The Relations of Gender and Personality Traits on Different Creativities: A Dual-Process Theory Account

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In the present study we examine the ways in which gender and personality traits are related to divergent thinking and insight problem solving. According to the dual-process theory account of creativity, we propose that gender and personality traits might influence the ease and choice of the processing mode and, hence, affect 2 creativity measures in different ways. Over 300 participants’ responses on the Abbreviated Torrance Test for Adults (Chen, 2006), HEXACO Personality Inventory (Ashton & Lee, 2009; Lee & Ashton, 2004), Raven’s Advanced Progressive Matrices (Yu, 1993), and performance while conducting insight-problem tasks, are collected. The results show that Openness was positively correlated with divergent thinking performance, whereas Emotionalty was negatively correlated with insight problem-solving performance. Women performed better on divergent thinking tests, whereas men’s capabilities were superior on insight problem tasks. Furthermore, Openness exhibited a mediating effect on the relationships between gender and divergent thinking. The relationships among gender, personality, and creative performance, as well as the implications of these findings on cultural differences and real-field creativity, are discussed.

Keywords: HEXACO, personality trait, gender, divergent thinking, insight problem-solving

Creativity is closely related to human development and achievement at the individual or societal level. Researchers have investigated creativity from several aspects (e.g., the 4P model, or the Person, the Product, the Process, and the Press; Mooney, 1963; Rhodes, 1961). Various measures are used to differentiate high from low creative abilities. When considering people’s creative potentials, divergent thinking is the main focus of the “psychometric approach,” and creative problem solving (e.g., insight problem solving) is extensively investigated in the “cognitive approach” (Sternberg & Lubart, 1999; Sternberg, Lubart, Kaufman, & Pretz, 2005). Both are representative indexes that were widely applied. Nevertheless, theories and accumulating evidence have shown that these two measures of creativity might involve two distinct processes (Perkins, 1998; Sternberg et al., 2005; Wakefield, 1989). These two processes are correlated with different cognitive factors (Lin, 2006; Lin, Hsu, Chen, & Chang, 2011; Lin & Lien, 2011). Further, individuals’ performances on the two measures are not correlated (Lin, Lien, & Jen, 2005). In the present study we investigate how personality traits, as well as gender, correlate differently with divergent thinking and creative problem-solving abilities in accordance with the dual-process theory account of creativity (Lin & Lien, 2011). In the following paragraphs, we briefly review the distinction between these two types of creativity measures. Our predictions about the ways they relate to individuals’ personality traits and gender, based on the dual-process theory account of creativity, are then proposed.

Distinction Between Divergent Thinking and Creative Problem Solving

The concept of divergent thinking refers to the ability to generate diverse and numerous responses to a given question that increases the likely output of creative ideas (Guilford, 1956). It serves as the theoretical basis for many creativity tests (Guilford, 1963; Torrance, 1966; Wallach & Kogan, 1965) in the psychometric approach for creativity (Sternberg & Lubart, 1999; Sternberg et al., 2005). For example, the examinee is asked to list as many as possible interesting and unusual uses for a brick in accordance with the Unusual Uses Test (Guilford, 1956). Four main indexes are then applied to assess responses and reflect divergent thinking ability: (1) The fluency index refers to the
ability to generate many responses; (2) the flexibility index refers to the ability to switch categories between responses; (3) the originality index refers to the ability to generate rarely seen responses according to the norm; and (4) the elaboration index is specifically used with respect to a figurative question that refers to the degree of elaboration that is achieved by adding detailed decorations.

On the other hand, the tradition of investigating creative problem-solving ability in the cognitive approach traces back to studies about insight problems by Gestalt psychologists. Problem solvers usually encounter obstacles at first, then later invent a sudden "a-ha!" solution (Dominowski, 1995; Ohlsson, 1984; Wallas, 1926). For example, in a situation in which participants were required to attach a candle to a wall by using the only objects that were available, they usually encountered obstacles (functional fixedness of the tack box as a container, not a candlestick) and could not successfully solve the problem (i.e., the candle problem; Duncker, 1945). This type of problem is considered a "productive problem" and requires more creativity than a "reproductive problem" (such as algebraic problems) because it cannot be solved by the existing rules. Instead, a reconstruction of the problem representation is required to achieve success (Weisberg, 1995). The number of correctly solved insight problems is usually used as an index of creative ability in this approach.

Wakefield (1989) differentiated problem types along ill- versus well-defined and open- versus closed-solution dimensions. A divergent thinking task is described as a well-defined, open-solution problem, whereas an insight problem is considered as an ill-defined, closed-solution one. With respect to the essential properties of creativity (i.e., novelty and appropriateness; Mayer, 1999), an open-solution, divergent thinking question better emphasizes the novelty aspect of creativity (e.g., numerating the uses of a brick without considering whether they are practical. Only the number and unusualness of the responses are scored). In contrast, an insight or creative problem with a specific solution goal (e.g., successfully attaching a candle to a wall) demands ideas that are novel as well as appropriate, which are consistent with the problem constraints (e.g., using only objects available; Lin & Lien, 2011; Lin et al., 2005).

Empirical evidence indicates that individuals’ performance on the two tasks did not correlate with each other (e.g., Lin et al., 2005), as well as that various cognitive factors correlated differentially to these two measures. For example, intelligence is found to exhibit moderate positive correlations with creative problem solving, but it correlates with divergent thinking to a lesser extent (Stemberg et al., 2005). Similarly, working memory capacity is found to be positively correlated with insight problem solving, but not with divergent-thinking performance (Lin & Lien, 2011). Individuals with better divergent thinking performance are found to exhibit lower cognitive inhibition ability (as measured by a retrieval-induced-forgetting paradigm, Anderson, Bjork, & Bjork, 1994) than controls, whereas individuals with better insight problem-solving performance do not (Lin, 2006). In addition, the aspects of the breadth of attention are found to exhibit different roles in divergent thinking and insight problem solving (Lin et al., 2011).

Lin and Lien (2011) suggested that these results reflected different processes that might involve in divergent thinking and creative problem solving with respect to the framework of dual-process theories of cognition (J. St. B. T. Evans, 2003, 2007; Sloman, 1996; Stanovich & West, 2000). Dual-process theories have been proposed to account for individuals’ cognitive processing on wide-ranging cognitive functions, including learning and memory, reasoning, decision making, and judgment (J. St. B. T. Evans, 2008). These theories assume that people possess two alternative process systems under one cognitive function. System 1 (or the heuristic system) processes information in an associative, intuitive, and effortless manner without capacity limits. It is evolutionarily early and comprises prior knowledge and experience. On the other hand, System 2 (or the analytic system) involves logical and rule-based processes in which execution relies on cognitive resources. It is considered evolutionarily recent and permits abstract thinking. For example, in a syllogism task, a logically correct validity judgment is proposed to be derived from System 2 processing, whereas a judgment influenced by prior experiences or beliefs without considering its logical status is derived from System 1 processing (i.e., the belief-bias effect; J. St. B. T. Evans, 2003).

Different tasks also might require differential involvement of both systems (Stanovich, 1999). With respect to these viewpoints pertaining to the context of creativity, Lin and Lien (2011) proposed that idea generation in divergent thinking, which emphasizes novelty, primarily relies on associative, effortless System 1 processing. On the other hand, the ability to generate plausible solutions in creative problem solving reflects both novelty and appropriateness. It requires System 1 as well as rule-based, resource-limited System 2 processing.

According to Stanovich (1999), some individual difference variables could account for the choice of processing mode; for example, cognitive style. Cognitive style1 is a combination of mental abilities and personality (Guastello, Shissler, Driscoll, & Hyde, 1998). Research also revealed that there were gender differences in cognitive style (e.g., Sadler-Smith, 2001). Therefore, we hypothesize that personality traits and gender might also influence the ease and choice of the processing mode. We explored how personality traits and gender correlate differently with respect to the differential involvement of System 1 and System 2 processing during the divergent thinking and insight problem-solving measures.

1 Zhang and Sternberg (2006) proposed a “mode of thinking” in discussions about the cognitive styles. The three modes of thinking, which include analytic, holistic, and integrative, are similar conceptions to the dual-process theory (Stanovich & West, 2000). However, the dual-process theory (System 1 and System 2) focuses on depicting the fundamental information processing modes and is evident in various cognitive functions. On the other hand, cognitive style represents a higher level conception, a combination of mental abilities and personality, or the ways in which people prefer to use their abilities (Guastello et al., 1998). Besides, there are various concepts or taxonomies of cognitive styles (Zhang & Sternberg, 2009). As Stanovich and West (2000) pointed out, the dual-process theory depicted computational capacity at the algorithmic level of analysis, whereas cognitive or thinking styles indexed individual differences at the intentional level of analysis. Both contributed independently to the variances of individual differences in performance on various cognitive tasks (Stanovich & West, 1998). Further, the two conceptions are different in malleability that might be affected by long- or short-term practice (Baron, 1985).
The Relationships Between Personality Traits and Creativity

Several personality traits have been identified as being related to creativity. At the surface trait level, creative individuals are found to be more reserved, dominant, serious, inattentive to rules, sensitive, and self-sufficient (Guastello, 2009; Runco, 2007). At the source trait level, studies based on the five-factor model (McCrae & Costa, 2008) consistently find positive relationships between Extraversion, Openness to Experience, and creativity (Batey, Chamorro-Premuzic, & Furnham, 2010; Batey & Furnham, 2006; for the meta-analysis of the Big Five source traits with creative behavior, see Guastello, 2009). Conscientiousness is sometimes found to be negatively related to creativity (Batey et al., 2010; Batey & Furnham, 2006). However, Feist’s (1998) meta-analysis indicated that although artists were less conscientious than nonartists, scientists were more conscientious than nonscientists. Researchers also found that creative individuals possess some negative traits, such as deviance (Eisenman, 1997) and psychoticism (Eysenck, 1995). Although the results are fruitful, some paradoxical personalities existed. As Csikszentmihalyi (1996) pointed out in his interviews with highly successful individuals, these interviewees seemed to be both logical and naïve, disciplined yet playful, introverted and extraverted, realistic but imaginative, objective but passionate, and feminine and masculine.

The above results were usually derived from studying eminent people in various domains or assessing normal people’s creative potentials using certain measurements. As mentioned above, although different personality traits have been linked to scientific and artistic creativity (other artists’ traits included norm doubting, nonconformity, independence, hostility, and lack of warmth, and traits of scientists were dominance, arrogance, and high self-confidence; Feist, 1999), studies that investigated normal people mostly utilized divergent thinking tests to differentiate high from low creative people. The differences of personality traits between people with high and low creative problem-solving potentials seem to have been less extensively investigated.

Given that the two measures of divergent thinking and creative problem solving exhibit different properties and involve different processes, their relationships with different personality traits merit clarification. For example, Neuroticism or Emotionality, a construct in the five-factor model, is found closely related to mental pathology (Matthews, Deary, & Whiteman, 2003). It might hinder System 2 processing in which an objective, rational, and rule-based process is required that underlies creative problem solving. However, it might not necessarily hinder associative, intuitive System 1 processing that divergent thinking mainly requires. Some evidence gave support to this speculation. For example, research has found that Psychoticism (Eysenck, 1995) or mood disorders (Nowakowska, Strong, Santosa, Wang, & Ketter, 2005) were correlated with divergent thinking performance, whereas positive and stable emotions facilitated insight problem-solving abilities (G. Kaufmann, 2003). On the other hand, Openness to Experience might especially facilitate System 1 processing (and hence divergent thinking performance) when the richness of ideas, but not necessarily appropriateness, could effortlessly be associated. Previous research did find that Openness to Experience and divergent thinking were closely related (Batey & Furnham, 2006; Batey et al., 2010). It is still questionable whether Openness to Experience helps to generate novel and appropriate ideas that could fulfill the constraints of solving goals in creative problem solving.

The present study utilizes the HEXACO Personality Inventory (Ashton & Lee, 2009; Lee & Ashton, 2004), which is considered more generalizable and inclusive than the five-factor model. Honesty/Humility, Emotionality, Extraversion, Agreeableness, Conscientiousness, and Openness to Experience are assessed to determine the different relationships between personality traits and the two creativity measures.

The Relationships Between Gender and Creativity

Inconsistent results of gender differences in creativity have been obtained in the past (J. C. Kaufman, 2006). Some studies showed that no differences existed (e.g., P. C. Cheung, Lau, Chan, & Wu, 2004), but other studies found that women performed better on the divergent thinking tests than men (Dudek, Strobel, & Runco, 1993; Kim & Michael, 1995; Kuhn & Holling, 2009). Few studies have investigated gender differences in creative problem solving. However, some research has found that women possessed a more intuitive cognitive style, whereas men were found to be more sensational (Sadler-Smith, 2001). Further, women were determined to be more interested in people, while men were more attracted by objects (Baron-Cohen, 2003; Connellan, Baron-Cohen, Wheelwright, Batki, & Ahluwalia, 2000). Some researchers thus proposed that women preferred holistic, intuitive thinking and relied more on System 1 processing, whereas men were good at analytic thinking and System 2 processing (Wang, 2011). According to the dual-process theory account of creativity (Lin & Lien, 2011), divergent thinking mainly relies on System 1 processing, while creative problem solving also requires System 2 processing. It is hypothesized that women could perform better on divergent thinking tests, as previously findings have shown, whereas men could be more adept at solving creative or insight problems.

In the following experiment, we use a divergent thinking test (Abbreviated Torrance Test for Adults [ATTA]; Chen, 2006), an insight problem task (one of the representative creative problems), the HEXACO–PI–R (Revised HEXACO Personality Inventory, Lee & Ashton, 2004), as well as Raven’s Advanced Progressive Matrices (APM; Yu, 1993; a test for general intelligence3), to investigate the relationships between personality traits, gender, and intelligence.

2 The surface traits refer to personality traits that are the most specific and proximally related to external behaviors. The source traits refer to personality traits that are the results of factor-analysis on numerous personality tests (Guastello, 2009). The present study examined the relationships between creativity and the source traits (HEXACO) because the source traits, which were more basic, were thought to contain surface-level traits. We also could provide exploratory data of the Taiwanese sample and compare it with past findings on the relationship between the Big Five and creativity in different cultures.

3 According to the reviews of Sternberg and colleagues (2005), the relationships between intelligence and divergent thinking were more consistent with the threshold theory. It stated that intelligence and creativity are correlated up to an IQ of 120, and the relationship dissolves for higher IQs. However, the relationships between intelligence and creative problem solving are consistently correlated even for higher IQs. Besides, our participants were recruited from five universities and were possibly diverse in intelligence. Thus, we collected intelligence scores in the present study as a controlled variable. We also inspected its different roles on divergent thinking and creative problem solving.
the two creativity measures (i.e., divergent thinking and insight problem solving). Different relationships between personality traits and gender with different creativity measures are expected.

In addition, previous studies have inspected the relationships between personality and creativity, as well as the connection between gender and creativity (as described in the previous reviews, these analyses were often with a single creativity measure, divergent thinking) and the relationships between personality and gender (e.g., Costa, Terracciano, & McCrae, 2001; Schmitt, Realo, Voracek, & Allik, 2008). To our knowledge, there are no studies about how personality and gender interact or mediate each other to contribute to creative behavior. The moderation and mediation effects of personality and gender on divergent thinking and insight problem-solving performance also are explored in the present study.

Method

Participants and General Procedure

A total of 320 undergraduate students from five universities in Taiwan participated in this study (57.8% women; \( M = 19.45 \) years, \( SD = 1.89 \)). The collection of different university students exhibited no correlation (\( r = .07, p = .24 \)). The performance scores were calculated as the originality: \( M = 4.31 \), \( SD = 1.11 \); flexibility: \( M = 7.87 \), \( SD = 2.69 \); originality: \( M = 5.36 \), \( SD = 4.31 \). The scores for these indexes were mostly significantly correlated with those of each of the others (the Pearson’s \( r \) ranged from .31 to .83; \( p < .01 \)). The elaboration scores represented the sum of scores on each response in comparison to the norm and scored as either 0 or 1. The elaboration scores of the figural subtests were scored as the number of elaborated decorations in each response.

Participants’ performance on the ATTA was scored as follows: fluency: \( M = 12.11, SD = 4.01 \); flexibility: \( M = 7.87, SD = 2.69 \); originality: \( M = 5.36, SD = 4.31 \). The scores for these indexes were mostly significantly correlated with those of each of the others (the Pearson’s \( r \) ranged from .31 to .83; \( p < .01 \)); however, originality and elaboration exhibited no correlation (\( r = .07, p = .24 \)).

Personality measure—HEXACO–PI–R. The HEXACO–PI–R (Ashton & Lee, 2009; Lee & Ashton, 2004) measures six personality traits: Honesty/Humility, Emotionality, Extraversion, Agreeableness, Conscientiousness, and Openness to Experience. These six personality traits came from the factor analysis results of personality lexicons of six different languages. As previously mentioned, the inventory was considered to be more generalizable and inclusive than the five-factor model. There are 16 items for each personality trait, and a 5-response Likert scale is used from 1 (strongly disagree) to 5 (strongly agree). This inventory was translated into the Chinese version by one of the authors. Two Chinese personality psychologists who were trained in the United States and the United Kingdom examined the quality of this translation. The Chinese version of this inventory then was translated into English. The back-translation version of this inventory was checked by authors of this inventory and the incorrect translations were modified. Cronbach’s alpha coefficients, which ranged from .74 to .82, were obtained for the scores on these six scales of the Chinese version in this study. The different types of measurement equivalence (i.e., confirmatory, metric, and error variance) of the HEXACO–PI–R were found in multiple age groups ranging from early adolescence to adulthood by the use of confirmatory factor analysis (Hsu, 2010).

General ability measure—APM. The Chinese version of APM (Yu, 1993) was administered to assess participants’ general intelligence. In this test, every test item consists of the presentations of several graphs, including an empty one. Participants have to find the relationships between them by choosing the most

Divergent thinking measure—Abbreviated ATTA. The Chinese version of the ATTA (Chen, 2006) is a translated version of ATTA (Goff & Torrance, 2002). It includes three subtests: a verbal test (question enumeration) and two figural tests (figural completion). Three minutes is allowed for each subtest. The test, which was developed as a large-sample norm in Taiwan for undergraduate students, established satisfactory reliability and validity results (Chen, 2006).

Participants’ responses were scored by two independent raters for fluency, flexibility, originality, and elaboration, which are among the most representative indexes for divergent thinking abilities. The interrater reliability coefficients for these four kinds of scores ranged from .83 to .97. 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 in comparison to the norm and scored as either 0 or 1. The elaboration scores of the figural subtests were scored as the number of elaborated decorations in each response.

Participants’ performance on the ATTA was scored as follows: fluency: \( M = 12.11, SD = 4.01 \); flexibility: \( M = 7.87, SD = 2.69 \); originality: \( M = 5.36, SD = 4.31 \). The scores for these indexes were mostly significantly correlated with those of each of the others (the Pearson’s \( r \) ranged from .31 to .83; \( p < .01 \)); however, originality and elaboration exhibited no correlation (\( r = .07, p = .24 \)).

Instruments and Procedures

Creative problem-solving measure—Insight problem task. Eighteen insight problems (nine verbal and nine figural) were first selected from an insight-problems inventory Web site at Indiana University (http://www.indiana.edu/~bobweb/d4.html). The inclusion of these problems fulfilled the criterion of “pure” insight problems that necessarily require a reconstructing process, as suggested by Weisberg (1995). A pretest (\( n = 52 \)) on these 18 problems was then conducted. According to the results of the pretest, we chose five verbal problems and five figural problems with moderate difficulty levels (i.e., ranging from 25% to 70% for verbal problems and 21.6% to 62.7% for figural problems). The 10 problems that necessarily require a reconstructing process, as mentioned, the inventory was considered to be more generalizable and inclusive than the five-factor model. There are 16 items for each personality trait, and a 5-response Likert scale is used from 1 (strongly disagree) to 5 (strongly agree). This inventory was translated into the Chinese version by one of the authors. Two Chinese personality psychologists who were trained in the United States and the United Kingdom examined the quality of this translation. The Chinese version of this inventory then was translated into English. The back-translation version of this inventory was checked by authors of this inventory and the incorrect translations were modified. Cronbach’s alpha coefficients, which ranged from .74 to .82, were obtained for the scores on these six scales of the Chinese version in this study. The different types of measurement equivalence (i.e., confirmatory, metric, and error variance) of the HEXACO–PI–R were found in multiple age groups ranging from early adolescence to adulthood by the use of confirmatory factor analysis (Hsu, 2010).

General ability measure—APM. The Chinese version of APM (Yu, 1993) was administered to assess participants’ general intelligence. In this test, every test item consists of the presentations of several graphs, including an empty one. Participants have to find the relationships between them by choosing the most

4 The participants were also assessed with the Adult Temperament Questionnaire (D. E. Evans & Rothbart, 2007). The results are reported in another paper.
reasonable graph to accompany the empty one from among the eight graphs. The test has established stable reliability and validity results: The retest reliability was .91 (Fould, Forbes, & Bevans, 1962), and the correlations between the APM scores and intelligence tests were high (e.g., \( r_s = .4 \) to .6, Schweizer & Moosbrugger, 2004).

For a proper time control, we excluded the first 12 items, which were found to add little to the discriminative power of the test (Bors & Stokes, 1998), and used Items 13 to 36. The total administering time was 25 min. The performance scores were calculated as the total number of items correct. Our participants’ scores ranged from 0 to 23, with \( M_s = 12.45, SD = 5.16 \).

**Results**

**The Relationships Between the Two Measures of Creativity and General Intelligence**

We first examined the relationships between participants’ performances on divergent thinking and insight problem solving. As shown in Table 1, although fluency and flexibility scores exhibited small positive correlations with verbal, figural, and total insight problem-solving accuracy (\( r_s = .19, .22, .24; r_s = .23, .24, .26, p < .01 \), respectively), the indexes of originality and elaboration were not correlated with insight problem-solving performance (\( r_s = .01 \) to .11, \( n_s \)). Because the correlations between the four indexes of divergent thinking and the two indexes of insight problem solving were high, we partialed out the effects of other indexes within one task. The extent of correlations was smaller between fluency, flexibility, and insight problem-solving performance (\( r_s \) ranged from .12 to .19, \( p < .05 \)). These results indicate that individuals’ performances on the two creativity measures were only slightly related on some of the indexes.

The correlations between the participants’ creative performance and APM scores, referred to as their general intelligence and representing their cognitive abilities, were also computed. As Table 1 shows, participants’ divergent thinking performance—fluency, flexibility, and elaboration—were positively correlated with their APM scores (\( r_s = .21, .23, .20 \), respectively, small effect sizes as defined by Cohen, 1988; \( p < .01 \)). There was no correlation between intelligence scores and the originality index (\( r = .01, n_s \)). On the other hand, participants’ APM scores were more highly correlated to their insight problem-solving performance, with \( r_s = .39, .43, .46, p < .01 \), verbal, figural, and total problem-solving accuracy, respectively. All of these coefficients achieved a medium level of effect sizes, as defined by Cohen (1988). These results fit well with previous findings that creative problem-solving ability depended more on intelligence than did the divergent thinking performance (Sternberg et al., 2005).

**The Relationships Between Two Creativity Measures and Personality Traits**

One of the main purposes of the present study was to inspect how personality traits correlated differently with divergent thinking and creative problem-solving performance. As Table 2 shows, Openness to Experience was positively correlated to divergent thinking indexes (\( r_s = .24, .22, .24, .19, p < .01 \), for fluency, flexibility, originality, and elaboration indexes, respectively). Extraversion was also positively correlated to most of the divergent thinking indexes (\( r_s = .14, .13, .16, p < .05 \), for fluency, flexibility, and elaboration indexes, respectively, but not to the originality index, \( r = .10, n_s \)). Nevertheless, neither Openness to Experience or Extraversion exhibited correlations with most of the participants’ insight problem-solving performance (\( r_s \) ranged from .00 to .09, \( n_s \), except the verbal insight problem-solving performance exhibited a weak positive correlation with Openness to Experience, \( r = .13, p < .05 \)). On the other hand, Emotional lity was found to be negatively correlated to insight problem-solving performance (\( r_s = -.16, -.13, -.17, p < .01 \), for verbal, figural, and total insight problem-solving accuracy, respectively), but not to divergent thinking performance (\( r_s \) ranged from .01 to .08, \( n_s \); even emotionality and elaboration index were positively correlated, \( r = .12, p < .05 \)). Honesty, Agreeableness, and Conscientiousness were not correlated to either divergent thinking or insight problem-solving performance. The above results showed a pattern as predicted: Divergent thinking performances related positively to Openness to Experience and Extraversion, whereas insight problem-solving performances were hindered by Emotional lity.

Table 1

<table>
<thead>
<tr>
<th>Creativity measures</th>
<th>Divergent thinking</th>
<th>Insight problem</th>
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<tr>
<td></td>
<td>Fluency</td>
<td>Flexibility</td>
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<tr>
<td>Divergent thinking</td>
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<td>Fluency</td>
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<td>Flexibility</td>
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<td>Originality</td>
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<td>Elaboration</td>
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<td>Insight problem</td>
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<tr>
<td>Verbal</td>
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<td>Figural</td>
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<td>Total</td>
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*Note.* APM was used to measure participants’ intelligence. APM = Raven’s Advanced Progressive Matrices. ** \( p < .01 \).
The Relationships Between Two Creativity Measures and Gender

Another purpose of the present study was to inspect how gender correlated differently to the two creativity measures. We separately analyzed the performance of our female (n = 181 for ATTA and n = 169 for insight problem task) and male (n = 118 for ATTA and n = 111 for insight problem task) participants on the ATTA and insight problem task. The results, which are shown in Table 3, indicate that our male participants performed better on most of the insight-problem-solving indexes than their female counterparts: .48 ± .28 versus .40 ± .28, t(282) = 2.57, p < .05, d² = .31, for the verbal accuracy; and ,45 ± .26 versus .37 ± .24, t(282) = 2.45, p < .05, d = .30, for the total accuracy. Except for the figurual accuracy, only marginally significant effect of gender existed, .41 ± .30 vs. .35 ± .28, t(282) = 1.7, p = .09. On the contrary, female participants performed better in most of the divergent thinking indexes over male participants: 12.48 ± 4.0 versus 11.53 ± 4.19, t(297) = −1.97, p = .05, d = .23, for fluency; 8.15 ± 2.59 versus 7.42 ± 2.80, t(297) = −2.29, p < .05, d = .27, for flexibility; and 6.04 ± 4.43 versus 4.33 ± 3.94, t(297) = −3.41, p < .01, d = .40, for elaboration. The exception was that female participants did not perform better on the originality index than male counterparts: 3.36 ± 2.31 vs. 2.98 ± 2.58, t(297) = −1.33, n.s. These results indicate the different gender effects on divergent thinking and insight problem-solving performance and support our prediction.

The Relationships Between Personality Traits, Gender, and Two Creativity Measures

To understand how gender and personality traits contribute to the performance of divergent thinking and insight problem solving, several hierarchical multiple-regression analyses were conducted. In all of these analyses, the steps of the variables that entered the equations were as follows: (1) APM (where intelligence scores could be controlled), (2) gender, (3) Honesty-Humility, Extraversion, Emotionality, Agreeableness, Conscientiousness, and Openness to Experience. All of the personality variables in the final step were entered simultaneously.

Table 2
The Relationships Between Creativity Measures and Personality Traits

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<th>Creativity measures</th>
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<td>Divergent thinking</td>
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<td>Fluency</td>
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<td>.14*</td>
<td>.05</td>
<td>.06</td>
<td>.24**</td>
</tr>
<tr>
<td>Flexibility</td>
<td>.03</td>
<td>.08</td>
<td>.13*</td>
<td>−.03</td>
<td>.03</td>
<td>.22**</td>
</tr>
<tr>
<td>Originality</td>
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<td>.01</td>
<td>.10</td>
<td>.05</td>
<td>.02</td>
<td>.24**</td>
</tr>
<tr>
<td>Elaboration</td>
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<td>.12</td>
<td>.16*</td>
<td>−.03</td>
<td>−.02</td>
<td>.19**</td>
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<tr>
<td>Insight problem</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verbal</td>
<td>−.03</td>
<td>−.16**</td>
<td>.00</td>
<td>.07</td>
<td>.01</td>
<td>.13*</td>
</tr>
<tr>
<td>Figural</td>
<td>−.07</td>
<td>−.13</td>
<td>.05</td>
<td>.09</td>
<td>.05</td>
<td>.03</td>
</tr>
<tr>
<td>Total</td>
<td>−.05</td>
<td>−.17**</td>
<td>.03</td>
<td>.10</td>
<td>.03</td>
<td>.09</td>
</tr>
</tbody>
</table>

Note. H = Honesty-Humility; E = Emotionality; X = Extraversion; A = Agreeableness; C = Conscientiousness; O = Openness to Experience. *p < .05. **p < .01.

As Table 4 shows, the APM score accounted for 4 to 18% of variance of two creativity indexes, ΔF(1, 318) = 11.91 to 67.65, p < .001, except for the originality index of divergent thinking. When the gender variable was entered into the equation (Model 2), the amount of variance explained in both creativity measures (ΔR² = .01 to .04, p < .05) significantly increased from Model 1, in which only the APM scores was included, ΔF(1, 317) = 3.91 to 12.51, p < .05. When personality variables were further included in Model 3, the amount of variance explained (ΔR² = .05, for all the above three indexes, p < .01) in divergent thinking performance increased further, ΔF(6, 311) = 3.10 to 3.15, p < .01, but not in the insight problem-solving performance.

When intelligence, gender, and personality were included as predictors (Model 3), APM scores could predict significantly both creative performances (with βs = .34 to .41 for insight problem-solving, p < .001, and βs = .20 to .21 for divergent thinking, p < .001, except originality). The predictive powers were larger for the insight problem-solving consideration. Gender significantly predicted some of the indexes of both creative performances, but in an opposite direction. For insight problem solving, βs = −.14 (p < .01) and −.12 (p < .01) for verbal and total accuracy. On the other hand, β = .16 (p < .01) for the elaboration index on divergent thinking.

As for the predictive powers of personality traits on creativity measures, Openness to Experience could significantly predict all of the four indexes of divergent thinking (with βs = .19, .18, .20, .15, p < .05, for fluency, flexibility, originality, and elaboration indexes, respectively). Nevertheless, it could only predict one index, verbal accuracy, of insight performance (with β = .13, p < .01). In addition, Extraversion could only predict elaboration scores in divergent thinking (β = .13, p < .05).

The above results indicate that, after controlling the effects of intelligence on two creativity performances, our male and female participants performed better at different creativity tasks (i.e., insight problem solving and divergent thinking), respectively. As for the roles of

5 The effect size, , is computed according to the formula: $d = t(1/n_1 + 1/n_2)^{1/2}$ (Cortina & Nouri, 2000), where t refers to the statistical value of t test, n₁ and n₂ refer to the numbers of female and male participants. This formula is used for an unequal cell condition.
of personality traits, the regression results were more complex, although most of the patterns were preserved as in the correlation analysis (see Table 2). Personality also seemed to exhibit a lesser effect on insight problem solving than divergent thinking.

Inspecting Table 4, it was found that, compared to Model 2, the predictive powers of gender were diminished when the personality variables were entered into the regression analysis in Model 3 for the indexes of fluency and flexibility. These results revealed that the mediation effects of personality traits (especially Openness to Experience) could be found. The mediation analyses were further conducted to investigate whether different gender predicted different creative performances through personality traits. The results revealed (see Figure 1A) that the initial associations between gender and fluency scores were eliminated by the inclusion of Openness to Experience, indicating a full mediation effect (Sobel z value = 2.05, p < .05). The associations between gender and flexibility scores were also attenuated by the mediation of Openness (see Figure 1B), to a marginally significant degree (Sobel z value = 1.74, p = .08). Other analyses did not show any significant mediation effects of personality on the relationships between gender and creative performances.

In addition, we examined whether gender and personality variables interacted on the two creative performances. Therefore, Model 4 was constructed and Gender × Personality variables were entered as predictors. The results showed no significant moderation effects.

### Discussion

The present study specifies and examines how personality traits and gender are related to different creativity measures: divergent thinking and insight problem solving. These two creativity measures are investigated and applied extensively but independently by the psychometric and cognitive approach in creativity research literature. Our results mainly showed that different personality traits in the HEXACO–PI–R were related to different creativity measures. Our male and female participants performed differently in the two creativity measures. Interesting findings were also obtained when considering the relationships between gender, personality traits, and creativity. The more detailed discussions of these findings are stated as follows.

As our data showed (see Table 2), Openness to Experience and Extraversion correlated significantly to most of the participants’ divergent thinking performances. These results replicated the previous findings in which these two personality traits were identified as being important in creativity, when only the divergent thinking sort of measurement was used (Batey & Furnham, 2006; Batey et al., 2010). However, Openness to Experience and Extraversion were not so related to close-ended, insight problem solving when we took this measurement into consideration. Instead, individuals who performed better on insight problem solving possessed less Emotionality, as our data showed a negative correlation between Emotionality and insight problem-solving performance.

### Table 4

**Intelligence, Gender, and Personality Traits as Predictors of the Two Creativity Measures**

<table>
<thead>
<tr>
<th>Predictors in model</th>
<th>Insight problem</th>
<th></th>
<th></th>
<th>Divergent thinking</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Verbal</td>
<td>Picture</td>
<td>Total</td>
<td>Fluency</td>
<td>Flexibility</td>
</tr>
<tr>
<td>Model 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>APM</td>
<td></td>
<td>.350***</td>
<td></td>
<td>.389***</td>
<td>.419***</td>
<td>.195***</td>
</tr>
<tr>
<td>ΔR²</td>
<td></td>
<td>.123***</td>
<td></td>
<td>.151***</td>
<td>.175***</td>
<td>.038***</td>
</tr>
<tr>
<td>Model 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>APM</td>
<td></td>
<td>.352***</td>
<td></td>
<td>.390***</td>
<td>.420***</td>
<td>.193***</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td>−.150**</td>
<td></td>
<td>−.102*</td>
<td>−.144**</td>
<td>.111*</td>
</tr>
<tr>
<td>ΔR²</td>
<td></td>
<td>.023**</td>
<td></td>
<td>.010*</td>
<td>.021**</td>
<td>.012*</td>
</tr>
<tr>
<td>Model 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>APM</td>
<td></td>
<td>.342***</td>
<td></td>
<td>.389***</td>
<td>.413***</td>
<td>.197***</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td>−.141**</td>
<td></td>
<td>−.069</td>
<td>−.121**</td>
<td>.096*</td>
</tr>
<tr>
<td>Honesty</td>
<td></td>
<td>−.028</td>
<td></td>
<td>−.062</td>
<td>−.051</td>
<td>−.026</td>
</tr>
<tr>
<td>Emotionality</td>
<td></td>
<td>−.091</td>
<td></td>
<td>−.081</td>
<td>−.096†</td>
<td>.011</td>
</tr>
<tr>
<td>Extraversion</td>
<td></td>
<td>−.019</td>
<td></td>
<td>.044</td>
<td>.014</td>
<td>.083</td>
</tr>
<tr>
<td>Agreeableness</td>
<td></td>
<td>.003</td>
<td></td>
<td>.037</td>
<td>.028</td>
<td>−.009</td>
</tr>
<tr>
<td>Conscientiousness</td>
<td></td>
<td>.029</td>
<td></td>
<td>.072</td>
<td>.051</td>
<td>.050</td>
</tr>
<tr>
<td>Openness to Experience</td>
<td></td>
<td>.127*</td>
<td></td>
<td>−.006</td>
<td>.069</td>
<td>.187***</td>
</tr>
<tr>
<td>ΔR²</td>
<td></td>
<td>.028</td>
<td></td>
<td>.019</td>
<td>.023</td>
<td>.054**</td>
</tr>
</tbody>
</table>

**Note.** APM was used to measure participants’ intelligence; Gender: Male 0, Female 1. 
*p < .10.  *p < .05. **p < .01. ***p < .001.

![Figure 1](image-url)  
**Figure 1.** The mediation effects of personality trait (Openness to Experience) on the relationships between gender and the fluency (A), flexibility (B) index of divergent thinking.  
*A p = .05. **p = .01. ***p = .001.
An interesting finding in the regression analysis (see Table 4) revealed that Openness to Experience also significantly predicted verbal insight problem-solving performance even after intelligence and gender were controlled. Given that Openness to Experience is assumed to be related to the richness of ideas an individual holds and processes (Batey et al., 2010), one possible explanation is that some less dominant concepts (but that are keys to the correct answers) that lie in the descriptions of our particular verbal insight problems were equally and properly processed as the dominant concepts by individuals with a high level of Openness to Experience; hence, the likelihood of correct solutions increased. The role of Openness to Experience on insight problem solving still needs further investigation with different problems as measures.

Turning to the role of gender, our data showed a pattern of disassociation between gender and different creativity measures (see Table 3). Although women performed better on most of the indexes of divergent thinking test, which was also demonstrated by previous studies (Dudek et al., 1993; Kim & Michael, 1995; Kuhn & Holling, 2009), our data first showed that men were better at an insight problem-solving task. When inspecting the relationships between gender, personality traits, and creativity, our results showed that the predictive powers of gender generally decreased when personality variables were included in the regression analyses, especially for divergent thinking indexes (see Table 4). Although the moderation effects of gender and personality were not significant, the mediation analyses showed some interesting findings. Women performed better on divergent thinking tasks and are more open to experience than men (additional analysis that we performed showed a significant correlation between gender and Openness to Experience, $r = .12, p < .05$). The significant mediation effects of Openness to Experience on the relationships between gender and divergent thinking indexes (fluency, in particular) indicated that women possessed a higher level of Openness to Experience, which further enhanced their fluency in divergent thinking.

There was no significant mediation effect of personality on the relationships between gender and insight problem-solving performance, even though analysis showed that gender and Emotionality were significantly correlated ($r = .21, p < .01$). In addition, Table 4 also showed that the amount of variance explained in insight problem-solving performance did not increase when personality variables were further included in the regression analysis. These results indicate that gender did not predict insight problem-solving performance through Emotionality and personality traits played smaller roles on insight problem solving. Instead, insight problem-solving performance was mainly predicted by intelligence (APM) and gender differences. Although the regression weights that were obtained, as shown in Table 4, were rather low, the present study may provide an exploratory direction. The ways in which gender and personality interact to influence different creativity measures remain an interesting issue that merits further exploration.

As previously mentioned, Lin and Lien (2011) proposed a dual-process account of creativity to explore the differential involvement of Systems 1 and 2 processing in divergent thinking and creative problem solving. In respect to this theory, the present study hypothesizes that different gender and personality traits might influence the ease and choice of the processing mode and, hence, affect divergent thinking or creative problem solving differently on either side (as we used insight problems as one kind of creative problems). Our results support this theory. First, the participants’ performances on the two measures were only slightly correlated, indicating different processes that the two measures might possibly involve. Second, although women have been suggested to be prone to holistic, intuitive, and System 1 thinking, and men have been suggested to be dominated by analytic and System 2 thinking (Wang, 2011), our results showed that female and male participants performed better at divergent thinking and insight problem solving, respectively. Third, Emotionality, which was hypothesized to hinder analytical, System 2 processing with its high level, was found to be negatively related to insight problem-solving performance. Openness to Experience, which might especially facilitate associative, System 1 processing, was found to be positively related to divergent thinking performance. These results support the notions of dual-process account of creativity (Lin & Lien, 2011) in that the idea generation in divergent thinking mainly relies on associative, intuitive, and effortless System 1 processing. However, generating plausible solutions in creative problem solving additionally requires rule-based, analytical, and resource-limited System 2 processing.

Another interesting issue that requires further discussion is how culture may have played a role in our study on the relationships between gender, personality, and creativities. Our data was collected in Taiwan, but some researchers pointed out that gender differences in creativity (divergent thinking performance, in particular) could be best expected in Western cultures (e.g., Kuhn & Holling, 2009). As mentioned, P. C. Cheung and colleagues (2004) found no gender differences in the fluency index in a Hong Kong sample. Our results showed that Taiwanese women performed better in divergent thinking than men, consistent with the findings in Western culture (Dudek et al., 1993; Kuhn & Holling, 2009) as well as Kim and Michaels’ (2005) finding on a significant gender difference in creativity in a Korean sample. In addition, although creativity could be hindered by the social structure of the collectivist culture (Runco, 2007) and Openness to Experience could be not encouraged in Chinese society (McCrae, Yik, Trapnell, Bond, & Paulhus, 1998), we found that Openness to Experience and Extraversion were positively related to divergent thinking. As F. M. Cheung and colleagues (2008) argued, the construct of openness in Chinese culture should incorporate the idea- or interest-related cognitive styles in Western culture with interpersonal potency and Extraversion in the collective culture. Our measures of Openness to Experience and Extraversion could capture the part of the Chinese notion of Openness to Experience. Our results also imply that, even in a detrimental context (e.g., collectivist culture) for creativity, the personal dispositions could enhance one’s creativity.

Although many factors may contribute to the real-life achievement of creativity, creativity potentials or abilities (such as divergent thinking and creative problem solving) were considered the essential components of this achievement (Eysenck, 1995; Sternberg et al., 2005). The present study that focuses on individuals’ creative potentials might provide some implications for real-world creativity. A scientist discovers the principles of the world according to phenomena and evidence, whereas an artist creates works of art without constraining the work to concrete explanations of objectives (Simonton, 2008; Stent, 2001). Creative problem solving, with its closed-ended property, could be closer to the scientific discovery processes, whereas divergent thinking tasks might characterize more artistic processes by their open-ended nature (Lin & Lien, 2011). Previous work has identified some different personality traits that belong to artists and scientists (Feist, 1999). Our study suggests that Emotionality and...
Openness to Experience might be other traits that could differentiate them with a possible theoretical base (i.e., the dual-process account of creativity, Lin & Lien, 2011). Our study also gives support to and a possible explanation concerning the observations that women are more interested in social and artistic events, whereas men are more interested in scientific activities (Betz & Fitzgerald, 1987). Further, men are better than women at scientific studies (Ceci, Williams, & Barnett, 2009; Martin, Mullis, Gonzalez, & Chrostowski, 2004).

If factors are found to be correlated differently with divergent thinking and creative problem solving, they might be used to differentiate individuals with distinct potentials and design for various training programs that are applied to improve different creative achievements.

References


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Kim, J., & Michael, W. B. (1995). The relationship of creativity measures to school achievement and to preferred learning and thinking style in a

(Appendix follows)
Appendix A

Ten Insight Problems and Solutions Used

<table>
<thead>
<tr>
<th>Problems</th>
<th>Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Earth problem</td>
<td>Still 6 sextillion (the concrete and stone were already part of the earth when it was weighed)</td>
</tr>
<tr>
<td>It is estimated that the earth weighs 6 sextillion tons. How much more would the earth weigh if 1 sextillion tons of concrete and stone were used to build a wall?</td>
<td></td>
</tr>
<tr>
<td>2. Hole problem</td>
<td>Zero (there is no dirt in a hole)</td>
</tr>
<tr>
<td>How many cubic centimeters of dirt are in a hole 6 meters long, 2 meters wide, and one meter deep?</td>
<td></td>
</tr>
<tr>
<td>3. Cabin problem</td>
<td>The match</td>
</tr>
<tr>
<td>Erin stumbles across an abandoned cabin one cold, dark and snowy night. Inside the cabin are a kerosene lantern, a candle, and wood in a fireplace. She only has one match. What should she light first?</td>
<td></td>
</tr>
<tr>
<td>4. Magician problem</td>
<td>He threw it up in the air</td>
</tr>
<tr>
<td>A magician claimed to be able to throw a ping pong ball so that it would go a short distance, come to a dead stop, and then reverse itself. He also added that he would not bounce the ball against any object or tie anything to it. How could he perform this feat?</td>
<td></td>
</tr>
<tr>
<td>5. Socks problem</td>
<td>Three (if the first is brown and the second black then the third one will match either the brown or black)</td>
</tr>
<tr>
<td>If you have black socks and brown socks in your drawer, mixed in a ratio of 4 to 5, how many socks will you have to take out to make sure that you have a pair the same color?</td>
<td></td>
</tr>
<tr>
<td>6. Line problem</td>
<td></td>
</tr>
<tr>
<td>How can you draw a straight line through the circle that separates numbers and equals the sums of numbers in the two splits?</td>
<td></td>
</tr>
<tr>
<td>7. Pigpen problem</td>
<td></td>
</tr>
<tr>
<td>Nine pigs are kept in a square pen. Build two more square enclosures that would put each pig in a pen by itself.</td>
<td>(Appendix continues)</td>
</tr>
</tbody>
</table>
Appendix (continued)

<table>
<thead>
<tr>
<th>Problems</th>
<th>Solutions</th>
</tr>
</thead>
</table>
| 8. Match problem  
How can you take four matches and leave  
only eight small squares? | ![Match Problem Solution](image1) |
| 9. Cake problem  
How can you make only three cuts to make a round cake into eight pieces? | ![Cake Problem Solution](image2) |
| 10. Coin problem  
How can you move only one coin to make five coins total in each line? | ![Coin Problem Solution](image3) |

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