Risk-taking and creativity: Convergent, but not divergent thinking is better in low-risk takers

Wangbing Shen [a, b, *], Bernhard Hommel [b, *], Yuan Yuan [c, *], Chang, Liu [d], Wei Zhang [e]
[a] School of Public Administration and Business School, Hohai University, Nanjing, CHINA
[b] Institute for Psychological Research, Leiden University, Leiden, The Netherlands
[c] School of Rehabilitation Science, Nanjing Normal University of Special Education, Nanjing, CHINA
[d] Lab of Cognitive Neuroscience, Nanjing Normal University, Nanjing, CHINA
[e] School of Preschool education Yancheng Kindergarten Teachers College, Yancheng, CHINA

Acknowledgments—This work was supported by the National Natural Science Foundation of China (31500870), the Fundamental Research Funds for the Central Universities (2017B14514), China Postdoctoral Science Foundation (2017M621603), Natural Science Foundation of Jiangsu College of China (17KJB90002), and the Philosophical and Social Science Foundation of Jiangsu Colleges of China (2017SJB0649). We send our sincere thanks to Miss Zongying Liu, Haixia Gu, and Yuan Zhao for their scoring the divergent thinking test.

* Corresponding authors.
Date of Revision Submission: Nov 7, 2017

Address:
Dr. Wangbing Shen
School of Public Administration and Business Shool,
Hohai University
No 8, Focheng West Road, Nanjing, China
Email: wangbingshpsy@163.com

Dr., Prof., Hommel Bernhard,
Institute of Psychological Research
Leiden University, Wassenaarseweg 52
2333 AK Leiden, The Netherlands
Email: hommel@fsw.leidenuniv.nl

Dr. Yuan Yuan
School of School of Rehabilitation Science,
Nanjing Normal University of Special Education,
Nanjing, 210038,
No 1 Shennong Road,
Email: psychyy1989@163.com

Abstract

The relationship between risk-taking and creativity is critical to understanding social harmony and innovation. While some studies have assessed the link between risk-taking and divergent thinking, the association between risk-taking and convergent thinking remains unclear. Two studies were conducted to systemically investigate whether risk-taking is linked to convergent thinking. In Study 1, a sample of 127 healthy participants performed a Chinese Remote Associate Test (RAT) and completed a risk-taking questionnaire. As predicted, risk-taking was negatively correlated with RAT performance, implying that risk-taking may have a negative association with convergent thinking. Study 2 was an online survey study that replicated Study 1, and extended the measures to include self-rated risk and a measure of divergent thinking (the Alternate Uses Task). The findings were fully replicated, showing that low risk-taking goes with better convergent thinking, while risk-taking was not significantly correlated with divergent thinking. Furthermore, the risk-taking/convergent-thinking relationship was best described by a linear regression model in both studies. Taken together, these results suggest that appropriate reductions in risk-taking can boost convergent thinking.

Keywords: convergent thinking; risk-taking; divergent thinking; remote associates test

Risk-taking and creativity: Convergent, but not divergent thinking is better in low-risk takers

The relationship between risk-taking and creativity is particularly important and interesting because these two constructs are crucial to the maintenance of social harmony and the development of scientific technology. Mounting evidence suggests that we all live in a highly complex, and therefore risky society in which we are confronted by various difficult to predict challenges. Perhaps due to the pervasiveness of risks and risk-taking in contemporary society, researchers have argued that our society is becoming a "risky society" (e.g., Beck, 2002). Against this background the study of how, when, and why people take risks seems especially important as it may unravel better ways of managing risk or ways of enabling more people to benefit from risk-taking, e.g. through making large profits from highly risky investments (e.g., Platt & Huettel, 2008; Sternberg & Lubart, 1992). The concept of creativity is similar to that of risk-taking. Being creative often involves, sometimes even requires taking some degree of risk, and it can also generate considerable improvements in quality of life and wellbeing, including enabling individuals to mate with attractive partners, promoting development of high-tech devices and scientific inventions, leading to medical breakthroughs that improve health and enabling individuals to make large profits from entrepreneurial activities (Baas, Koch, Nijstad, & De Dreu, 2015; Sternberg & Lubart, 1992). Despite such similarities, the actual relationship between creativity and risk-taking is still unclear.

The possibility that such a relationship might exist has long been recognized. Many early studies on creative thinking show that risk-taking is integral to creativity (Eisenman, 1987; Dewett, 2007; Feist, 1998; Sternberg & Lubart, 1992). Perhaps influenced by this view of the relationship, William's (1980) well-known 50-item scale for measuring creativity personality, the William Test of Creative Propensity, includes a risk-taking subscale. At the end of the 20th century, the significance of investigating the link between risk(-taking) and creativity has been successively elevated by the achievement motivation theory (Dewett, 2006; Zhou & George, 2001) and creativity's investment theory (Sternberg & Lubart, 1992; Sternberg, 2006), both of which posit that taking sensible risks is a prerequisite for creativity.

Although the theoretical significance of the relationship between creativity and risk-taking has been recognized, there have been only a few empirical studies examining it. Eisenman (1987) found positive correlations between risk-taking and three separate indicators of creativity, namely creative attitude, divergent thinking and creative preference for complexity, in a sample of middle-class men. Creativity and risk-taking were also found to be positively correlated in separate samples of advertising executives (El-Murad & West, 2003) and employees working in research and development (Dewett, 2006, 2007). A recent study of 120 undergraduate students (Simmons & Ren, 2009) also documented a positive relationship between situational risk and creativity as measured by the in-basket task (e.g., Shalley, 1991). A positive relationship in students has also been reported by Tyagi, Hanoch, Hall, Runco, and Denham (2017), but only between high-level, biographical measures of creativity and social risk-taking, while neither divergent nor convergent thinking (as assessed by the Alternate Uses Task [AUT] and the Remote Associates Task [RAT], respectively) correlated with any risk-taking measure. In summary, some aspects of creativity have been linked to some aspects of risk-taking in diverse samples (varying from undergraduates to employees to middle-class men) and using diverse methods of assessing creativity and risk-taking.

With the exception of Tyagi et al., the relevant studies (e.g., Eisenman, 1987; Dewett, 2007; Shen, Yuan, Liu, Yi, & Dou, 2016; Tyagi et al., 2017) have focused on the association between risk-taking and divergent thinking (brainstorming-like creativity), while the relationship between risk-taking and convergent ("deep") thinking has received almost no attention. Divergent thinking involves generating many possible solutions to an often vaguely defined problem or puzzle, whereas convergent thinking relies on speed, accuracy, logic and the capacity to quickly recognize the best, correct solution to a clearly defined problem (Cropley, 2006; Lee & Therriault, 2013). Importantly, a growing number of empirical studies consolidate previous ideas that convergent thinking is dissociable from divergent thinking. As new kinds of evidence for such distinctiveness, for example, Hommel and colleagues showed that divergent and convergent thinking are differently affected by mood induction (Akbari Chermahini & Hommel, 2012), individual dopamine levels (Akbari Chermahini & Hommel, 2010), physical exercise (Colzato, Szapora, Panekoek, & Hommel, 2013), and meditation (Colzato, Szapora, Lippelt, & Hommel, 2017). Specifically, they observed that divergent thinking both improves and is improved by mood, and has an inverted U-shape relationship with dopamine levels, whereas convergent thinking lowers mood and tends to be negatively correlated with dopamine levels. This implies that creativity is no homogeneous concept but relates to different, separable subprocesses that are likely to reflect the same mechanisms. The authors therefore agree with Tyagi et al. (2017) that the present inconsistency in findings on the relationship between risk-taking and creativity are likely to reflect the use of different tests and methods to assess the underlying concepts, but they do not share their optimism that a "holistic" approach that considers as many creativity measures as possible will make it easier to come to a conclusion. Many available measures have been developed for practical, rather than theoretical reasons (leaving their relationships entirely undefined) and for the purpose of personality assessment, rather than the identification of the underlying cognitive mechanisms, which makes us skeptical about a multidimensional approach will lead to theoretically interpretable outcomes.

The present study therefore focused on a single convergent-thinking task, the RAT. For one, because this task has been often used in studies on the cognitive and neural mechanisms underlying this aspect of creativity (e.g., Akbari Chermahini & Hommel, 2010, 2012; Kounios et al., 2006; Shen, Yuan, Liu, & Luo, 2016; Subramaniam, Kounios, Parrish, & Jung-Beeman, 2009). For another, because of the observation that psychological safety improves creativity as assessed by the RAT (Mikulincer, Shaver, & Rom, 2011). Considering that psychological safety implies the opposite of risk, this research predicted that risk-taking would be negatively correlated with convergent thinking (RAT performance). To test this hypothesis, Study 1, a laboratory study with computerized cognitive measures of risk-taking and convergent thinking (using a Chinese version of the RAT) was devised. The findings were consistent with our hypothesis, suggesting that convergent thinking seems better in less risk-taking individuals. Given that these findings are inconsistent with the observations of Tyagi et al. (2017), whose article appeared only after having run our first study, we tried to replicate and extend our findings in another, more heterogeneous sample in Study 2, which also compared the risk-taking measure and creativity task that were used in Study 1 with another risk-taking measure and a divergent-thinking task, respectively.

Study 1

Method

Participants

A sample of 127 paid volunteers was recruited for this study. The sample consisted of healthy, right-handed undergraduates from two universities (87 men, 40 women) aged between 19 and 28 years (*M* = 20.96, *S.D.* = 1.42). All the participants are native Chinese and gave written, informed consent prior to participation, had no history of neurological disorder or psychiatric illness, had not been exposed to similar cognitive tasks and had normal or corrected-to-normal vision.

Measures

Risk-taking preference

The risk-taking preference index (RPI; Hsee & Weber, 1997, 1999) is a commonly used tool for measuring individuals' preferred level of risk-taking which has good cross-national validity (Hsee & Weber, 1999). An RPI score is computed from responses to a set of 14 questions related to two types of situation and can range from 1 (most risk-averse) to 8 (most risk-seeking). In the gain situations, if a participant choses the 'sure' option in all of the given seven questions, her/his RPI equals 1 (most risk-aversive). If she/he choses the risky option in all seven questions, her/his RPI equals 8 (most risk-seeking). According to Hsee and Weber (1999), if the participant choses the risk option in Question 1 through Question i-1, and the "sure" option in Question I through Question 7, her/his RPI is scored as i. The reverse marking scheme is used in the loss situations.

Convergent thinking

A Chinese Remote Associate Task (RAT) was utilized to assess convergent creativity. The task is a variant of the English-language RAT originally developed by Mednick (1968). In the original RAT each item consists of three "clue" words that can be associated with a "solution" word to form a compound word or specify a semantic association (Shen, Yuan, Yi, et al., 2016).

Our Chinese version has been validated and has already been used in research with native Chinese participants (e.g., Wo, Chen, Liu, & Lin, 2010; Huang, 2017). Like the original RAT, our version requires respondents to choose a fourth (solution) word or Chinese character-pair that can be associated with each triad. All items are constructed in such a way that only a solution is possible. For example, the solution to the triad "*Orbit (轨道), Weather (气象), Earth (地球)*" is "*Satellite (卫星)*" and the problem "*Candle (蜡烛), Cigarette (香烟), Girl (女孩)*" is "*Match (火柴)*". This study used 54 of the 97 RAT items (6 items were used in practice and 48 in experimental testing). The difficulty of this subset of RAT items ranged from 0.2 to 0.8 in a sample of 141 undergraduates.

Procedure

All participants completed the two cognitive tasks (the RAT, used to measure convergent thinking, and the RPI, used to measure risk-taking preference) individually, in a dimly lit room sitting approximately 70 cm away from the computer monitor. After completing the first task participants were allowed to take a brief break (about 90 seconds) during which they had to remain quietly at their desk. After this they completed the second task. The order of the two tasks was counterbalanced across participants.

The participants were invited to individually complete the pencil-and-paper survey on the RPI. As in the RAT, all the items were presented using E-prime 2.0 software. The stimulus presentation process is illustrated in Fig. 1. Each trial started with the participant fixating on a cross positioned in the center of the screen for 0.5 s to ensure that she or he would see the problem words, which were presented subsequently. The problem words were presented together, in their normal orientation, in a horizontal line across the screen. Participants were instructed to press the space bar as soon as they had thought out the solution and were given 10 s to do so. When the participant pressed the space bar a white screen was displayed for 0.3 s, then the participant was required to enter her or his solution in the designated spot. Participants were instructed to not to enter anything at this point if they had not worked out a solution before the disappearance of the problem words. There are two ratings without any time limit, involving solution strategy (insight vs. non-insight) and difficulty level individually, before the ended white screen persisting for 1 s.

[INSERT FIGURE 1 HERE]

Results

Descriptive statistics for convergent thinking and risk-taking are listed in Table 1. Given the gender imbalance in the sample and previous reports that gender is associated with both risk-taking (e.g., Cárdenas, Dreber, Von Essen, & Ranehill, 2012) and creativity (Abraham, Thybusch, Pieritz, & Hermann, 2014; Abraham, 2015; Shen, Yuan, Shi, & Liu, 2015) independent-sample *t*-tests were applied to assess whether gender was associated with any of the variables investigated. The association between gender and solution time just failed to reach significance, $t_{(125)} = 1.96$, $p = 0.052$, Cohen's $d = 0.37$, and gender was not associated with any of the other dependent variables, all $|t|$s < 1.5, all ps > 0.05. Most importantly, Pearson correlation analysis revealed a significant negative correlation between risk-taking and RAT solution accuracy, $r_{(127)} = -0.20$, $p < 0.05$.

[INSERT TABLE 1 HERE]

To determine the nature of the relationship between risk-taking and RAT solution accuracy, this study calculated curve (including logarithmic model and quadratic model) and linear regressions. As illustrated in Figure 2, the results showed the quadratic model is inappropriate (p>0.05) and the effects of gender and age are insignificant across three regression models. The logarithmetic and linear model are both significant, but the linear regression model (R^2 = 4%) is relatively better than the logarithmic regression model (β = -0.18, *SE* = 0.04, t_{125} = -2.07, $p <$ 0.05, R^2 = 3%) in accounting variance. Accordingly, only the linear model was accepted, as Table 2 illustrated, which implies there is linearly negative association between risk-taking and convergent thinking performance and the low-risk takers behave better performance in convergent thinking than the high-risk takers.

[INSERT FIGURE 2 HERE]

Discussion

Consistent with the prediction of an inverse relationship between risk-taking and convergent thinking, our study revealed that participants' risk-taking level is negatively correlated with the RAT performance. Although this result is contradictory with popular belief mentioned in some self-help books that argue for the facilitating effect of risk-taking on creative performance, the present finding is supported by some studies on convergent thinking (e.g., Mikulincer et al., 2011). And yet, it is also important to point out that our finding is inconsistent with the results of Tyagi and colleagues (2017), which were published after our Study 1 was completed. They found no relationship between performance in the RAT or in the AUT, a measure of divergent thinking, with any of their indicators of risk-taking. Before considering some possible explanations for this discrepancy, the researchers wanted to confirm that our finding is sufficiently robust and replicable. The authors therefore replicated the design of Study 1 in an online setting (Study 2), which permitted us to test participants with various kinds of Chinese culture backgrounds. Study 2 also extended the design by adding a second measure of risk-taking, based on self-report, and a divergent-thinking task—the AUT that was also used by Tyagi et al. It is expected that risk-taking would again be negatively correlated with convergent thinking.

[INSERT TABLE 2 HERE]

Study 2

Method

Participants

The sample comprised 198 Chinese people (51 males) from 11 provinces/regions of China. All participants were recruited through campus advertisements, forum posters, telephone messages, or emails. A total of 44 respondents was excluded due to incomplete responses in one or more of the three measures (two creativity measures and the RPI measure), or because of suspiciously short (<650s) or long (>9000s) overall response time, or due to indications of random response patterns (e.g., more than 10 or 15 response repetitions). The final sample included 154 healthy and well-educated volunteers (40 men) from eight provinces/regions of China, aged between 15 and 47 years (*M*= 21.24, *S.D.*=4.05). All participants provided informed consent prior to participation, had no (self-reported) history of neurological disorder or psychiatric illness, and had not yet been exposed to similar cognitive tasks.

Measures

Risk-taking preference

In addition to the risk-taking measure used in Study 1, this study also adopted another self-reported risk-taking measure in which the participants were asked to directly score their own adventurousness on the scale ranging from 0 to 100.

Convergent thinking

This measure was same as that in Study 1. However, the 48 RAT items were represented on a web page listing all items rather than item-by-item.

Divergent thinking

The Alternate Uses Task (AUT) was adopted to assess individuals' divergent thinking and creative potential (Runco & Acar, 2012). Participants were asked to generate as many different uses as possible for four common objects, namely "leather shoes", "shoebox", "candle", and "iron nail". The participants' responses were initially screened to exclude irrelevant responses and were then independently rated by three trained postgraduate students on three of the four[①] standard AUT dimensions, namely fluency (the total sum of intelligible responses), flexibility (the number of categories in which these responses fell), and originality (2 points for responses with a total frequency of less than 5% in the sample; 1 point for a frequency of 5-10%). Tutorials were given to raters for the AUT together with the definition of each indicator to score. In line with Amabile's (1982) Consensual Assessment Technique (CAT), raters used their own definitions of creativity. The inter-rater reliability was 1 for fluency; 0.95-0.98 for flexibility; and 0.79-0.83 for originality.

Procedure

This study was conducted online and data were collected via the web-based questionnaires hosted by wenjuanxing (www.sojump.com), a Chinese professional survey platform similar to SurveyMonkey. The participants were invited to individually provide the demographic information, and work through the risk-taking questions and the creativity tests. The order of the four measures was fixed: demographic information, divergent thinking task, risk-taking measure, and convergent thinking task. All the tasks were presented in an online survey web service without any time restriction, but the participants were encouraged to complete each divergent thinking item within the maximum 3 minutes[②]. To ensure the validity and reliability of the

① The elaboration score is not enough meaningful due to only a few elaborated responses provided by participants.

② The responding time was controlled by the participants through their own timing tools (e.g., timing software in their computers/telephones or alarm clocks/watches). To ensure participants followed the rules and completed each divergent thinking item within the time interval, they were informed that the responding time for each item was automatically monitored by the web service platform and their time-keeping performance would be rewarded.

results, three forward and backward self-paced turning pages (individually to present the measures on demographic information and divergent thinking, risk-taking, and convergent thinking) were designed. The participants were compensated by a raffle ticket of 10 Yuan or course credit after completing their test.

Results

Independent *t*-tests did not yield any differences between females and males on the creativity and risk-taking measures. The Pearson correlation analyses revealed a significant correlation between RAT accuracy and both the risk preference as assessed by RPI (r=-0.163, p<0.05) and the self-reported adventurousness score (r=-0.204, p<0.05). Even though the measures of convergent thinking and of divergent thinking were correlated (Table 3), there was no significant correlation between the two risk-taking scores and any of the three indicators of divergent thinking (i.e., flexibility, originality, and fluency). Given the subjective risky level and the RPI are only two different indicators of risk-taking, rather than two different observed variables. Accordingly, they are employed two independent regression model, not as two predictors into one regression model[③]. As exhibited in Table 2, the linear regression analysis results showed that the RPI (R^2 = 3%) and subjective risky level (R^2 = 4%) reliable predicted the RAT solution accuracy, respectively.

[INSERT TABLE 3 HERE]

General Discussion

The results from this online study demonstrate a significant negative association between risk-taking and convergent thinking as assessed by RAT, corroborating our finding from Study 1.

[③] The curve (including the logarithmic model and quadratic model) regression of these two risk-taking measures on the Chinese RAT solution accuracy and on three indicators of divergent thinking were also calculated, but none of them reached the level of statistical significance (p>0.05), except the significant quadratic model of the RPI (only for the square of the RPI on the average originality score; β = -0.66, SE = 0.003, t_{151} = -2.27, p<0.05).

Importantly, the link between the two constructs was further supported by additional results showing a negative correlation between RAT accuracy and the level of self-reported adventurousness. It is interesting to note that the two risk-taking measures did not correlate and yet both measures were correlated with convergent thinking. This implies that our two measures picked up different aspects of risk-taking, which nevertheless share the negative association with convergent thinking. Hence, the underlying association seems to be rather robust, and as in Study 1, it seems to be rather linear.

The findings for convergent thinking were again inconsistent with previous observations of Tyagi et al. (2017), who found no relationship. Several factors may be responsible for this inconsistency. First, Tyagi and colleagues have used a different measure of risk-taking. While this might have been responsible for the different outcomes, the fact that the authors found the same negative correlation for both of our measures of risk-taking renders this possibility not particularly likely. Second, Tyagi and colleagues have pointed out that their version of the RAT turned out to be rather difficult, presumably too difficult for many participants, which must have rendered the test undiagnostic. In comparison, our findings do not suggest any particular measurement problem, such as a floor or ceiling effect, which the current study thinks renders our findings more trustworthy with respect to the convergent thinking measure. Third, and perhaps most interestingly, various authors have considered the possibility that sample characteristics might play an important role (e.g., Fleming & Weintrauh, 1962; Dewett, 2004, 2007). Indeed, given that Chinese culture defines and values creativity differently from Western culture (Shen, et al., in press; Niu, & Kaufman, 2013; Lan & Kaufman, 2012), the discrepancy to the findings of Tyagi et al. (2017) may also indicate an interesting cultural difference that calls for further investigations. In this context, it may be important to note that our Study 2 revealed significant positive correlations between convergent and divergent measures. In previous studies of one of us carried out in the Netherlands, these correlations were close to zero and, if anything, negative (e.g., Akbari Chermahini & Hommel, 2010). The fact that these correlations were far from zero and positive in the present study, which used a Chinese sample, might be related to the dominant role in widespread use of dialectical thinking in Chinese thought (Shen et al., in press). This tradition considers two things with opposite characteristics as an integrated continuum so that two contradictory things should not necessarily be treated as two independent things, but as two sides of the same (integrated) thing. While this is an interesting possibility[④], the researchers admit that it remains speculative and is not exclusive. For example, consistent with the present result, Wu, Chang and Chen (2017) reported a similar positive correlation between convergent thinking and divergent thinking, which, however, is ascribed to the common involvement of associative process in these two types of creative thinking (Lee & Therriault 2013; Shen, Yuan, Liu, & Luo, in press). Accordingly, future studies should conduct cross-culture design to further investigate these interesting speculations.

Even though convergent and divergent thinking scores were correlated in the present study, convergent thinking in a tighter, more reliable link to risk-taking than divergent thinking had. This tighter link makes functional sense: divergent thinking requires an individual to explore several cognitive paths, which sometimes may involve taking some risks in order to generate multiple solutions to a puzzle or problem. Convergent thinking, in contrast, involves focusing on finding the single correct solution, which is less likely to require risk-taking. Our findings

---

[④] As the reviewers and handling editors stressed, there may be an alternative explanation for the found correlation between convergent thinking and divergent thinking that the requested time limitation might inhibit the participants' divergent thinking performance, particularly inhibit their originality. This is because the participants in the time-limited context would think they are being tested, rather than playing with the divergent thinking tasks. In fact, after reviewing previous studies, we found nearly all researchers required their participants to complete divergent thinking task within a limited time interval and considerable studies requested the participants to complete each of the-like items within 3 minutes (Silvia et al., 2008; Fink, Graif, & Neubauer, 2009) or shorter time interval (e.g., Forthmann, Holling, Çelik, Storme, & Lubart, 2017).

suggest that convergent thinking may benefit from risk-avoidance, which fits with the observation that being conservative or taking less risk can promote convergent problem-solving (Bassett-Jones, 2005). Considering the positive relationship between risk-taking and impulsivity (disinhibition), our findings also fit with the observation that performance on cognitive inhibition tasks was positively correlated with RAT performance (Koppel & Storm, 2014).

Taken altogether, our findings have a number of interesting implications for future studies. First, it should note that the true nature of risk-taking remains unclear, which calls for further investigation. Our results do not provide information for determining the specific nature of risk(-taking) in creativity because risk(-taking) can be situational (e.g., willingness to take risks; see Dewett, 2006) or cross-situational in nature, or can operate as (intrinsic) motivation or as propensity (e.g., Simmons & Ren, 2009). Future studies should therefore continue to investigate the complex relationship between risk-taking and creativity. Second, the relationship between creativity and risk-taking is likely to be linear but not follow an (inverted) U-shaped relationship, which has implications for attempts to foster creativity in educational or organizational settings. Finally, the negativity of the correlation between risk-taking and convergent thinking suggests that risk-taking should not be considered integral to creativity as a whole, which stands in stark contrast to often-found recommendations in self-help books on creativity training. Nevertheless, our results do imply that psychological safety plays an important role in nurturing creativity and convergent thinking in particular.

References

Abraham, A. (2015). Gender and creativity: An overview of psychological and neuroscientific literature. *Brain Imaging and Behavior*, 1-10.

Abraham, A., Thybusch, K., Pieritz, K., & Hermann, C. (2014). Gender differences in creative thinking: Behavioral and fMRI findings. *Brain Imaging and Behavior, 8*(1), 39-51.

Akbari Chermahini, S. A., Hickendorff, M., & Hommel, B. (2012). Development and validity of a Dutch version of the Remote Associates Task: An item-response theory approach. *Thinking Skills and Creativity, 7*(3), 177-186.

Akbari Chermahini, S. A., & Hommel, B. (2010). The (b) link between creativity and dopamine: spontaneous eye blink rates predict and dissociate divergent and convergent thinking. *Cognition, 115*(3), 458-465.

Akbari Chermahini, S., & Hommel, B. (2012). More creative through positive mood? Not everyone! *Frontiers in Human Neuroscience, 6:319*.

Amabile, T. M. (1982). Social psychology of creativity: A consensual assessment technique. *Journal of Personality and Social Psychology*, *43,* 997-1013.

Baas, M., Koch, S., Nijstad, B. A., & De Dreu, C. K. (2015). Conceiving creativity: The nature and consequences of laypeople's beliefs about the realization of creativity. *Psychology of Aesthetics, Creativity, and the Arts*, *9*(3), 340-354.

Bassett-Jones, N. (2005). The paradox of diversity management, creativity and innovation. *Creativity and Innovation Management*, *14*(2), 169-175.

Beck, U. (2002). The terrorist threat: World risk society revisited. *Theory, Culture & Society*, *19*(4), 39-55.

Cárdenas, J. C., Dreber, A., Von Essen, E., & Ranehill, E. (2012). Gender differences in competitiveness and risk taking: Comparing children in Colombia and Sweden. *Journal of Economic Behavior & Organization*, *83*(1), 11-23.

Colzato, L.S., Szapora, A., Lippelt, D., & Hommel, B. (2017). Prior meditation practice modulates performance and strategy use in convergent- and divergent-thinking problems. *Mindfulness, 8*, 10-18.

Colzato, L. S., Szapora, A., Pannekoek, J. N., & Hommel, B. (2013). The impact of physical exercise on convergent and divergent thinking. *Frontiers in Human Neuroscience, 7*, 824.

Cropley, A. (2006). In praise of convergent thinking. *Creativity research journal*, *18*(3), 391-404.

Dewett, T. (2004). Employee creativity and the role of risk. *European Journal of Innovation Management*, *7*(4), 257-266.

Dewett, T. (2006). Exploring the role of risk in employee creativity. *The Journal of Creative Behavior*, *40*(1), 27-45.

Dewett, T. (2007). Linking intrinsic motivation, risk taking, and employee creativity in an R&D environment. *R&D Management*, *37*(3), 197-208.

Eisenman, R. (1987). Creativity, birth order, and risk taking. *Bulletin of the Psychonomic Society*, *25*(2), 87-88.

El-Murad, J., & West, D. C. (2003). Risk and creativity in advertising. *Journal of Marketing Management*, *19*(5-6), 657-673.

Feist, G. J. (1998). A meta-analysis of personality in scientific and artistic creativity. *Personality and Social Psychology Review*, *2*(4), 290-309.

Fink, A., Graif, B., & Neubauer, A. C. (2009). Brain correlates underlying creative thinking: EEG alpha activity in professional vs. novice dancers. *NeuroImage*, *46*(3), 854-862.

Fleming, E. S., & Weintraub, S. (1962). Attitudinal rigidity as a measure of creativity in gifted children. *Journal of Educational Psychology*, *53*(2), 81-85.

Forthmann, B., Holling, H., Çelik, P., Storme, M., & Lubart, T. (2017). Typing speed as a confounding variable and the measurement of quality in divergent thinking. *Creativity Research Journal*, *29*(3), 257-269.

Hsee, C. K., & Weber, E. U. (1997). A fundamental prediction error: Self–others discrepancies in risk preference. *Journal of Experimental Psychology: General*, *126*(1), 45-53.

Hsee, C. K., & Weber, E. U. (1999). Cross-national differences in risk preference and lay predictions. *Journal of Behavioral Decision Making*, *12*, 165-179.

Huang, P. S. (2017). An exploratory study on remote associates problem solving: Evidence of eye movement indicators. *Thinking Skills and Creativity*, *24*, 63-72.

Koppel, R. H., & Storm, B. C. (2014). Escaping mental fixation: Incubation and inhibition in creative problem solving. *Memory*, *22*(4), 340-348.

Kounios, J., Frymiare, J.L., Bowden, E.M., Fleck, J.I., Subramaniam, K., Parrish, T.B., & Jung-Beeman, M. (2006). The prepared mind: Neural activity prior to problem presentation predicts subsequent solution by sudden insight. *Psychological Science, 17,* 882-890.

Lan, L., & Kaufman, J. C. (2012). American and Chinese similarities and differences in defining and valuing creative products. *The Journal of Creative Behavior*, *46*(4), 285-306.

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.

Mednick, S.A. (1968).The remote associates test.*The Journal of Creative Behavior*, *2*(3),213-214.

Merrifield, P.R., Guilford, J. P., Christensen, P. R., & Frick, J. W. (1961). Interrelationships between certain abilities and certain traits of motivation and temperament. *The Journal of General Psychology*, *65*(1), 57-74.

Mikulincer, M., Shaver, P. R., & Rom, E. (2011). The effects of implicit and explicit security priming on creative problem solving. *Cognition and Emotion*,*25*(3), 519-531.

Niu, W., & Kaufman, J. C. (2013). Creativity of Chinese and American cultures: A synthetic analysis. *The Journal of Creative Behavior*, *47*(1), 77-87.

Platt, M. L., & Huettel, S. A. (2008). Risky business: the neuroeconomics of decision making under uncertainty. *Nature Neuroscience*, *11*(4), 398-403.

Runco, M. A., & Acar, S. (2012). Divergent thinking as an indicator of creative potential. *Creativity Research Journal*, *24*(1), 66-75.

Shalley, C. E. (1991). Effects of productivity goals, creativity goals, and personal discretion on individual creativity. *Journal of Applied psychology*, *76*(2), 179-185.

Shen, W. B., Yuan, Y., Liu, C., & Luo, J. (2016). In search of the 'Aha!'experience: Elucidating the emotionality of insight problem-solving. *British Journal of Psychology*, *107*, 281-298.

Shen, W. B., Yuan, Y., Liu, C., & Luo, J. (in press). The roles of the temporal lobe in creative insight: An integrated review. *Thinking and Reasoning*. doi:10.1080/13546783.2017.1308885.

Shen, W. B., Liu, Yuan, Y., & Shi, C. H. (2015). Gender differences in creative thinking. *Advances in Psychological Science*, *23*(8), 1380-1389.

Shen, W. B., Yuan, Y., Liu, C., Yi, B. S., & Dou, K. (2016). The development and validity of a Chinese Version of the Compound Remote Associate Test. *American Journal of Psychology*, *129*(3), 245-258.

Shen, W. B., Yuan, Y., Zhao, Y., Zhang, X. J., Liu, C., ... & Fan, L. L. (in press). Defining insight: A study examining implicit theories of insight experience. *Psychology of Aesthetics Creativity and the Arts*. Doi: 10.1037/aca0000138.

Simmons, A. L., & Ren, R. (2009). The influence of goal orientation and risk on creativity. *Creativity Research Journal*, *21*(4), 400-408.

Silvia, P. J., Winterstein, B. P., Willse, J. T., Barona, C. M., Cram, J. T., Hess, K. I., ... & Richard, C. A. (2008). Assessing creativity with divergent thinking tasks: Exploring the reliability and validity of new subjective scoring methods. *Psychology of Aesthetics, Creativity, and the Arts*, *2*(2), 68-85.

Sternberg, R. J. (2006). The nature of creativity. *Creativity Research Journal*, *18*(1), 87-98.

Sternberg, R. J., & Lubart, T. I. (1992). Buy low and sell high: An investment approach to creativity. *Current Directions in Psychological Science*, *1*(1), 1-5.

Subramaniam, K., Kounios, J., Parrish, T.B., & Jung-Beeman, M. (2009). A brain mechanism for facilitation of insight by positive affect. *Journal of Cognitive Neuroscience*, *21*, 415-432.

Tyagi, V., Hanoch, Y., Hall, S. D., Runco, M., & Denham, S. L. (2017). The risky side of creativity: domain specific risk taking in creative individuals. *Frontiers in Psychology*, *8*.

Williams, F. E. (1980). *Creativity Assessment Packet:(CAP)*. DOK Publishers.

Wo, J. Z., Chen, W. R., Liu, Y., & Lin, C. D. (2010). The eye movement differences during category learning process between high and low creativity students. *Acta Psychologica Sinica*, *42*(5), 251-261.

Wu, C. L., Chang, Y. L., & Chen, H. C. (2017). Enhancing the measurement of remote associative ability: A new approach to designing the Chinese Remote Associates Test. *Thinking Skills and Creativity*, *24*, 29-38.

Zhou, J., & George, J. M. (2001). When job dissatisfaction leads to creativity: Encouraging the expression of voice. *Academy of Management Journal*, *44*(4), 682-696.

Captions

Figure 1 Schematic diagram of the trial procedure for the Chinese RAT

Figure 2 Performance in the convergent creativity task as a function of RPI score

Table 1 Descriptive result on RPI and RAT performance[⑤]

Table 2 Linear regression analyses results on various measures of creativity and risk-taking

Table 3 the correlations among different measures of creativity and risk preference

[⑤] Mean is listed in the Table 1 and Standard Deviation is placed in the parenthesis.

Figure 1

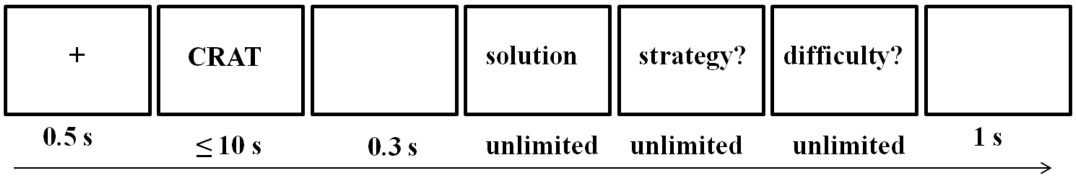
+
CRAT
solution
strategy?
difficulty?
0.5 s
≤ 10 s
0.3 s
unlimited
unlimited
unlimited
1 s

Figure 2

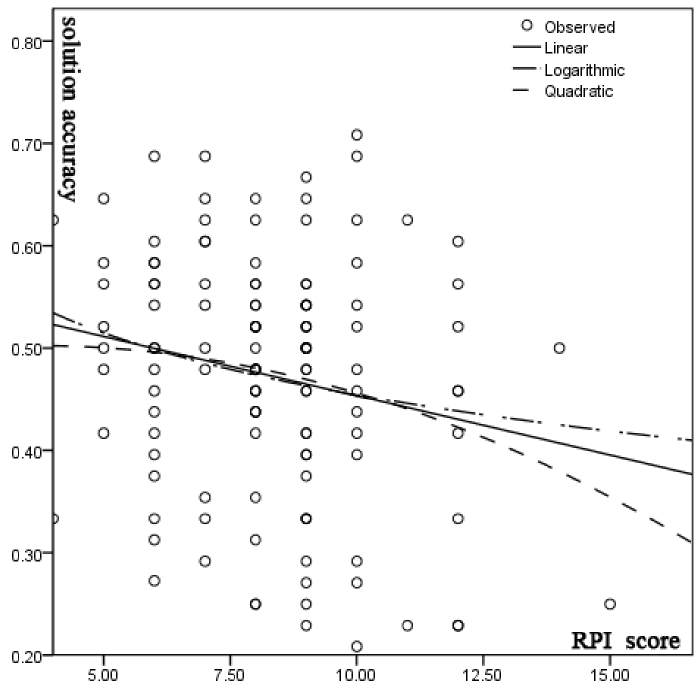
solution accuracy
RPI score
Observed
Linear
Logarithmic
Quadratic
0.80
0.70
0.60
0.50
0.40
0.30
0.20
5.00
7.50
10.00
12.50
15.00

Table 1

variable	solution accuracy (%)	RPI
Male	46.58 (11.85)	8.15 (2.00)
Female	48.85 (11.98)	8.65 (1.98)
Total	47.29 (11.89)	8.31 (2.00)

Table 2

study	predictors		B	β	SE	t
Study1	RPI		-0.012	-0.195	0.005	-2.22*
Study 2	RPI	RAT	-0.009	-0.163	0.004	-2.04*
	subjective risky level	RAT	-0.002	-0.204	0.001	-2.57*

Notes**:** * indicates $p<0.05$.

Table 3

Measures	Subjective risk level	RPI	RAT accuracy	Fluency	Flexibility
RPI	.031				
RAT accuracy	**-.204***	**-.163***			
Fluency	-.117	-.095	**.375****		
Flexibility	-.117	-.083	**.378****	**.981****	
Originality	-.114	-.069	**.356****	**.801****	**.836****

***Notes*:** * indicates p<0.05, ** indicates p<0.01, *** indicates p<0.001.