Journal of Research in Education Sciences
2019, 64(3), 143-168
doi:10.6209/JORIES.201909_64(3).0006

Revolutionary Drawing: Measuring Adaptive and Innovative Creativity

Jon-Chao Hong
Department of Industrial Education/
Institute for Research Excellence in Learning Sciences,
National Taiwan Normal University

Kai-Hsin Tai
Department of Industrial Education/
Institute for Research Excellence in Learning Sciences,
National Taiwan Normal University

Po-Hsi Chen
Department of Educational Psychology and Counseling/
Institute for Research Excellence in Learning Sciences,
National Taiwan Normal University

Shao-Zu Su
Department of Educational Psychology and Counseling/
Institute for Research Excellence in Learning Sciences,
National Taiwan Normal University

Abstract

Creativity measurement has been the subject of empirical research for decades, with the most prominent notions about the creative process being Torrance's Tests on Creative Thinking (TTCT). However, those studies focused on divergent thinking measurement. To integrate divergent and convergent thinking measurements, the present study developed a novel image-based creativity measure, named "revolutionary drawing," in which images replace the conventional response scale, to examine the interrelatedness of creative thinking types: adaptive creativity or innovative creativity. The target sample of this study was 332 teachers who had joined the creative development program, from whom 324 valid data were collected for analysis to test the hypotheses. Our evidence indicated that the two types of creativity were negatively correlated. Moreover, three of the four sub-abilities of innovative creativity, cross-category, multiple-direction, and reverse thinking, were positively inter-correlated. Only originality thinking, the fourth sub-ability of innovative creativity, was not correlated to the other three sub-abilities of innovative creativity. The two sub-abilities of adaptive creativity, diffusive thinking and enriched thinking, were positively correlated. The results of this study revealed that females performed better than males with respect to age differences in innovative creativity. The younger participants performed better than the older participants, but on adaptive

Corresponding Author: Po-Hsi Chen, E-mail: lorenz1020@gmail.com
Manuscript received: Jan. 30, 2019; Revised: Aug. 2, 2019; Accepted: Aug. 15, 2019.

creativity, only participants aged under 30 performed better than participants aged 40 and over. The findings of this study suggest that revolutionary drawing could be used for testing innovative creativity and adaptive creativity as cognitive processes for divergent and convergent thinking.

Keywords: adaptive creativity, convergent thinking, creativity assessment, divergent thinking, innovative creativity

Introduction

Creativity is widely considered as an important component of human behavior leading to a broad consensus that it is the processes and abilities that facilitate the generation of new, imaginative, useful, and valuable ideas and products (Boden, 2004; Hughes, Furnham, & Batey, 2013; Mumford, 2003). There is a need to use an assessment tool as a starting point for measuring creativity (Hermann, 1988). An overview of the prominent process- and systems-orientated models that have been developed to assess creativity follows. To show how creativity research and creative thinking have developed over time, 25 models since 1929 have been studied (Kleibeuker, De Dreu, & Crone, 2013). Of these models, the Guilford Aptitude Research Project (ARP) was used as the basis of the development of the Torrance Test of Creative Thinking (TTCT). The TTCT is a key method for testing individual creativity, and it can be applied at all educational levels, from kindergarten to graduate school. It is still a widely used measure in today's creativity research (Mouchiroud & Lubart, 2001). Despite this, Treffinger (2009) argued that there is a lack of good tests of creativity. Of course, the "goodness" of a test may be a question of technical adequacy. For example, TTCT is used to measure the potential of creativity and is usually assessed by means of other tests that measure divergent thinking ability (Runco, 2010), in which it can be used to predict later creative performance with correlations that typically range from .2 to .3 (Sternberg & Lubart, 1996). Kaufmann (2003) argued that creativity requires both divergent and convergent thinking, and needs to combine the two to assess individual creativity. However, measuring two types of creative thinking in a single instrument has not yet been achieved, so we developed a measuring tool known as revolutionary drawing, which is based on rule-bound criteria to simultaneously measure divergent and convergent thinking.

With respect to types of creativity, Kirton (1976) proposed the Adaptation-Innovation theory whereby creativity is broken down into two types: innovative and adaptive. These types are presented as a continuum from highly adaptive to highly innovative on which everyone can be located (Kirton, 2003). Benedek, Franz, Heene, and Neubauer (2012) showed that creativity is substantially predicted by the ability of dissociation and associative combination when they measured the novelty and appropriateness of the combined ideas. The types of creativity are concerned with innovative types of creativity, which are related to the existing assumptions of the creator as well as the ability to imagine and generate solutions from "outside the box" thoughts. Conversely, adaptors like to make incremental improvements or changes by working within a

structure, a system, or a paradigm (Kirton, 2003). They aim to do things better when solving problems, compared with innovators who aim to do things differently (Kirton, 1999). Previous instruments to evaluate creativity focused on divergent thinking, but few instruments have been developed to test the combination of both divergent and convergent thinking. Moreover, whether previous instruments measure adaptive and innovative creativity is unclear; therefore, two types of creativity with a combination of divergent and convergent thinking can be assessed by using the instrument developed in this study. That is, few studies have focused on developing an instrument to explore individuals' two types of creativity with divergent and convergent thinking, and so we designed revolutionary drawing and attempted to explore the proposition of testing adaptive and innovative creativity.

Gender differences in creativity have been found to arise from divergent thinking tasks (Rosa, Qualls, & Ruth, 2014), where concepts which seem to have no relation are combined and assessed for their novelty and functionality. In these tests, women have been found to be more creative than men across all age groups (e.g., Baer & Kaufman, 2008; Kim & Michael, 1995). On the other hand, Bradley, Gao, and Sousa (2013) conducted a cross-cultural survey based on the data of 1,365 managers operating in eight countries and found that gender did not appear to have a significant effect on the resultant creativity. Moreover, He and Wong (2011) used the Test for Creative Thinking-Drawing Production (Urban & Jellen, 1996) subscales to analyze gender differences in creative thinking. Their study found that both genders have relative strengths and weaknesses in their creative thinking, as girls tended to outperform boys in their thoroughness of thinking, whereas boys outperformed girls in their boundary-breaking thinking. The gender issue in relation to creativity development has been studied in many fields. For example, women's creative performance was found to be equivalent to men's in real-world divergent thinking tasks (Kapoor, 2019), but no study has compared the gender difference in adaptive and innovative creativity. Thus, how revolutionary drawing can credibly assess gender differences was explored in this study.

Albert (1996) discovered that the level of creativity is typically not maintained from childhood to adulthood. Drawing creativity is an early and basic form of artistic activity for children. After examining the creative artistic expression of children, Dziedziewicz, Oledzka, and Karwowski (2013) argued that representational flexibility increases with age. Moreover, Diamond (1986) pointed out that the trend in creativity as one ages is nonlinear, indicating that creative productivity is likely to rise rapidly to a definite peak and will then gradually decline to about half the rate of that peak. Simonton (1988) stated that these changes vary according to the domain of creative performance. For instance, the creative drama process helps to enhance two important aspects of divergent

thinking: fluency and flexibility (Karakelle, 2009). According to those arguments, there is a need to test the credibility of age difference with a new measurement. In line with the above exceptions, the purpose of this study was to explore the age and gender interventions in creativity using revolutionary drawing to measure different types of creativity.

Theoretical Background

Previous Instruments for Measuring Creative Thinking

Creativity is manifested on different levels and in different research approaches. These different approaches include Wallas' (1926) creativity process model, Rossman's (1931) creativity model, Guilford's (1950) divergent thinking model, Osborn's (1952) seven step model, Torrance's (1966) Tests of creative thinking, Parnes' (1992) and Isaksen and Treffinger (1987) CPS model, Kirton's (1987) model, Fritz's (1991) model, Plsek's (1997) directed creativity cycle model, and Luecke and Katz's (2003) innovation model.

The TTCT-Figural is used for measuring participant creativity. The TTCT was developed by Torrance and colleagues over a period of more than 25 years (Torrance, 1974). Their aim was to use activities that modeled the creative thinking process, where each activity involved different kinds of thinking and contributed something unique to the batteries they were developing. The TTCT consists of both verbal and figural batteries of test activities that can be used in all cultures, and are suitable for all ages. It is the most widely used instrument to measure creativity (Davis, 1999), and was adopted in three-quarters of all published studies on creativity involving elementary and secondary school children identified by Baer (1993). Conclusively, the divergent thinking tests of Guilford, Torrance, and Wallach and Kogan are viewed as dealing with the creative process or potential (Abdulla & Cramond, 2017), but it seems that no particular study has focused on measuring convergent thinking. We therefore developed revolutionary drawing with the intention of measuring these two types of creative thinking.

The TTCT-Figural uses three picture-based exercises to assess creativity. It is a culturally fair measurement for people who are not native English speakers because it is not based on respondent verbal ability. The TTCT comprises two equivalent forms: A and B, each of which includes three activities: picture construction, picture completion, and repeated figures of lines or circles. Each of the activities is completed within 10 minutes. Respondents generate ideas that are unique using a given stimulus, and then draw it. The stimulus is an integral part of the picture. The common theme which emerges from most definitions of creativity in the literature is that it is the ability to produce

work that is both novel (i.e., original and unexpected) and appropriate (i.e., useful concerning the task constraints). The TTCT cannot be applied to test adaptive and innovative creativity (Kirton, 1976); thus, this study developed a new instrument to examine individuals' two types of creativity.

Creativity Assessment Instrument Design: Revolutionary Drawing

An image-based measure may be particularly effective for measuring creativity (Plucker & Makel, 2010). Therefore, divergent cross-categorical mental processing is required when combining convergent thinking with mental images (Leutner, Yearsley, Codreanu, Borenstein, & Ahmetoglu, 2017). Accordingly, this study designed a revolutionary drawing test which requires individuals to apply divergent and convergent thinking in the drawing process based on the following guidelines.

Regulations of Drawing

Creativity is imagining, using new approaches to analyze, explain, and evaluate events, and making connections between objects. According to Torrance (1995), creativity is the formulation of something new and is a constructive response to an existing or new situation. From these definitions and views, as well as for the purpose of our study, creativity is defined as the purposeful making of connections to generate ideas. Accordingly, creative drawings for our study were highly rule-bound with clear criteria, provided as follows. (1) In the designated drawing areas, draw pictures of objects in sequence. You should create objects that have some meaning to you on a personal level and with simple shapes (i.e., the fewer lines and curves you draw, the better). (2) Each object should be unique. (3) You may draw your first object in any way you like (e.g., □ or ○ or △). (4) A subsequent imaginative object MUST follow the previous object by adding a few lines. (5) Place a name for each object under the object's drawing area. (6) Each object can ONLY have one name, and there can be no duplication or repetition. (7) Try to use the previous images as the basis for you to draw the next object. (8) Specify whether the drawing is created by multiple-direction thinking or reverse thinking.

Creativity Types and Scoring Scheme

Subjective ratings of creativity have revealed good inter-rater reliability for different kinds of creative products including drawings (e.g., Dollinger & Shafran, 2005). This agreement by creativity researchers evidences that, generally speaking, creativity is both an identifiable and a quantifiable characteristic of new ideas and products (Benedek & Jauk, 2014). It was also highlighted by Petrowski (2000) that scores for creativity are based on originality (statistical rarity of given responses), fluency (total number of relevant responses), flexibility (total number of different

categories represented by relevant responses) and elaboration (amount of detail in responses). Additionally, the TTCT has five norm-referenced criteria for measuring creativity, including fluency, originality, elaboration, abstractness of titles, and resistance to premature closure. However, using fluency, flexibility, and originality as measures of creative performance is problematic for conceptual and statistical reasons (Nicholls, 1972). There are often differential predictors for fluency, flexibility, and originality when compared to expert, peer, or supervisor rated creative performance (Baas, De Dreu, & Nijstad, 2008; Friedman & Förster, 2001, 2005). In this sense, the components of creativity of our study included cross-category thinking, multiple-direction thinking, originality thinking, and reverse thinking as constituting innovative creativity. Enriched thinking and diffusive thinking were included for adaptive creativity.

1. Innovative creativity: (1) Cross-category thinking: This type of thinking is required for creators to draw something different from the previous categories, such as after adding two lines, a house becomes a bomb (i.e., the original object disappears after adding lines). This can be considered as one type of flexibility as in Torrance's TTCT. (2) Multiple-direction thinking: This is the flexibility of visualizing an object from different perspectives and adding several lines to make it become another object. This can also be considered as one type of flexibility, but one that is not included in Torrance's TTCT. (3) Reverse thinking: This is to visualize and transfer a large object into a smaller one. This can also be considered as one type of flexibility, but one that is not included in Torrance's TTCT. (4) Originality thinking: This refers to the statistical rarity of the responses. This type of thinking is similar to the definition of originality by Torrance, that is only 2.5% of all images was categorized as this type of thinking.

2. Adaptive creativity: (1) Diffusive thinking: Takeuchi and Kawashima (2018) highlighted diffusive thinking as a type of cognitive process associated with changes in some function-related traits and states. Accordingly, diffusive thinking refers to the ability to transform an object into a new object, but both objects are still in the same classification or have the same function. For example, an airplane becomes a space shuttle. Both objects are transportation modes. (2) Enriched thinking: This is to revise the content of a drawing without changing its function, but with more detail than in the original image. For example, more lines are added to a drawing of a house so that it becomes a house with a bridge; the house remains there and does not disappear (see Appendix).

Every type of creative thinking was counted by frequency to quantitatively explain the degree of creative thinking. If the frequency of cross-category thinking was counted from the total pictures drawn for that test, the remaining frequencies belonged to diffusive thinking or enriched thinking exclusively. In other words, the sum of frequencies including cross-category thinking, diffusive

thinking, and enriched thinking were similar to the fluency variable of TTCT. Therefore, creativity was divided into six types of thinking which are composed of two types of creativity thinking, and were subjected to testing to confirm the research hypotheses.

Methods

Hypotheses

In assessing creativity, Sternberg (2012, p. 8) strongly suggested assessing what and how people "(1) create, (2) invent, (3) discover, (4) imagine if…, (5) suppose that…, or (6) predict." In addition, Torrance (1979) offered four creative thinking indicators: fluency, flexibility, elaboration, and originality. Creativity evolves and changes with time and across contexts, and it is therefore not realistic to expect there to be a single, all-purpose instrument. The instruments to measure creativity have notable differences in terms of their technical adequacy depending on the age and gender, which variables are being assessed, the extent to which individual assessments or group comparisons are made, and the extent to which the goals involve evaluation (Treffinger, 2009). In this regard, we proposed the following hypotheses:

H1: There is a significant correlation between the creative components.

H2: There is a significant difference in comparing innovative creativity to adaptive creativity in relation to gender.

H3: There is a significant difference in comparing innovative creativity to adaptive creativity in relation to age.

H4: There is a significant difference in gender in relation to innovative creativity.

H5: There is a significant difference in age in relation to innovative creativity.

H6: There is a significant difference in gender in relation to adaptive creativity.

H7: There is a significant difference in age in relation to adaptive creativity.

Procedure

The effect of the time limit which the respondents are given to complete the Torrance test is another issue worth considering. In other words, speed is an integral part of performance on the Torrance tests. Considering that there is a time limitation, the respondents may adopt different types of cognitive response strategies according to what they think they are being requested to do. After a pilot study in which we gave participants 30 minutes to draw as many figures as they could, they

complained that they lost patience with having to continuously draw. We therefore reduce the time by half, giving them 15 minutes, but then most participants complained that the time pressure was too high. Thus, 20 minutes was given to the participants to reflect on actual creative thinking for all 18 figures.

Participants

This study focused on school teachers who received creativity lessons as a requirement of their professional development programs. The available sources supported this investigation during the beginning of creativity lessons held by the Teacher Professional Development Center of Taipei. Where creative performance appears to differ slightly centers on the rationale for why human fluid and crystalized intelligence are essential to the creative process (Zabelina, Friedman, & Andrews-Hanna, 2019). Accordingly, we targeted teachers who had bachelor degrees at least as the samples of this study as they were involved in in-service training, and they were mostly aged over 25 years old.

There were 332 participants who joined this study, of whom eight were eliminated because of their incomplete answers, giving us 324 effective data, with an effective questionnaire return rate of 98.00%. There were slightly more female participants, with the 184 female participants accounting for 56.79% and the 140 male participants accounting for 43.21%. Most participants (155) were under 29 years old, accounting for 47.84%. The age range of 30-39 included 81 participants, accounting for 25.00%. There were 88 participants aged 40 and above, accounting for 27.16% of the total (Table 1).

Table 1

Sample Frequency Distribution

Variable	Category	Frequency	%
Gender	Male	140	43.21
	Female	184	56.79
Age	Under 29	155	47.84
	30-39	81	25.00
	Over 40	88	27.16

Reliability Analysis

To assess the reliability of this instrument, triangulation was used to ensure the inter-rater

reliability (Cohen, Manion, & Morrison, 2000) in the present study. The three experts who joined our research continued with the rating process until the consistent result exceeded 95%. Those images for which they could not reach agreement were excluded from further analysis.

Results

Table 2 shows that the three most influential creative components of the participants' creativity performance were: originality thinking (M = 4.84), cross-category thinking (M = 3.79), and reverse thinking (M = 1.17). Originality thinking had the highest standard deviation (SD = 3.15). This finding suggested that a high variation or dispersion from the average existed among the participants with a significantly higher SD in originality.

Table 2

The Mean and Standard Deviation of Each Type of Thinking (N = 324)

Thinking Variables	Minimum Value	Maximum Value	*M*	*SD*
Cross-category Thinking	0	5	3.79	1.39
Multiple-direction Thinking	0	5	0.83	1.09
Reverse Thinking	0	5	1.17	0.96
Originality Thinking	0	17	4.84	3.15
Diffusive Thinking	0	3	0.58	0.66
Enriched Thinking	0	5	0.65	1.10

Correlation Analysis of Creativity Thinking Types

There were positive correlations among cross-category thinking, multiple-direction thinking, and reverse thinking (Table 3). The higher creative component a participant possessed, the higher the ability of the other two creative components. Additionally, with a correlation coefficient of .13, originality thinking was positively correlated with cross-category thinking. Diffusive thinking was also positively correlated to enriched thinking. Therefore, if a participant had a strong skill of cross-category thinking (or diffusive thinking), he/she was more likely to come up with original ideas (or elaborate ideas) when solving problems or developing products.

Conversely, diffusive thinking was negatively correlated to cross-category thinking, multiple-direction thinking, and reverse thinking. A similar correlation also existed for enriched thinking. These findings indicated that, if a participant had either good diffusive thinking or enriched

Table 3

The Correlation Between Different Types of Creativity

	Cross-category Thinking	Multiple-direction Thinking	Reverse Thinking	Originality Thinking	Diffusive Thinking	Enriched Thinking
Cross-category Thinking	1					
Multiple-direction Thinking	.29**	1				
Reverse Thinking	.48**	.23**	1			
Originality Thinking	.13*	.06	-.09	1		
Diffusive Thinking	-.23**	-.15**	-.22**	.09	1	
Enriched Thinking	-.58**	-.19**	-.30**	.10	.42**	1

*$p < .05$. **$p < .01$.

thinking skills, he/she might not do well in cross-category thinking, multiple-direction thinking, or reverse thinking.

TTCT-Figural is seen as a reasonably reliable measurement of creativity. In another study, the Abbreviated Torrance Test for Adults (ATTA) was adapted from the TTCT (Torrance, 1998) with good predictive and discriminant validity (e.g., Althuizen, Wierenga, & Rossiter, 2010; Kharkhurin & Motalleebi, 2008). On the other hand, revolutionary drawing provides an understanding, according to Table 3, that the relationships between cross-category thinking, multiple-direction thinking, original thinking and reverse thinking were positively correlated. Moreover, those creative components of divergent thinking were negatively related to diffusive thinking and enriched thinking, except for original thinking. However, the relationship between the two types of convergent thinking related to adaptive creativity was positively correlated.

Gender Difference in Creative Components

The results of this study indicated that there was a significant gender-based difference in original thinking ability (Table 4). Additionally, the mean value for females was found to be slightly higher than that of males. Cohen's f^2 was calculated to be $d = .23$. Therefore, females were "moderately" more original than males. Upon analyzing gender homogeneity, significant differences were not observed in relation to cross-category thinking ($t = .27$, $p = .79$), multiple-direction thinking ($t = -.07$, $p = .95$), reverse thinking ($t = -.44$, $p = .67$), diffusive thinking ($t = -1.24$, $p = .23$), or enriched thinking ($t = -1.86$, $p = .06$). In terms of examining innovative creativity in relationship to gender, no significant differences were observed. Previous studies have focused on descriptions of gender differences in creativity (e.g., Norlander, Erixon, & Archer, 2000). As another example, gender-related differences were analyzed in assessing novelty and functionality; women are more

Table 4

Creative Components: Independent-Sample t Test

Thinking Variable	Gender	*N*	*Mean*	*t*
Cross-category Thinking	Male	140	3.81	.27
	Female	184	3.77	
Multiple-direction Thinking	Male	140	.83	-.07
	Female	184	.84	
Reverse Thinking	Male	140	1.14	-.44
	Female	184	1.19	
Originality Thinking	Male	140	4.44	-2.00*
	Female	184	5.15	
Diffusive Thinking	Male	140	.53	-1.24
	Female	184	.67	
Enriched Thinking	Male	140	.53	-1.86
	Female	184	.83	

*$p < .05$.

creative than men are across age groups (e.g., Baer & Kaufman, 2008; Kim & Michael, 1995). Our findings were contrary to those of previous studies (e.g., Torrance, 1993) which suggested that males were superior in terms of flexibility and originality (two important aspects of innovative creativity). Nevertheless, the findings supported the conclusion of Ai (1999) that females generally have superior adaptive creativity performance to males.

Age Difference in Creative Components

Significant age-based differences were not observed for either reverse thinking ($F = 1.98$, $p = .14$) or diffusive thinking ($F = .79$, $p = .45$) (Table 5). In contrast, there were age differences in cross-category thinking, multiple-direction thinking, originality thinking, and enriched thinking. According to the Scheffé's post-hoc analysis, young participants (below 30 years of age) had a stronger cross-category thinking ability than participants aged 30 and over. A similar result was reached for multiple-direction thinking ability. In addition, the young participant group was able to create more original work than participants aged between 30 and 39 years were. This group was also able to enrich much more of the content of the work than the participants 40 years and over were. Furthermore, for these four creative components: the Cohen's f^2 values were calculated to be $d = .28$, .22, .57, and .22, respectively. Therefore, those values of effect size indicated that the degree of practical significance was at a moderate level.

Table 5

Creative Components: ANOVA

Dependent Variable	*F*	Cohen's *d*	Scheffé's test
Cross-category Thinking	6.73***	.28	1>2>3
Multiple-direction Thinking	6.67***	.22	1>2; 1>3
Reverse Thinking	1.98	n.a.	n.a.
Originality Thinking	5.39**	.57	1>2
Diffusive Thinking	0.79	n.a.	n.a.
Enriched Thinking	6.58**	.22	1>3

Notes. For Scheffé's post-hoc comparison: 1 represents the participant group aged 1 to 29 years; 2 represents the participant group aged 30 to 39 years; 3 represents the participant group aged 40 years and over.
**$p < .01$. ***$p < .001$.

Several studies (Frosch, 2011; Ng & Feldman, 2008; Simonton, 1988) have examined creativity in relation to age. They concluded that seniors showed higher levels of creative thinking and performance. Nonetheless, few studies have compared the correlations between innovative creativity and adaptive creativity in relation to different life stages. This study contributes to the research topics by showing that the level of innovative creativity increased with age, but young participants aged less than 30 years performed better than participants 40 years and over in cross-category, multiple-direction, and originality thinking in innovative creativity, and enriched thinking in adaptive creativity (Table 5).

Difference in Adaptive and Innovative Creativity

We further applied ANOVA to investigate the difference in innovative creativity and adaptive creativity. Table 6 shows that significant gender-based differences were not observed for either innovative creativity ($F = 0.21$, $p = .65$) or adaptive creativity ($F = -1.91$, $p = .06$). In contrast, there are significant differences among innovative creativity ($F = 8.78$, $p < .001$) and adaptive creativity ($F = 4.46$, $p < .05$). In addition, young participants aged less than 30 years appeared to be the most innovative compared to participants between 30 and 39 years, or participants aged 40 years and over; young participants aged less than 30 years appeared to be the most adaptive compared to participants aged 40 years and over.

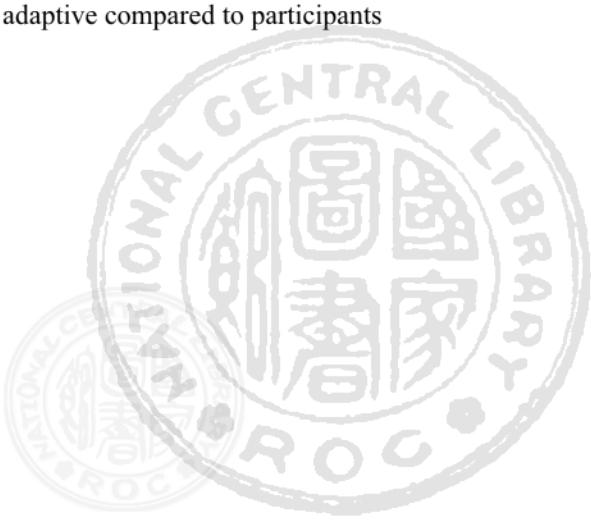


Table 6

Summary of Difference in Creativity Thinking Types

Dependent Variable	Independent Variable	*F*	Cohen's *d*	Scheffé's test
Innovative Creativity	Gender	0.21	n.a.	n.a.
	Age	8.78***	.25	1>2; 2>3
Adaptive Creativity	Gender	-1.91	n.a.	n.a.
	Age	4.46*	.22	1>3

Notes. For Scheffé's post-hoc comparison: 1 represents the participant group aged 1 to 29 years; 2 represents the participant group aged 30 to 39 years; 3 represents the participant group aged 40 years and over.
*$p < .05$. ***$p < .001$.

Previous studies (e.g., Baer & Kaufman, 2008; Kim & Michael, 1995) have examined the impact of age and gender on creativity types. These studies concluded that females are generally more creative than males across age groups. However, a limited amount of research is focused on the impact of gender and increasing age on creativity (Diamond, 1986). The current study contributes to this research topic by showing that there are gender and increasing age-based differences in adaptive creativity.

Discussion

Kirton (1999) stated that approach to change is the primary difference between adaptors and innovators. Adaptors tend to try to do things better, whereas innovators are more likely to try to do things differently. Adaptors tend to produce ideas that are all linked to the problem in a consensually agreed way, while innovators tend to generate ideas that may threaten traditional boundaries or paradigms (Isaksen & Lauer, 2002; Kirton, 1999). Accordingly, we have begun to address these concerns by exploring the relationships between adaptive and innovative creativity related to divergent and convergent thinking abilities. Consequently, we have provided evidence for the associative underpinnings of cross-categories, multiple-direction, reverse, and originality thinking as innovative creativity, and diffusive thinking as well as enriched thinking to test adult divergent thinking and convergent thinking. According to Guilford (1967), there are four main components of divergent production, namely fluency, flexibility, originality, and elaboration. In this study, elaboration was related to the practice of diffusive thinking and enriched thinking in revolutionary drawing.

Updating is the ability to monitor and to quickly add or delete content; shifting is the ability to flexibly shift between different tasks or mental sets. According to a previous study by Zabelina et al.

(2019) fluency and flexibility of divergent thinking are uniquely predicted by the ability to shift one's mental set. Creativity is associated with people who use divergent thinking more than convergent thinking. Accordingly, adaptive creativity is linked to updating one's mental set and is related to convergent thinking, and innovative creativity is associated with shifting one's mental set and is related to divergent thinking. In this sense, how divergent thinking applies to innovative creativity and how convergent thinking is employed in adaptive creativity were verified in this study.

Gender differences in creativity have not been unequivocally confirmed in previous research. Whereas some studies have found that gender differences in creativity do exist (e.g., Kim & Michael, 1995), others have not (Norlander et al., 2000). While Kirton (1999) posited that while adaptors' original ideas are more likely to fit the existing paradigm, innovators' original ideas are more likely to challenge the existing paradigm. In terms of gender, in Castillo-Vergara, Galleguillos, Cuello, Alvarez-Marin, and Acuña-Opazo's (2018) study, it was found that females performed better than males in terms of their fluency, flexibility, and originality. They found that females were 1.2 times more creative than males in Chilean public schools. Supporting their results, the present study showed that female participants outperformed males in adaptive creativity, but no difference was found in innovative creativity.

Age is an important factor explaining the differences between adaptive and innovative creativity with the different genders. It appears that few studies to date have described the impact of gender on older men and women at any length (Diamond, 2001). Previous research shows inconsistency regarding how creativity is related to age (e.g., Wu, Cheng, Ip, & McBride-Chang, 2005). Some studies have found a nonlinear developmental trend in creativity (Smolucha & Smolucha, 1985), where creative thinking is a negative coefficient for increasing age (Liu et al., 2018). Accordingly, the present study used revolutionary drawing to study how age contributes to different types of creativity, and the results showed that the group aged less than 30 performed better than the other two groups, and the group aged between 30 and 39 performed better than the group aged 40 and over in relation to innovative creativity. However, only the group aged less than 30 performed better than the group aged 40 and over in adaptive creativity.

Conclusion

Taken together, the findings of this study suggest three principal contributions. First, this study introduces a new perspective to measure adult creativity, an important tool relevant to the study of creativity measurement. Where prior research failed to produce consistent conclusions to explain the

differences in measuring divergent thinking and convergent thinking by means of innovative and adaptive creativity, the results of the current study showed that cross-category, multiple-direction, reverse and originality thinking can be taken as innovative creativity with both divergent and convergent thinking, while diffusive thinking and enriched thinking can be seen as adaptive creativity with divergent thinking only.

Second, this study lends further support to relational perspectives on gender differences. Where prior research established the importance of gender characteristics in relation to creativity measurement, we have advanced the understanding of relational dynamics by showing how females perform better than males only in the measurement of adaptive creativity. This effect was related to the group aged 40 and over. Conversely, with respect to age difference, the results indicated that the older the person is, the less innovative creativity he or she has. In this way, combinative relations are seen to have a meaningful understanding in gender and age differences as demonstrated in prior research. Third, our study supports an expanded perspective on the measurement of creativity as a means of self-verifying creativity, asserting the distinctiveness of innovative and adaptive creativity.

Theoretical Implications

One's propensity for convergent thinking tends to become increasingly internalized with age, at the cost of creative potential (Kraft, 2005). Convergent reasoning in creativity tasks invokes criteria functionality and appropriateness (Kaufmann, 2003). Adult creative production is as much based on knowledge and analytical thinking as on imagination and divergent thinking (Cropley, 2006; Gabora & Kaufman, 2010). Accordingly, in the present study, revolutionary drawing was used to explore how the creative process interacts with divergent and convergent thinking for different age groups or genders. The results of this study also showed that people self-evaluate with creativity measurements. This promises to pave the way for developing theoretical understanding of measuring innovative and adaptive creativity in relation to individual motivation or cognitive abilities.

Original thinking has not been correlated to multiple-direction thinking and reverse thinking in this study, but provides an untapped potential for explaining creativity measurements. Most previous explanations have focused almost exclusively on originality in the measurement of creativity (e.g., Runco & Charles, 1993). However, this study introduced an explanation based on individual revolutionary drawing and delivered a support for cross-category thinking, multiple-direction thinking, and reverse thinking as succeeding in a way that may lead to innovative creativity along with divergent thinking.

Practical Implications

These findings have meaningful implications for the practical assessment of creative cognition. Divergent thinking has been described as an inductive process that is related to idea generation, and convergent thinking is often characterized as a deductive process that is related to searching for a single, correct solution (Brophy, 2001; Guildford, 1957). Revolutionary drawing provides empirical evidence that divergent thinking and convergent thinking are integrated, and a commonly used creative thinking test can tap the distinct cognitive mechanisms.

Treffinger (2009) suggested that it would be both possible and worthwhile to assess creativity in an appropriate context and for appropriate purposes if we can establish the goal of gathering data that will allow us to understand the richness and breadth of creativity. In this sense, revolutionary drawing can be applied other than at the elementary level to measure divergent thinking with convergent thinking.

Limitations and Future Study

According to Torrance (1993), creative thinking is a process of sensing difficulties, problems, gaps in information, missing elements, or something askew. It involves making guesses, formulating hypotheses about deficiencies, evaluating and testing those guesses and hypotheses, and then possibly revising and retesting them. Lastly, the results have to be communicated. Accordingly, there is a need to consider the possible range of cognitive processes that underlie creativity (Lee & Therriault, 2013). Creative cognition and creative personality are subsets of creative potential as well as a set of personality variables (Feist, 2010), and the differences of personality traits are valuable to explored (Liang, Chang, & Hsu, 2014). Therefore, future studies may focus on the cognitive trait and personality traits concerning innovative and adaptive creativity.

Criterion-related validity can test the correlation between one instrument and another to support the suitability of new instruments. Future studies may take the current instruments which were applied to measure convergent and divergent thinking to obtain the concurrent validity and predictive validity to ensure the credibility of revolutionary drawing.

An important role in generating multiple answers on divergent thinking tasks is played by working memory. As working memory is strongly linked with fluid and crystallized intelligence (Kim, Cramond, & VanTassel-Baska, 2010), it is likely that creativity is often linked with intelligence. The participants of this study were limited to school teachers; future studies may invite different professionals or those with different knowledge backgrounds to test their innovative and adaptive creativity. Besides, Chang, Chien, Yu, Lin, and Chen (2016) pointed out that the learning

environment might affect people's creativity performance, future study may consider how learning environment affect different types of creativity performance. Moreover, according to the study of Hsiao (2017) and Wang (2019), self-efficacy and engagement could be given to evaluate the relation with one's innovativeness or creativity; future studies can also focus applying adaptive and innovative creativity on exploring the correlates among self-efficacy, engagement, and innovative performances.

Acknowledgements

This work was financially supported by the "Institute for Research Excellence in Learning Sciences" of National Taiwan Normal University (NTNU) from The Featured Areas Research Center Program within the framework of the Higher Education Sprout Project by the Ministry of Education (MOE) in Taiwan.

References

Abdulla, A. M., & Cramond, B. (2017). After six decades of systematic study of creativity: What do teachers need to know about what it is and how it is measured. *Roeper Review, 39*(1), 9-23. doi:10.1080/02783193.2016.1247398

Ai, X. (1999). Creativity and academic achievement: An investigation of gender differences. *Creativity Research Journal, 12*(4), 329-337. doi:10.1207/s15326934crj1204_11

Albert, R. S. (1996). Some reasons why childhood creativity often fails to make it past puberty into the real world. *New Directions in Child Development, 72*, 43-56. doi:10.1002/cd.23219967205

Althuizen, N., Wierenga, B., & Rossiter, J. (2010). The validity of two brief measures of creative ability. *Creativity Research Journal, 22*(1), 53-61. doi:10.1080/10400410903579577

Baas, M., De Dreu, C. K. W., & Nijstad, B. A. (2008). A meta-analysis of 25 years of mood-creativity research: Hedonic tone, activation, or regulatory focus? *Psychological Bulletin, 134*(6), 779-806. doi:10.1037/a0012815

Baer, J. (1993). *Creativity and divergent thinking: A task specific approach*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Baer, J., & Kaufman, J. C. (2008). Gender differences in creativity. *The Journal of Creative Behavior, 42*(2), 75-105. doi:10.1002/j.2162-6057.2008.tb01289.x

Benedek, M., Franz, F., Heene, M., & Neubauer, A. C. (2012). Differential effects of cognitive inhibition and intelligence on creativity. *Personality and Individual Differences, 53*(4), 480-485. doi:10.1016/j.paid.2012.04.014

Benedek, M., & Jauk, E. (2014). Creativity: Lost in simplification? *Creativity, Theories, Research, Applications, 1*(2), 213-219. doi:10.15290/ctra.2014.01.02.06

Boden, M. A. (2004). *The creative mind: Myths and mechanisms*. London, UK: Routledge.

Bradley, F., Gao, Y., & Sousa, C. M. P. (2013). A natural science approach to investigate cross-cultural managerial creativity. *International Business Review, 22*(5), 839-855. doi:10.1016/j.ibusrev.2013.01.006

Brophy, D. R. (2001). Comparing the attributes, activities, and performance of divergent, convergent, and combination thinkers. *Creativity Research Journal, 13*(3&4), 439-455. doi:10.1207/S15326934CRJ1334_20

Castillo-Vergara, M., Galleguillos, N. B., Cuello, L. J., Alvarez-Marin, A., & Acuña-Opazo, C. (2018). Does socioeconomic status influence student creativity? *Thinking Skills and Creativity,*

29, 142-152. doi:10.1016/j.tsc.2018.07.005

Chang, Y.-S., Chien, Y.-H., Yu, K.-C., Lin, H.-C., & Chen, M. Y.-C. (2016). Students' innovative environmental perceptions and creative performances in cloud-based m-learning. *Computers in Human Behavior, 63*, 988-994. doi:10.1016/j.chb.2016.06.032

Cohen, L., Manion, L., & Morrison, K. (2000). *Research methods in education* (5th ed.). London, UK: Routledge.

Cropley, A. (2006). In praise of convergent thinking. *Creativity Research Journal, 18*(3), 391-404. doi:10.1207/s15326934crj1803_13

Davis, G. A. (1999). *Creativity is forever*. Dubuque, IA: Kendall/Hunt.

Diamond, A. M. (1986). The life-cycle research productivity of mathematicians and scientists. *Journal of Gerontology, 41*(4), 520-525. doi:10.1093/geronj/41.4.520

Diamond, M. C. (2001). *Good news about the aging brain*. San Francisco, CA: American Society on Aging.

Dollinger, S. J., & Shafran, M. (2005). Note on consensual assessment technique in creativity research. *Perceptual and Motor Skills, 100*(3), 592-598. doi:10.2466/pms.100.3.592-598

Dziedziewicz, D., Oledzka, D., & Karwowski, M. (2013). Developing 4- to 6-year-old children's figural creativity using a doodle-book program. *Thinking Skills and Creativity, 9*, 85-95. doi:10.1016/j.tsc.2012.09.004

Feist, G. J. (2010). The function of personality in creativity: The nature and nurture of the creative personality. In J. C. Kaufman & R. J. Sternberg (Eds.), *Cambridge handbook of creativity* (pp. 113-130). New York, NY: Cambridge University Press.

Friedman, R. S., & Förster, J. (2001). The effects of promotion and prevention cues on creativity. *Journal of Personality and Social Psychology, 81*(6), 1001-1013. doi:10.1037/0022-3514.81.6.1001

Friedman, R. S., & Förster, J. (2005). Effects of motivational cues on perceptual asymmetry: Implications for creativity and analytical problem solving. *Journal of Personality and Social Psychology, 88*(2), 263-275. doi:10.1037/0022-3514.88.2.263

Fritz, R. (1991). *Creating*. New York, NY: Fawcett Columbine.

Frosch, K. H. (2011). Workforce age and innovation: A literature survey. *International Journal of Management Reviews, 13*(4), 414-430. doi:10.1111/j.1468-2370.2011.00298.x

Gabora, L., & Kaufman, S. B. (2010). Evolutionary approaches to creativity. In J. C. Kaufman & R. J. Sternberg (Eds.), *Cambridge handbook of creativity* (pp. 279-300). Cambridge, UK: Cambridge University Press.

Guilford, J. P. (1950). Creativity. *American Psychologist, 5*(9), 444-454. doi:10.1037/h0063487

Guildford, J. P. (1957). Creative abilities in the arts. *Psychological Review, 64*(2), 110-118. doi:10.1037/h0048280

Guilford, J. P. (1967). *The nature of human intelligence*. New York, NY: McGraw-Hill.

He, W. J., & Wong, W. C. (2011). Gender differences in creative thinking revisited: Findings from analysis of variability. *Personality and Individual Differences, 51*(7), 807-811. doi:10.1016/j.paid.2011.06.027

Hermann, N. (1988). Whole brain activity. In R. L. Kuhn (Ed.), *Handbook for creative and innovative managers* (pp. 55-59). New York, NY: McGraw-Hill.

Hsiao, C.-C. (2017). Longitudinal research on in-service trainee teachers development of self-efficacy for creative teaching. *Journal of Research in Education Sciences, 62*(3), 25-55. doi:10.6209/jories.2017.62(3).02

Hughes, D. J., Furnham, A., & Batey, M. (2013). The structure and personality predictors of self-rated creativity. *Thinking Skills and Creativity, 9*, 76-84. doi:10.1016/j.tsc.2012.10.001

Isaksen, S. G., & Lauer, K. J. (2002). The climate for creativity and change in teams. *Creativity and Innovation Management Journal, 11*(1), 74-86. doi:10.1111/1467-8691.00238

Isaksen, S. G., & Treffinger, D. J. (1987). *Creative problem solving: Three components and six specific stages*. Buffalo, NY: Center for Studies in Creativity.

Kapoor, H. (2019). Sex differences and similarities in negative creativity. *Personality and Individual Differences, 142*, 238-241. doi:10.1016/j.paid.2018.04.043

Karakelle, S. (2009). Enhancing fluent and flexible thinking through the creative drama process. *Thinking Skills and Creativity, 4*(2), 124-129. doi:10.1016/j.tsc.2009.05.002

Kaufmann, G. (2003). What to measure? A new look at the concept of creativity. *Scandinavian Journal of Educational Research, 47*(3), 235-251. doi:10.1080/00313830308604

Kharkhurin, A. V., & Motalleebi, S. N. S. (2008). The impact of culture on the creative potential of American, Russian, and Iranian college students. *Creativity Research Journal, 20*(4), 404-411. doi:10.1080/10400410802391835

Kim, J., & Michael, W. B. (1995). The relationship of creativity measures to school achievement and to preferred learning and thinking style in a sample of Korean high school students. *Educational and Psychological Measurement, 55*(1), 60-74. doi:10.1177/0013164495055001006

Kim, K. H., Cramond, B., & VanTassel-Baska, J. (2010). The relationship between creativity and intelligence. In J. C. Kaufman & R. J. Sternberg (Eds.), *The Cambridge handbook of creativity* (pp. 395-412). New York, NY: Cambridge University Press. doi:10.1017/

CBO9780511763205.025

Kirton, M. J. (1976). Adaptors and innovators: A description and measure. *Journal of Applied Psychology, 61*(5), 622-629. doi:10.1037/0021-9010.61.5.622

Kirton, M. J. (1987). Adaptors and innovators: Cognitive style and personality. In S. G. Isaksen (Ed.), *Frontiers of creativity research: Beyond the basics* (pp. 282-304). Buffalo, NY: Bearly Limited.

Kirton, M. J. (1999). *Kirton adaption-innovation inventory manual*. Berkhamstead, UK: Occupational Research Centre.

Kirton, M. J. (2003). *Adaption-innovation: In the context of diversity and change*. London, UK: Routledge.

Kleibeuker, S. W., De Dreu, C. K. W., & Crone, E. A. (2013). The development of creative cognition across adolescence: Distinct trajectories for insight and divergent thinking. *Developmental Science, 16*(1), 2-12. doi:10.1111/j.1467-7687.2012.01176.x

Kraft, U. (2005). Unleashing creativity. *Scientific American Mind, 16*(1), 16-23. doi:10.1038/scientificamericanmind0405-16

Lee, C.-S., & Therriault, D. J. (2013). The cognitive underpinnings of creative thought: A latent variable analysis exploring the roles of intelligence and working memory in three creative thinking processes. *Intelligence, 41*(5), 306-320. doi:10.1016/j.intell.2013.04.008

Leutner, F., Yearsley, A., Codreanu, S.-C., Borenstein, Y., & Ahmetoglu, G. (2017). From Likert scales to images: Validating a novel creativity measure with image based response scales. *Personality and Individual Differences, 106*, 36-40. doi:10.1016/j.paid.2016.10.007

Liang, C., Chang, C.-C., & Hsu, Y. (2014). Differential effects of personality traits and environmental predictors on reproductive and creative imagination. *The Journal of Creative Behavior, 48*(4), 237-253. doi:10.1002/jocb.50

Liu, Z., Zhang, J., Xie, X., Rolls, E. T., Sun, J., Zhang, K., …Feng, J. (2018). Neural and genetic determinants of creativity. *NeuroImage, 174*, 164-176. doi:10.1016/j.neuroimage.2018.02.067

Luecke, R., & Katz, R. (2003). *Managing creativity and innovation*. Boston, MA: Havard Business School Press.

Mouchiroud, C., & Lubart, T. (2001). Children's original thinking: An empirical examination of alternative measures derived from divergent thinking tasks. *The Journal of Genetic Psychology, 162*(4), 382-401. doi:10.1080/00221320109597491

Mumford, M. D. (2003). Where have we been, where are we going? Taking stock in creativity research. *Creativity Research Journal, 15*(2-3), 107-120. doi:10.1080/10400419.2003.9651403

Ng, T. W. H., & Feldman, D. C. (2008). The relationship of age to ten dimensions of job

performance. *Journal of Applied Psychology, 93*(2), 392-423. doi:10.1037/0021-9010.93.2.392

Nicholls, J. G. (1972). Creativity in the person who will never produce anything original and useful: The concept of creativity as a normally distributed trait. *American Psychologist, 27*(8), 717-727. doi:10.1037/h0033180

Norlander, T., Erixon, A., & Archer, T. (2000). Psychological androgyny and creativity: Dynamics of gender-role and personality trait. *Social Behavior and Personality: An international Journal, 28*(5), 423-435. doi:10.2224/sbp.2000.28.5.423

Osborn, A. F. (1952). *Wake up your mind: 101 ways to develop creativeness*. New York, NY: Scribners.

Parnes, S. J. (1992). *Sourcebook for creative problem solving*. Buffalo, NY: Creative Education Foundation Press.

Petrowski, M. J. (2000). Creativity research: Implications for teaching, learning and thinking. *Reference Services Review, 28*(4), 304-312. doi:10.1108/00907320010359623

Plsek, P. E. (1997). *Creativity, innovation, and quality*. Milwaukee, WI: ASQ Quality Press.

Plucker, J. A., & Makel, M. C. (2010). Assessment of creativity. In J. C. Kaufman & R. J. Sternberg (Eds.), *The Cambridge handbook of creativity* (pp. 48-73). New York, NY: Cambridge University Press.

Rosa, J. A., Qualls, W. J., & Ruth, J. A. (2014). Consumer creativity: Effects of gender and variation in the richness of vision and touch inputs. *Journal of Business Research, 67*(3), 386-393. doi:10.1016/j.jbusres.2012.12.023

Rossman, J. (1931). *The psychology of the inventor: A study of the patentee*. Washington, DC: Inventors.

Runco, M. A. (2010). Divergent thinking, creativity, and ideation. In J. C. Kaufman & R. J. Sternberg (Eds.), *The Cambridge handbook of creativity* (pp. 413-446). New York, NY: Cambridge University Press. doi:10.1017/CBO9780511763205.026

Runco, M. A., & Charles, R. E. (1993). Judgments of originality and appropriateness as predictors of creativity. *Personality and Individual Differences, 15*(5), 537-546. doi:10.1016/0191-8869(93)90337-3

Simonton, D. K. (1988). Age and outstanding achievement: What do we know after a century of research? *Psychological Bulletin, 104*(2), 251-267. doi:10.1037/0033-2909.104.2.251

Smolucha, L. W., & Smolucha, F. C. (1985). A fifth Piagetian stage: The collaboration between analogical and logical thinking in artistic creativity. *Visual Arts Research, 11*(2), 90-99.

Sternberg, R. J. (2012). The assessment of creativity: An investment-based approach. *Creativity*

Research Journal, 24(1), 3-12. doi:10.1080/10400419.2012.652925

Sternberg, R. J., & Lubart, T. I. (1996). Investing in creativity. *American Psychologist, 51*(7), 677-688. doi:10.1037/0003-066X.51.7.677

Takeuchi, H., & Kawashima, R. (2018). Mean diffusivity in the dopaminergic system and neural differences related to dopaminergic system. *Current Neuropharmacology, 16*(4), 460-474. doi:10.2174/1570159X15666171109124839

Torrance, E. P. (1966). *The Torrance tests of creative thinking-norms technical manual research edition-verbal tests, forms A and B figural tests, forms A and B*. Princeton, NJ: Personnel Press.

Torrance, E. P. (1974). *Torrance Tests of Creative Thinking: Norms-technical manual*. Lexington, MA: Personnel Press.

Torrance, E. P. (1979). *The search for satori and creativity*. New York, NY: Creative Education Foundation.

Torrance, E. P. (1993). Understanding creativity: Where to start? *Psychological Inquiry, 4*(3), 232-234. doi:10.1207/s15327965pli0403_17

Torrance, E. P. (1995). Insights about creativity: Questioned, rejected, ridiculed, ignored. *Educational Psychology Review, 7*(3), 313-322. doi:10.1007/BF02213376

Torrance, E. P. (1998). *Torrance Tests of Creative Thinking: Norms-technical manual figural (streamlined) forms A & B*. Bensenville, IL: Scholastic Testing Service.

Treffinger, D. J. (2009). Myth 5: Creativity is too difficult to measure. *Gifted Child Quarterly, 53*(4), 245-247. doi:10.1177/0016986209346829

Urban, K. K., & Jellen, H. R. (1996). *Test for creative thinking-drawing production (TCT-DP)*. Lisse, the Netherland: Swets and Zeitlinger.

Wallas, G. (1926). *The art of thought*. London, UK: Watts.

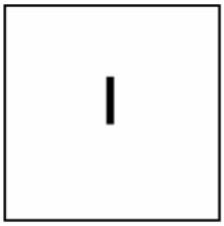
Wang, H.-C. (2019). The influence of creative task engagement on English L2 learners' negotiation of meaning in oral communication tasks. *System, 80*, 83-94. doi:10.1016/j.system.2018.10.015

Wu, C.-H., Cheng, Y., Ip, H. M., & McBride-Chang, C. (2005). Age differences in creativity: Task structure and knowledge base. *Creativity Research Journal, 17*(4), 321-326. doi:10.1207/s15326934crj1704_3

Zabelina, D. L., Friedman, N. P., & Andrews-Hanna, J. (2019). Unity and diversity of executive functions in creativity. *Consciousness and Cognition, 68*, 47-56. doi:10.1016/j.concog.2018.12.005

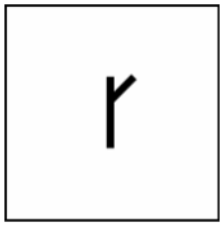
Appendix

the first object



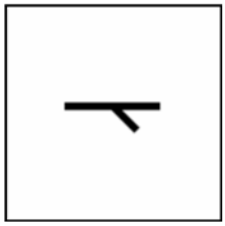
Name: utility pole
Specify: n.a. direction

cross-category reverse



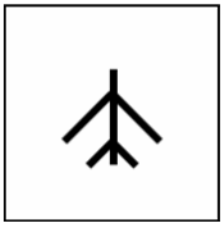
Name: tuning peg
Specify: reverse

no line added
not scored



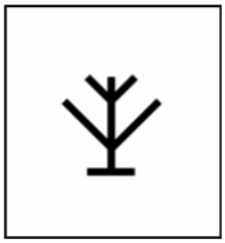
Name: handgun
Specify: change direction

cross-category
multiple-direction



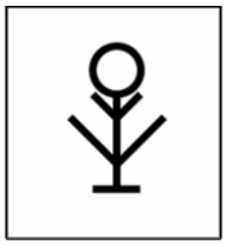
Name: airplane
Specify: change

cross-category
multiple-direction
reverse



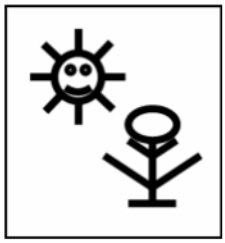
Name: tree
Specify: reverse & direction

reverse
mono-category (plant)



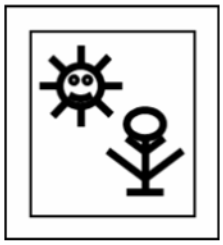
Name: flower
Specify: reverse

enrichment
(enrich the content)



Name: flower under the sun
Specify: n.a.

enrichment
(enrich the content)



Name: picture
Specify: n.a.

教育科學研究期刊　第六十四卷第三期
2019 年，64（3），143-168
doi:10.6209/JORIES.201909_64(3).0006

調適性與創新性創造力之評量

洪榮昭
國立臺灣師範大學
工業教育學系暨
學習科學跨國頂尖研究中心

戴凱欣
國立臺灣師範大學
工業教育學系暨
學習科學跨國頂尖研究中心

陳柏熹
國立臺灣師範大學
教育心理與輔導學系暨
學習科學跨國頂尖研究中心

蘇少祖
國立臺灣師範大學
教育心理與輔導學系暨
學習科學跨國頂尖研究中心

摘要

創意的量測一直是近代實證研究的主題，最突出的是托倫斯的創造性思維測驗（TTCT），這些創造力評量工具大多強調擴散性思考的評量，對聚斂性思考較少著墨。本研究開發一個可同時應用擴散性與聚斂性思考的圖像量測工具——「圖繪展開創意評量」，以圖片取代傳統反應量表，並可用來測量調適性創造力及創新性創造力。本研究的研究對象為 332 位參與創造力發展課程的教師，其中有效樣本為 324 筆，並以此進行研究假設驗證。研究結果顯示，這兩種類型呈現負相關。創新性創造力中除了原創性思維外，另外三個創新性思維類型：多向性思維、異類思維及逆向思維皆呈正相關。調適性創造力中的同類性思維與豐富化思維兩者呈正相關。研究結果顯示，女性在創新性創造力方面的表現優於男性，較年輕的受試者表現優於比較年長的受試者，但在調適性創造力方面，只有 30 歲以下的受試者表現優於 40 歲以上的受試者。本研究建議「圖繪展開創意評量」可用於評量個體的創新性創造力與調適性創造力，是一種能同時評量擴散性思考與聚斂性思考的評量工具。

關鍵詞：調適性創造力、聚斂性思考、創造力評量、擴散性思考、創新性創造力

通訊作者：陳柏熹，E-mail: lorenz1020@gmail.com
收稿日期：2019/01/30；修正日期：2019/08/02；接受日期：2019/08/15。