (insight

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1 Besides Eysenck’s (1995) pioneering idea about the relationships between high creativity and low inhibition, several recent studies empirically support this notion. For example, empirical evidence demonstrated that highly creative individuals showed lower inhibitory function in the latent inhibition paradigm (Carson, Peterson, & Higgins, 2003; Kéri, 2011), using divergent-thinking kinds of creativity measures.
problem task, HEXACO Personality Inventory, and Adult Temperament Questionnaire: \( n = 284 \); Abbreviated Torrance Test for Adults: \( n = 301 \); Raven’s Advanced Progressive Matrices: \( n = 291 \) in consecutive testing sessions at two-week interval, with each session lasting 1 h. All participants received a gift and were debriefed after finishing all tasks.

2.2. Attentional traits measures

Effortful control and orienting sensitivity were assessed by using the ATQ (Evans & Rothbart, 2007), including the subscales of activation control (12 items), attention control (12 items), and inhibitory control (11 items) as the measures of effortful control and the subscales of general-perceptual sensitivity (17 items), affective-perceptual sensitivity (18 items), and associative sensitivity (17 items) as the measures of orienting sensitivity. A 5-response Likert scale was used. Descriptive statistics and intercorrelations for the scales of orienting sensitivity and effortful control are reported in Table 1. As shown in Table 1, six subscales had satisfactory levels of internal consistency, as did the whole scale of effortful control and orienting sensitivity.

2.3. Creativity measures and procedures

2.3.1. Insight problem task

Eighteen insight problems (9 verbal and 9 figural) were first chosen from an insight problem inventory website at Indiana University (www.indiana.edu/~bobweb/d4.html), with respect to the criterion of “pure” insight problems that necessarily require a reconstructing process (Weisberg, 1995). Based on a pretest, problems with moderate difficulty levels (accuracy rates ranging from 21.6% to 70%) were chosen. The chosen verbal/figural problems correlated moderately with the figural/verbal problem accuracy and correlated significantly with total accuracy. Therefore, the insight problem task for the test consisted of 10 problems: 5 verbal (e.g., the earth problem, the hole problem) and 5 figural (e.g., the line problem, the pigpen problem), counterbalancing the proceedings of the verbal and figural questions.

The participants were given 20 min for this task and each problem was checked at the end to determine whether participants had previously known the answer to any of the problems. The performance scores were calculated as the percentage of correct answers to unfamiliar problems of the verbal and figural problems, as well as to the total of 10 insight problems. The participants’ average accuracy rates on the verbal, figural, and all problems were 38% (SD = .29), 43% (SD = .28), and 40% (SD = .25), respectively. The correlation of accuracy rates between the verbal and figural problems was .55 (\( p < .01 \)). To accurately estimate the coefficients of internal consistency for the scales of insight problems, tetrachoric correlations were used to calculate a coefficient alpha (Gadermann, Guhn, & Zumbo, 2012). As Table 1 shows, Cronbach’s \( \alpha \) was .68 for the verbal problems and the figural problems, and .88 for all problems.

2.3.2. Abbreviated Torrance Test for Adults (ATTA)

The Chinese version of the ATTA (Chen, 2006) is an abbreviated and translated version of the Torrance Tests of Creative Thinking (Torrance, 1966). The test was developed as a large-sample norm in Taiwan for undergraduate students and established stable reliability and validity results. It includes three subtests: a verbal test (question enumeration) and two figural tests (figural completion), with 3 min allowed for each subtest. The participants’ responses were scored by two independent raters for fluency, flexibility, originality, and elaboration scores, which are among the most representative indices of divergent thinking abilities. The fluency scores were simply the total number of responses generated by each participant. The flexibility scores represented the number of different categories of responses. The originality scores represented the sum of scores on each response compared to the norm; they were scored as either 0 (responses within the norm) or 1 (novel responses). The elaboration scores of the figural subtest were scored as the number of elaborated decorations in each response. Descriptive statistics are reported in Table 1.

The participants’ performance on the ATTA was scored as follows: fluency: 12.11 ± 4.09; flexibility: 7.87 ± 2.69; originality: 3.22 ± 2.42; and elaboration: 5.36 ± 4.31. The scores for these indices were significantly correlated with the scores for each of the others (the Pearson’s \( r \) ranged from .31 to .83, \( p < .01 \), except for originality and elaboration exhibited no correlation, \( r = .07 \)). The inter-rater reliability ranged from .83 to .96.

2.4. Personality measures

Lee and Ashton (2004) and Ashton and Lee (2009) developed a Revised HEXACO Personality Inventory (HEXACO-PI-R) that measures six personality traits: honesty/humility, emotionality, extraversion, agreeableness, conscientiousness, and openness to experience. These six personality traits were derived from the factor analysis results of the personality lexicons of six different languages, and this personality model was considered to be more generalizable and inclusive than the five-factor model (Lee & Ashton, 2004). There are 16 items for each personality trait. A 5-response Likert scale was used. There were satisfactory levels of internal consistency coefficients across the six scales (ranging from .74 to .82) in this study.
Table 1
Basic descriptions and intercorrelations for the scales of attentional traits and creativities.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>Correlations</th>
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<tr>
<td><strong>ATQ Effortful Control</strong></td>
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<tr>
<td>1. Inhibitory control</td>
<td>39.65</td>
<td>4.96</td>
<td>.62</td>
</tr>
<tr>
<td>2. Activation control</td>
<td>43.90</td>
<td>5.73</td>
<td>.40</td>
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<tr>
<td>3. Attention control</td>
<td>44.17</td>
<td>5.93</td>
<td>.42</td>
</tr>
<tr>
<td>4. Effortful control</td>
<td>127.89</td>
<td>12.63</td>
<td>.76</td>
</tr>
<tr>
<td><strong>ATQ Orienting Sensitivity</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>5. General-perceptual sensitivity</td>
<td>70.41</td>
<td>7.71</td>
<td>.10</td>
</tr>
<tr>
<td>6. Affective-perceptual sensitivity</td>
<td>69.40</td>
<td>7.62</td>
<td>.11</td>
</tr>
<tr>
<td>7. Associative sensitivity</td>
<td>62.60</td>
<td>8.17</td>
<td>-.06</td>
</tr>
<tr>
<td>8. Orienting sensitivity</td>
<td>202.72</td>
<td>19.46</td>
<td>.04</td>
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<tr>
<td><strong>Insight problem task</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>9. Insight-figural</td>
<td>.38</td>
<td>.29</td>
<td>.07</td>
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<tr>
<td>10. Insight-verbal</td>
<td>.43</td>
<td>.28</td>
<td>.09</td>
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<tr>
<td>11. Insight-total</td>
<td>.40</td>
<td>.25</td>
<td>.09</td>
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<tr>
<td><strong>ATTA</strong></td>
<td></td>
<td></td>
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<tr>
<td>13. Originality</td>
<td>3.22</td>
<td>2.42</td>
<td>-.05</td>
</tr>
<tr>
<td>14. Elaboration</td>
<td>5.36</td>
<td>4.31</td>
<td>.02</td>
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</tbody>
</table>

Coefficients on diagonal: Cronbach’s alpha.
* Inter-rater reliabilities.
** p < .05.
*** p < .01.
2.5. Intelligence measure and procedures

The Chinese version of Raven’s Advanced Progressive Matrices (APM; Yu, 1993) was administered to assess participants’ fluid intelligence (Raven & Raven, 2008). In each test item, several shapes were presented together with an empty one. The participants had to identify the relationships between the presented shapes, choosing the most reasonable shape from among eight shapes to predict the blank one. We excluded the first 12 items and used items 13–36 because the first 12 items were found to add little to the discriminative power of the test (Bors & Stokes, 1998). The total administration time was 25 min.

The participants’ performance scores were calculated as the total number of items answered correctly. Our participants’ scores ranged from 0 to 23, with means = 12.45 and SD = 5.16 (Cronbach’s α was .84).

2.6. Plan of analysis

Before examining the main predictions of this study, we inspected the structure of attentional traits and creativities. Besides examining the correlations among attentional traits, creativity performances, personality traits and intelligence, several confirmatory factor analyses (CFA) were conducted to examine a one-factor model and a two-factor model for attentional traits and creativities, respectively. The maximum likelihood estimation method was used in the LISREL 8.80 for all of these CFA. The details of the different models are described in Section 3.

After these analyses, a series of hierarchical multiple regression analyses were conducted to examine the effects of effortful control and orienting sensitivity on insight problem-solving and divergent thinking. In order to control the effects of many personality and intelligence variables, we entered personality and intelligence variables into the equation in the first step to rule out the effects of those control variables in the regression analyses. Then, orienting sensitivity and effortful control were entered in the second step to examine the contributions of those attentional traits to different creativities.

3. Results

3.1. Distinctions between different attentional constructs

3.1.1. Orienting sensitivity and effortful control

As shown in Table 1, the three aspects of orienting sensitivity—general-perceptual sensitivity, affective-perceptual sensitivity, and associative sensitivity—were positively correlated with one another (rs = .63, .43, and .49) and correlated significantly with the whole scale (rs above .79). The three aspects of effortful control—inhibitory control, activation control, and attention control—were also positively correlated (rs = .40, .42, and .30) and correlated significantly with the whole scale (rs above .75). Although both constructs reflect the concept of attentional breadth, some aspects of orienting sensitivity and effortful control were not correlated (rs ranged from −.06 to .11), and some were mildly positively correlated (rs ranged from .13 to .24) with small effect sizes, as defined by Cohen (1988).

To further inspect the two constructs of attentional traits, confirmatory factor analyses were conducted to verify the structure of effortful control and orienting sensitivity. A two-factor model with correlated factors was tested. Activation control, inhibitory control, and attention control were the indicators of effortful control; general-perceptual sensitivity, affective-perceptual sensitivity, and associative sensitivity were the indicators of orienting sensitivity. The model fit the data well: χ² (8; n = 281) = 23.33, p < .001, root mean square error of approximation (RMSEA) = .078, 90% Confidence Interval (CI) for RMSEA = (.040; .119), standard root mean square residual (SRMR) = .05, non-normed fit index (NNFI) = .93, and comparative fit index (CFI) = .96. In addition, we also set and tested all scales of effortful control and orienting sensitivity in a one-factor model. The model did not fit the data: χ² (9; n = 281) = 120.52, p < .001, RMSEA = .21, 90% CI for RMSEA = (.178; .245), SRMR = .132, NNFI = .54, and CFI = .73. Those results indicated that these two constructs were better considered as distinct.

3.1.2. Relationships between attentional traits and control variables

The correlations of orienting sensitivity and effortful control with the scales of HEXACO-PI-R are reported in Table 2. All of the subscales of orienting sensitivity were mainly positively correlated to openness (rs ranged from .49 to .64). On the other hand, inhibitory control, activation control, and effortful control were mainly positively correlated with conscientiousness (rs = .45, .60, and .58); however, the correlation of attention control with conscientiousness was only .28. In addition, attention control was positively and moderately correlated with agreeableness (r = .25) and openness (r = .30) but negatively with emotionality (r = −.39). Activation control had moderate correlations with honesty–humility (r = .19), agreeableness (r = .15), and openness (r = .13). Inhibition control was positively and moderately correlated with honesty–humility (r = .27) and agreeableness (r = .30) but negatively with emotionality (r = −.21). Moreover, General-perceptual sensitivity and affective-perceptual sensitivity were mildly correlated with extraversion (both r = .20) and conscientiousness (rs = .18 and .25, respectively). Other correlations of the subscales of effortful control and orienting sensitivity with the scales of HEXACO-PI-R were low. Finally, inhibitory control and associative sensitivity were positively correlated with APM (rs = .11 and .12, respectively), whereas activation control was negatively correlated with APM (r = −.13).
Table 2
The relationships between attentional traits, creativity measures and control variables.

<table>
<thead>
<tr>
<th></th>
<th>HEXACO-PF-R</th>
<th>APM</th>
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<tbody>
<tr>
<td></td>
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<tr>
<td><strong>ATQ, Effortful Control</strong></td>
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<td></td>
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<tr>
<td>Inhibitory control</td>
<td>.27**</td>
<td>-.21**</td>
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<tr>
<td>Activation control</td>
<td>.19**</td>
<td>-.03</td>
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<tr>
<td>Attention control</td>
<td>.09</td>
<td>-.39'</td>
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<tr>
<td>Effortful control</td>
<td>.24**</td>
<td>-.28'</td>
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<tr>
<td><strong>ATQ, Orienting Sensitivity</strong></td>
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<tr>
<td>General-perceptual sensitivity</td>
<td>-.02</td>
<td>-.04</td>
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<tr>
<td>Affective-perceptual sensitivity</td>
<td>-.12'</td>
<td>-.13</td>
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<tr>
<td>Associative sensitivity</td>
<td>-.15'</td>
<td>-.05</td>
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<tr>
<td>Orienting sensitivity</td>
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<td>.01</td>
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<tr>
<td><strong>Insight problem task</strong></td>
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<tr>
<td>Insight-figural</td>
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<td>-.10</td>
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<td>Insight-verbal</td>
<td>.05</td>
<td>-.18'</td>
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<tr>
<td>Insight-total</td>
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<td>-.16'</td>
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<td><strong>ATA</strong></td>
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<tr>
<td>Elaboration</td>
<td>-.09</td>
<td>.11</td>
</tr>
</tbody>
</table>

APM, advanced progressive matrix; H, honesty–humility; E, emotionality; X, extraversion; A, agreeableness; C, conscientiousness; O, openness to experience.  
** p < .05.  
* p < .01.

3.2. Distinctions between different creativity measures

3.2.1. Divergent thinking and insight problem performance

The results showed that *fluency* and *flexibility* in the divergent thinking test exhibited low positive correlations with the *verbal*, *figural*, and *total insight* problem-solving accuracy (rs ranged from .19 to .26), while the indices of *originality* and *elaboration* were not correlated with insight problem performance (rs ranged from .01 to .11).

In CFA for examining the factor structure of creativity performance, a two-factor model with correlated factors was also set. *Fluency, flexibility, originality, and elaboration* were the indicators of divergent thinking; *verbal problem-solving* and *pictorial problem-solving* were the indicators of insight problem-solving. The model fit indices were satisfactory: $\chi^2 (8; n = 281) = 5.93, p = .65$; RMSEA = .002, 90% CI for RMSEA = (.0002; .059), SRMR = .02, NNFI = .98, and CFI = .98. In addition, we also set and tested all scales of insight problem-solving and divergent thinking in a one-factor model. The model did not fit the data: $\chi^2 (9; n = 281) = 80.68, p < .001$, RMSEA = .17, 90% CI for RMSEA = (.136; .203), SRMR = .109, NNFI = .69, and CFI = .81. Those results indicated that these two constructs could be considered as distinct.

3.2.2. Relationships between two creativity measures and control variables

As shown in Table 2, the indices of divergent thinking were found to mainly positively correlate to *openness to experience* (rs ranged from .19 to .24, $p < .01$), while the indices of insight problem-solving were mainly negatively correlated to *emotionality* ($r = -.18$ and $-.16$ for verbal and total scores, $p < .05$, and $r = -.10$ for figural scores) and also positively correlated with *agreeableness* (rs ranged from .17 to .20, $p < .05$). Both the indices of divergent thinking and insight problem-solving were positively correlated to the APM scores, although the extent of the correlations was smaller for the former (rs ranged from .20 to .23, $p < .01$, except for originality: $r = .01$) than the latter (rs ranged from .39 to .46, $p < .01$). These results indicate that individuals’ performance on the two creativity measures was not closely related and that the two measures correlated differently with personality traits and intelligence, suggesting a distinction between the two measures.

3.3. Relationships between different attentional constructs and different creativity measures

As shown in Table 1, most of indices of divergent thinking were positively correlated to *orienting sensitivity* and its subscales (rs ranged from .12 to .21, except the *originality* and *elaboration* indices with associative sensitivity, where rs = .05 and .08, respectively). Furthermore, the *fluency* and *flexibility* indices were positively correlated to *attention control* ($r = .23$ and .18, $p < .01$, respectively) and to the whole scale of *effortful control* ($r = .14$ and .13, $p < .05$, respectively). On the other hand, most of the indices of insight problem-solving were positively correlated to *associative sensitivity* (rs = .23 and .20 for the *verbal* and total indices, $p < .01$; and $r = .13$ for the *figural* index, $p < .05$) and to the whole scale of *orienting sensitivity* (rs = .17 and .16 for the *verbal* and total indices, $p < .05$; except $r = .11$ for the *figural* index). The indices of insight problem-solving were not correlated with *effortful control*. 
Table 3
The predicted values of intelligence, personality traits and attentional constructs on creativity performances.

<table>
<thead>
<tr>
<th></th>
<th>Insight problem</th>
<th>Divergent thinking</th>
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<tbody>
<tr>
<td></td>
<td>Verbal</td>
<td>Figural</td>
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<tr>
<td>Model 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>APM</td>
<td>.34***</td>
<td>.39***</td>
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<tr>
<td>H</td>
<td>−.05</td>
<td>−.07</td>
</tr>
<tr>
<td>E</td>
<td>−.13†</td>
<td>−.10†</td>
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<tr>
<td>X</td>
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<td>.05</td>
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<tr>
<td>A</td>
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<td>C</td>
<td>.04</td>
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<tr>
<td>O</td>
<td>.11†</td>
<td>−.02</td>
</tr>
<tr>
<td>ΔR</td>
<td>.16</td>
<td>.18</td>
</tr>
<tr>
<td>ΔR7, 312)</td>
<td>8.20***</td>
<td>9.53***</td>
</tr>
<tr>
<td>Model 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>APM</td>
<td>.34***</td>
<td>.39***</td>
</tr>
<tr>
<td>H</td>
<td>−.02</td>
<td>−.05</td>
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<tr>
<td>E</td>
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<td>A</td>
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<td>C</td>
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<tr>
<td>O</td>
<td>.02</td>
<td>−.10</td>
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<tr>
<td>OS</td>
<td>.15</td>
<td>.14†</td>
</tr>
<tr>
<td>EC</td>
<td>−.08</td>
<td>−.02</td>
</tr>
<tr>
<td>ΔR</td>
<td>.02</td>
<td>.01</td>
</tr>
<tr>
<td>ΔR2, 310)</td>
<td>2.95†</td>
<td>2.35*</td>
</tr>
</tbody>
</table>

APM, advanced progress matrix; H, honesty–humility; E, emotionality; X, extraversion; A, agreeableness; C, conscientiousness; O, openness to experience; OS, orienting sensitivity; EC, effortful control.
† p < .05.
‡ p < .01.
*** p < .001.

According to the aforementioned results, intelligence and some personality traits were correlated with performance on these two creativity measures and attentional traits. Thus, to clarify how orienting sensitivity and effortful control could predict creative performance, hierarchical multiple regression analyses were conducted. In these regression analyses, the personality traits of HEXACO-PI-R as well as intelligence were entered first as control variables; then orienting sensitivity and effortful control were entered to estimate their effects on two creativity performances. These regression analyses results are shown in Table 3.

As Table 3 shows the effects of most of the control variables were similar in Model 1 and Model 2. In the Model 2 (after entering the orienting sensitivity and effortful control), the APM scores were able to predict both creativity performance (with β = .20 to .41, except for originality β = .01); emotionality negatively predicted insight problem-solving performance (with β = −.11 to −.15); and openness to experience positively predicted divergent thinking performance (with β = .16–.23). This result pattern is similar to the correlational findings. Interestingly, when APM scores and the personality traits of HEXACO-PI-R were controlled for, orienting sensitivity could predict only insight problem-solving (β = .15, .14, and .17 for the verbal, figural, and total scores, p < .05 and < .01, ΔR² = .01–.02, p < .05). On the other hand, effortful control could predict only the flexibility index (with β = .16, p < .05, ΔR² = .01, p < .1) in divergent thinking, although the “positive” value was not expected.

4. Discussion

The present study examined how two attentional constructs relate in different ways to two measures of creativity. Our results generally showed that the assessment of orienting sensitivity and effortful control in the ATQ as well as the creativity measurements of divergent thinking and insight problem-solving were distinct constructs or processes, and that they showed respectively different relationships with the personality traits of HEXACO-PI-R and APM. In the regression analyses, although APM scores exhibited significant predictive power with respect to creativity—which is consistent with previous notions (e.g., Nusbaum & Silvia, 2011; Sternberg et al., 2005)—attention scales did have independent effects on creativity when the effects of personality traits and intelligence were controlled for. Orienting sensitivity was found to be able to predict insight problem-solving performance, while effortful control could predict fluency and flexibility in divergent thinking. These results indicated that the two attentional constructs exhibited different relationships with the two creativity measures.

4.1. Orienting sensitivity, effortful control, and personality traits

Evans and Rothbart (2007) separated effortful control from orienting sensitivity and found that there was negative relation between these two constructs (see also, Komsi et al., 2010). When inspecting the results concerning two attention
constructs and their relationships with openness and conscientiousness, we found that all of the scales of orienting sensitivity were strongly correlated to openness, while attention control and effortful control were mildly positively correlated with openness. By contrast, all of the scales of effortful control were strongly correlated with conscientiousness, while general-perceptual, affective-perceptual sensitivity, and orienting sensitivity had mildly positive correlations with conscientiousness. These results further implied that effortful control and orienting sensitivity were different but positively related. Past research found similar patterns of correlation between effortful control and orienting sensitivity in Taiwanese adolescents (Hsu, 2010). As Rogoff (2003) suggested, middle-class U.S. parents train their children to focus on one thing at a time, whereas Mayan parents direct their children's attention broadly. The effect of cultural difference on the relationships between effortful control and orienting sensitivity is an interesting issue worthy of further exploration.

Furthermore, the distinction between orienting sensitivity and effortful control might be reconsidered conceptually in a broader context with respect to the framework of dual-process theories of cognition (Evans, 2003, 2008; Evans & Frankish, 2009; Stanovich & West, 2000). The dual-process theories suggest that people possess two alternative processing systems under one cognitive function. One is the heuristic system (or System 1), which processes information in an associative, intuitive, and effortless manner without capacity limits; the other is the analytic system (or System 2), which involves logical and rule-based processes in which execution relies on cognitive resources. Researchers (e.g., Stanovich, 1999) indicate that the choice of processing mode depends partly on variables of individual differences, for example, different cognitive styles (such as those seen in the innovator–adapter distinction, Kirton, 1994; or in the holistic–analytic distinction, Zhang & Sternberg, 2006) and personality traits. Openness was found to be positively related to System 1 processing (e.g., Lin et al., 2012), and our results also show that orienting sensitivity is particularly related to openness. How the two constructs of attention correspond to dual-process modes is another interesting issue worth further investigation.

4.2. Orienting sensitivity and two different creativities

Our results show that orienting sensitivity was positively correlated to insight problem-solving performance and could predict it even after personality traits and intelligence were controlled. On the other hand, although orienting sensitivity exhibited positive correlations with indices of divergent thinking, this effect disappeared after personality traits (especially openness) and intelligence were controlled for in the regression analysis in Table 3. These results, taken together, not only suggest that the two creativity measures correlate differently with distinct attentional constructs, but also suggest that there are two components of orienting sensitivity that could be found: one is related to the absorptive nature of openness, and the other is related to cognitive flexibility, as proposed by Feist (1998). Cognitive flexibility could foster the ability to attend flexibly to information and is especially crucial in solving insight problems (e.g., Weisberg, 1995), while divergent thinking performance could be fully explained by openness, not specifically with respect to this aspect of attentional traits.

4.3. Effortful control and divergent thinking

Although effortful control could predict only divergent thinking performance in our results, the positive coefficients were inconsistent with previous findings that there were negative correlations between cognitive inhibition and divergent thinking performance (e.g., Eysenck, 1995; Lin, 2006). Harnishfeger (1995) categorized the concept of inhibition into behavioral (action control) versus cognitive (thought control) categories, and research has found mixed correlational results for different inhibitory tasks (MacLeod, Dodd, Sheard, Wilson, & Bibi, 2003). For example, effortful control in the ATQ (some items could be more compatible with the behavioral level) was not correlated with the reaction time of conflict solution in the Attention Network Test (Posner et al., 2002). It is possible that the behavioral and cognitive levels of inhibition perform different roles in divergent thinking.

In addition, as shown in Table 1, only the subscale of attention control in effortful control was positively correlated with the fluency and flexibility indices in divergent thinking. The analyses showed that the other two subscales, as shown in Table 2—activation control and inhibitory control—were highly and positively correlated with conscientiousness, while attention control was moderately correlated with conscientiousness as well as with several other personality traits, such as agreeableness, openness, and emotionality. These results implied that the psychological processes of attention control could be somewhat different from the other two subscales of effortful control. Researchers (e.g., Anderson, 2002; Nusbaum & Silvia, 2011; Zabelina & Robinson, 2010) recently examined the role of executive functions in idea generation within divergent thinking. For example, Gilhooly, Fioratou, Anthony, and Wynn (2007) suggested that good divergent thinking performance requires identifying a useful strategy to resolve interference, and hence involves executive cognition. It is possible that attention control reflects more generally on the executive functions which fosters fluency and efficiency and enhances divergent thinking performance. These possibilities need to be further investigated.

5. Conclusion

This preliminary study provided empirical evidence demonstrating that aspects of attentional traits—for example, orienting sensitivity and effortful control—may have different effects on two widely applied creativity measures: divergent thinking and insight problem-solving. We used the orienting sensitivity and effortful control scales from ATQ as a measure of two aspects of attentional breadth in this study. Although these scales could measure some processes of cognitive
mechanisms, it is possible that some research procedures in a self-reported inventory could limit the effects of these two attentional traits. In addition, the low levels of internal consistency for the subscales of insight problems and the small effect size of attentional control on the performance of divergent thinking should be approached with caution to explain these results in this study and still need further investigation. In sum, the exploratory findings provided by this study could help clarify the relationships between the breadth of attention trait and different kinds of creative performance, suggesting an important direction for future research examining the mental construct of attentional traits and investigating the relationships of various factors with creativity.

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