Cognitive Inhibition Ability in High and Low Creative Thinkers: Behavioral and Physiological Evidence Postprint

Authors: Bai Xuejun, Yao Haijuan, Bai Xuejun

Date: 2018-09-07T00:00:00+00:00

Abstract

This study employed two experiments to examine differences between high- and low-creativity individuals under interference conditions in the Stroop task, exploring the relationship between cognitive inhibition and creative thinking through both behavioral and physiological measures, as well as the moderating role of time pressure on this relationship. Experiment 1 utilized a Stroop color-naming task. The results revealed that high-creativity individuals exhibited smaller interference effect sizes in both reaction time and accuracy compared to low-creativity individuals. Experiment 2 employed a more flexible Stroop word-color switching task, manipulating different time pressure conditions while recording participants' electrodermal activity during task performance. The findings demonstrated that high-creativity individuals showed significantly smaller interference effects under time pressure relative to no time pressure, whereas low-creativity individuals exhibited no significant differences in interference effects between these conditions; additionally, high-creativity individuals displayed significantly greater electrodermal activity changes under incongruent versus congruent conditions in the color-naming task, while low-creativity individuals showed no significant differences in electrodermal activity between congruent and incongruent conditions. The study indicates that, overall, high-creativity individuals possess superior cognitive inhibition abilities, enabling them to effectively suppress dominant but irrelevant response tendencies. Time pressure moderates the relationship between cognitive inhibition and creative thinking; high-creativity individuals can flexibly adjust their cognitive inhibition levels according to varying task demands and exhibit corresponding changes in physiological arousal. These results support the adaptive cognitive inhibition hypothesis of creative thinking.

Full Text

Preamble

Differences in Cognitive Inhibition Ability Between Individuals with High and Low Creative Thinking Levels: Behavioral and Physiological Evidence

Bai Xuejun[1], Yao Haijuan[2]
(1 Academy of Psychology and Behavior, Tianjin Normal University, Tianjin 300074, China)
(2 Department of Psychology, School of Law, Tianjin University of Commerce, Tianjin 300134, China)

Abstract

This study employed two experiments to examine differences between individuals with high and low creative thinking levels on interference conditions in Stroop tasks, exploring the relationship between cognitive inhibition and creative thinking through behavioral and physiological measures, as well as the moderating effect of time pressure on this relationship.

Experiment 1 used a Stroop color-naming task. Results showed that, compared to low-creativity individuals, high-creativity individuals exhibited smaller interference effects in both reaction time and accuracy. **Experiment 2** adopted a more flexible Stroop word-color switching task, manipulated different time pressure conditions, and recorded participants' electrodermal activity during task completion. Results revealed that high-creativity individuals showed significantly smaller interference effects under time pressure compared to no time pressure, whereas low-creativity individuals showed no significant difference in interference effects between time pressure conditions. Additionally, high-creativity individuals demonstrated significantly greater electrodermal activity changes under incongruent conditions in the color-naming task compared to congruent conditions, while low-creativity individuals showed no significant differences between congruent and incongruent conditions in the color-naming task.

Overall, the findings indicate that high-creativity individuals possess higher cognitive inhibition ability than low-creativity individuals, enabling them to effectively suppress dominant but irrelevant response tendencies. Time pressure moderates the relationship between cognitive inhibition and creative thinking; high-creativity individuals can flexibly adjust their cognitive inhibition levels according to task demands and exhibit variable physiological arousal levels. These results support the adaptive cognitive inhibition hypothesis of creative thinking.

Keywords: creative thinking; cognitive inhibition; time pressure; electrodermal activity
Classification Code: B842

Creative thinking is a high-level cognitive activity through which individuals solve problems in novel ways (Sternberg & Lubart, 1996). Research has demonstrated that executive function correlates with creative thinking (Beaty, Silvia, Nusbaum, Jauk, & Benedek, 2014; Benedek et al., 2014a; Benedek, Jauk, Sommer, Arendasy, & Neubauer, 2014b). Executive function represents the fundamental cognitive processing capacity to control one' s thoughts and behaviors, associated with the prefrontal cortex, and comprises three components: shifting, inhibition, and working memory updating (Zhou, 2013). Over the past decade, the relationship between cognitive inhibition and creative thinking has become a prominent research focus (Benedek, Franz, Heene, & Neubauer, 2012; Radel, Davranche, Fournier, & Dietrich, 2015; Zhang et al., 2016; Harnishfeger, 1995; Bai, Gong, Hu, Han, & Yao, 2014; Hu, Cheng, Jia, Han, & Chen, 2015; Zhang, Du, & Tong, 2017).

Researchers have proposed different theories to explain the relationship between creative thinking and cognitive inhibition. First, some researchers advanced the cognitive disinhibition hypothesis of creative thinking (hereafter referred to as the disinhibition hypothesis) (Eysenck, 1995). This hypothesis posits that, compared to individuals with low creative thinking levels (hereafter referred to as low-creativity individuals), individuals with high creative thinking levels (hereafter referred to as high-creativity individuals) exhibit elevated dopamine secretion and reduced serotonin, leading to decreased cognitive inhibition capacity. They adopt a stable defocused attention mode, enabling them to attend to and remember more irrelevant information (Vartanian, 2002), display greater impulsivity (Burch, Hemsley, Pavelis, & Corr, 2006), and show deficits in latent inhibition (Peterson & Carson, 2000; Peterson, Smith, & Carson, 2002; Carson, Peterson, & Higgins, 2003; Chirila & Feldman, 2012). Studies have found that reduced inhibition facilitates creative idea generation (Radel et al., 2015; Zhang et al., 2016). Research reducing cognitive inhibition by decreasing left frontal lobe activity and increasing right frontal lobe activity also found that diminished cognitive inhibition positively impacts creative idea generation (Mayseless & Shamay-Tsoory, 2015).

Subsequently, researchers proposed the cognitive inhibition hypothesis of creative thinking (hereafter referred to as the inhibition hypothesis) (Groborz & Necka, 2003). This hypothesis suggests that, overall, high-creativity individuals possess higher cognitive inhibition ability than low-creativity individuals. Previous studies using Stroop tasks found that high-creativity individuals showed significantly shorter reaction times under word-color incongruent conditions compared to low-creativity individuals (Edl, Benedek, Papousek, Weiss, & Fink, 2014; Groborz & Necka, 2003). Other studies measuring inhibition ability through random movement generation tests also found that cognitive inhibition positively correlates with idea fluency, self-reported creative behavior, and creative achievement (Benedek et al., 2012; Zabelina, Robinson, Council, & Bresin, 2012). Research on the relationship between executive function and creativity indicates that high executive function leads to high creativity, with inhibition and updating components of executive function predicting creativity (Benedek et al., 2014b). Neuroimaging studies have also found that hyperactivation of the prefrontal cortex benefits creative production, suggesting that effective cognitive control facilitates more creative idea generation (Colombo, Bartesaghi, Simonelli, & Antonietti, 2015).

Among the two hypotheses regarding cognitive inhibition and creative thinking, the former emphasizes automatic processing in creative thinking, suggesting that low cognitive inhibition plays an important role in creative processing. The latter emphasizes the importance of controlled processing in creative thinking, proposing that high-level creativity requires a certain degree of concentrated mental effort, and that high cognitive inhibition facilitates creative problem identification and solution (Groborz & Nęcka, 2003). However, creative processing may involve both automatic and controlled processing, with individuals tending to adopt certain processing modes at different stages or in different contexts. Kris (1952) proposed the primary-secondary process theory of creative thinking, where primary processing is characterized by egocentrism, free association, and lack of constraint, while secondary processing is often associated with conscious, purposeful thinking. High-creativity individuals are more adept at switching between these two processing modes. Therefore, both cognitive disinhibition and cognitive inhibition states can operate in high-creativity individuals, with cognitive disinhibition possibly representing a trait manifested when facing ambiguous problems or at certain stages (Cheng, Hu, Jia, & Runco, 2016; Zabelina & Beeman, 2013; Radel et al., 2015; Yao & Bai, 2014).

Recently, researchers have integrated the cognitive inhibition and disinhibition hypotheses of creative thinking, proposing the adaptive cognitive inhibition hypothesis of creative thinking (hereafter referred to as the adaptive inhibition hypothesis) (Martindale, 1999, 2007). This hypothesis suggests that high-creativity individuals can flexibly shift attentional focus when facing different task demands, demonstrating higher goal-directed attention skills. Compared to low-creativity individuals, high-creativity individuals can better adjust attentional focus according to task requirements. In the early stages of creative problem solving, when problems are relatively ill-defined, high-creativity individuals are more likely to adopt defocused attention, but this broad attention leads to slower information processing. In the later stages of creative problem solving, high-creativity individuals benefit from inhibiting irrelevant information and increasing focused attention on the task, narrowing attention and improving task processing speed (Ansburg & Hill, 2003; Vartanian, 2009; Zabelina & Beeman, 2013), and can flexibly adjust problem-solving strategies based on outcomes (Zabelina & Robinson, 2010). Cheng et al. (2016) examined the role of cognitive inhibition in early versus late stages of creative problem finding. Results showed that individuals' cognitive inhibition correlated with fluency and flexibility in problem-finding tasks but not with originality; low cognitive inhibition enhanced initial originality, but high cognitive inhibition facilitated creative processing in subsequent stages. This suggests that different cognitive inhibition levels are required in early and late stages of creative problem finding. Zhang et al. (2017) used a directed forgetting paradigm to explore the relationship between creative thinking level and cognitive inhibition. Results found that low-creativity individuals showed directed forgetting effects for neutral words at 2 s and 5 s intervals and for negative words at 5 s intervals, but not for negative words at 2 s intervals. High-creativity individuals showed directed forgetting effects for both neutral and negative words at the 2 s interval, indicating that high-creativity individuals have superior cognitive inhibition ability for negative emotions within shorter timeframes. Other studies have found that creative thinking level negatively correlates with reaction times in non-interference tasks (e.g., conceptual judgment tasks) but positively correlates with reaction times in interference-containing tasks (e.g., negative priming tasks) (Dorfman, Martindale, Gassimova, & Vartanian, 2008; Vartanian, Martindale, & Kwiatkowski, 2007). However, these two studies used tasks with different interference levels and did not separately examine high-creativity individuals' adaptive cognitive inhibition using a single cognitive inhibition task paradigm. Therefore, if high-creativity individuals' cognitive inhibition is adaptive, is this cognitive inhibition ability higher and more flexible, or lower and more flexible? This question requires examination using a single cognitive inhibition task paradigm.

Previous research has found that the Stroop task is an effective paradigm for measuring cognitive inhibition (Edl et al., 2014; Groborz & Necka, 2003; Zabelina & Robinson, 2010). This task requires individuals to judge either word meaning or color. Reaction times under word-color incongruent conditions are typically longer than under congruent conditions (Stroop, 1935). Therefore, the first purpose of this study was to use a classic Stroop task to examine the relationship between cognitive inhibition and creative thinking, testing both the disinhibition and inhibition hypotheses. In Experiment 1, we employed a classic Stroop task. If high-creativity individuals showed significantly smaller interference effects than low-creativity individuals, this would indicate stronger cognitive inhibition ability in high-creativity individuals; conversely, it would indicate weaker cognitive inhibition ability.

However, Experiment 1 could only test the disinhibition and inhibition hypotheses and could not examine the adaptive inhibition hypothesis. Based on the adaptive inhibition hypothesis, we expected that task factors might moderate the relationship between cognitive inhibition and creative thinking. Research has found that time pressure affects creative thinking, but conclusions are inconsistent. One view holds that time pressure reduces individual creativity. For example, Amabile, Hadley, and Kramer (2002) surveyed over 9,000 diary entries from 177 project personnel engaged in highly creative work and found they exhibited the worst creativity when racing against time to complete tasks. Another view holds that time pressure promotes individual creativity (Darini, Pazhouhesh, & Moshiri, 2011), or that time pressure can promote fluency of thinking (Zhang, Wang, Chu, & Xu, 2011). This study adopts Szollos' s (2009) definition of time pressure as an individual' s cognitive experience of not having enough time to do something. Therefore, the second purpose of this study was to explore the moderating effect of time pressure on the relationship between cognitive inhibition and creative thinking. In Experiment 2, a more flexible Stroop paradigm was used, manipulating time pressure versus no time pressure conditions to test the adaptive inhibition hypothesis.

From an information processing perspective, time pressure affects the objects and scope of attention in the task environment, causing individuals to focus more on task-relevant features while ignoring irrelevant features. Therefore, we expected high-creativity individuals to benefit more from time pressure situations than low-creativity individuals when inhibiting conflicting stimuli.

Research indicates that cognitive processing is related to autonomic arousal (Gendolla, Wright, & Richter, 2012). Pennebaker and Chew (1985) proposed that inhibition requires effort, which in turn leads to increased physiological costs. Therefore, Experiment 2 added physiological indicators to reflect internal arousal differences between high- and low-creativity individuals under different time pressure task situations. Currently, using electrodermal activity (EDA) to assess autonomic nervous system dynamics has become widespread (Bach & Friston, 2013). The autonomic nervous system is the body’ s internal regulatory network, reflecting an individual’ s perceived stress level by balancing sympathetic and parasympathetic nervous systems. EDA is a method for measuring changes in skin conductance, is non-invasive, and reflects sympathetic nervous system activation levels (Posada-Quintero et al., 2016). Many studies have used skin conductance responses (SCRs) as an indicator because SCRs represent rapid phasic shifts in EDA signals (Boucsein et al., 2012) and can quickly reflect changes in electrodermal activity caused by presented stimuli. Previous research has shown that processes such as focused attention, conflict detection, error awareness, and compensation in Stroop tasks are related to autonomic arousal (Kobayashi, Yoshino, Takahashi, & Nomura, 2007). Incongruent conditions produce greater electrodermal activity changes than congruent or neutral conditions (Kobayashi et al., 2007; Lemche et al., 2016), indicating that inhibiting conflict and resolution activates the sympathetic nervous system more intensely. Indirect support for the relationship between inhibition and physiological arousal comes from emotion regulation research, which shows that suppressing emotional responses produces sympathetic excitation, leading to increased electrodermal activity, finger pulse amplitude, and finger temperature (Demaree et al., 2006). Similarly, deception detection research indicates that criminals show greater electrodermal activity changes under countermeasure conditions than cooperative conditions (Zvi, Nachson, & Elaad, 2012). Researchers believe that enhanced electrodermal activity changes reflect higher defensive motivation and attempts to suppress physiological arousal under countermeasure conditions.

The above findings demonstrate that increased internal inhibition leads to increased skin conductance physiological arousal. However, electrodermal activity changes may also reflect unconscious evaluation processes—anticipation of possible (negative) outcomes or consequences of upcoming stimuli—or unconscious affective processing that serves as a somatic marker to guide future decision-making and help individuals navigate and act in risky or uncertain situations (Dawson, Schell, & Courtney, 2011). High- and low-creativity individuals may exhibit different physiological responses (Kwiatkowski, 2002; Martindale, 1999; Gu et al., 2015). Compared to low-creativity individuals, high-creativity individuals often have higher baseline arousal levels, manifested as lower alpha wave activity and higher skin conductance levels (Martindale, 1999), but show lower electrodermal activity changes in non-creative tasks (e.g., Iowa Gambling Task) (Galang, Castelo, Santos, Perlas, & Angeles, 2016) and higher sympathetic activation levels in divergent thinking tasks requiring creativity (Silvia, Beaty, Nusbaum, Eddington, & Kwapil, 2014). We expected that if the adaptive inhibition hypothesis holds true, high-creativity individuals would show variable physiological arousal levels under different task conditions, while low-creativity individuals would show fixed physiological arousal levels. If high-creativity individuals have stronger cognitive inhibition ability than low-creativity individuals, then compared to no time pressure, high-creativity individuals might not show significant differences in electrodermal activity changes under time pressure, whereas low-creativity individuals, who have more difficulty adapting to faster response requirements under time pressure, would require greater inhibitory effort and thus show significantly increased electrodermal activity changes.

In summary, based on previous research, this study used Stroop color-naming tasks and more flexible Stroop word-color naming switching tasks with manipulated time pressure to explore differences in cognitive inhibition ability between high- and low-creative thinking individuals. We predicted that if high-creativity individuals have higher and more flexible cognitive inhibition ability than low-creativity individuals, then behaviorally, high-creativity individuals would show significantly smaller Stroop interference effects than low-creativity individuals, with high-creativity individuals showing significantly smaller interference effects under time pressure than no time pressure, while low-creativity individuals would show no such difference. Physiologically, high-creativity individuals would show different arousal levels across conditions, while low-creativity individuals would maintain consistent arousal levels.

2.1.1 Participants

A total of 568 university students were administered the Torrance Tests of Creative Thinking (TTCT) Verbal and Figural forms. Fifteen participants who did not complete the tests were excluded, leaving 553 valid questionnaires (239 males, 314 females) with a mean age of 19.74 ± 1.06 years. After converting dimension scores to standard scores and summing them, participants were ranked by total score. Following the principle of voluntary participation, 30 high-creativity individuals (13 males, 17 females) with a mean age of 19.60 years and 30 low-creativity individuals (12 males, 18 females) with a mean age of 19.55 years were selected. An independent samples t-test revealed a significant difference in TTCT scores between the high-creativity group (M = 325.87, SD = 21.67) and low-creativity group (M = 108.50, SD = 23.49), t(58) = 37.25, $p < 0.001$. Intelligence was measured using Raven' s Standard Progressive Matrices, with no significant difference between high-creativity (M = 52.03, SD = 3.89) and low-creativity groups (M = 49.83, SD = 4.79), t(58) = 1.95, $p > 0.05$. All participants had no intellectual disabilities, color blindness, or color weakness, and received modest compensation after completing the experiment.

2.1.2 Experimental Design

The experiment employed a 2 (creativity group: high-creativity vs. low-creativity) × 2 (stimulus type: congruent vs. incongruent) mixed design, with creativity group as a between-subjects variable and stimulus type as a within-subjects variable. The dependent variables were reaction time and accuracy.

2.1.3 Apparatus and Materials

The experiment used a Dell laptop with stimuli presented on a 13.3-inch LCD monitor with a resolution of 1024 × 768. The Torrance Tests of Creative Thinking (TTCT) Chinese revised version (Ye, Hong, & Torrance, 1988) Verbal and Figural forms were used to measure creative thinking levels. Scoring method: Two undergraduate psychology majors (one male, one female) independently scored the tests. Correlation analysis of their ratings showed inter-rater reliability of 0.90 ($p < 0.001$) for the Verbal form and 0.89 ($p < 0.001$) for the Figural form, indicating high scoring reliability. Final test scores were the average of the two raters.

Raven' s Standard Progressive Matrices Chinese urban revised version (Zhang & Wang, 1989) was used. The test consists of 60 items with a 40-minute time limit, split-half reliability of 0.95, retest reliability of 0.82 after half a month and 0.79 after one month, and concurrent validity of 0.71, demonstrating good reliability and validity.

The classic Stroop task was used with stimuli being the Chinese characters for "red" and "green" printed in red and green colors. Each character measured 1.1° × 1.1°, creating two congruent stimuli and two incongruent stimuli against a black background. A total of 96 stimuli were used, with 48 congruent and 48 incongruent stimuli. Practice materials were red and green squares with 20 practice trials. All image files were created using Photoshop 7.0, and the experimental program was compiled using E-Prime 1.1.

2.1.4 Experimental Procedure

Before the formal experiment, participants were administered the creative thinking and intelligence tests in batches of approximately 20–40 people. The TTCT Verbal and Figural forms and Raven' s test were administered, with 15-minute rest periods between each test. Selected eligible participants were then contacted by phone to schedule laboratory sessions.

The formal experiment was conducted in a quiet, comfortable, well-soundproofed laboratory. Participants sat approximately 60 cm from the computer screen. The experiment consisted of practice and formal phases with identical procedures, as shown in Figure 1 [Figure 1: see original paper].

First, a fixation cross “+” appeared at the center of the screen for 500 ms, followed by an experimental stimulus (color word). The program allowed 3000 ms for responses, with a 500 ms interval between correct responses and the next stimulus. Incorrect responses were followed by 1000 ms error feedback as punishment to ensure high accuracy before analyzing reaction times; no feedback followed correct responses. Participants were instructed to respond quickly and accurately to the color of the presented stimulus words by pressing corresponding keys. The experiment lasted 5 minutes.

2.1.5 Data Analysis

Data were analyzed using SPSS 18.0. Reaction times exceeding 2000 ms were excluded, as were outliers beyond 3 standard deviations from the mean. Incorrect responses accounted for 4.80% of total data, and excluded data accounted for 3.72% of total data. Correct reaction times and accuracy rates for high- and low-creativity groups under congruent and incongruent conditions in the Stroop color-naming task were analyzed.

A 2 (creativity group: high-creativity vs. low-creativity) × 2 (stimulus type: congruent vs. incongruent) repeated measures ANOVA on reaction times revealed (see Figure 2 [Figure 2: see original paper]): a significant main effect of creativity group, $F(1, 58) = 8.46$, $p < 0.01$, $p^2 = 0.13$, with high-creativity individuals showing significantly shorter reaction times than low-creativity individuals; a significant main effect of stimulus type, $F(1, 58) = 24.92$, $p < 0.001$, $p^2 = 0.30$, with significantly shorter reaction times under congruent than incongruent conditions; and a significant interaction between creativity group and stimulus type, $F(1, 58) = 9.26$, $p < 0.05$, $p^2 = 0.14$. Further analysis revealed that high-creativity individuals showed significantly shorter reaction times than low-creativity individuals under both congruent ($p < 0.05$) and incongruent ($p < 0.01$) conditions. Interference effect magnitude was calculated by subtracting congruent from incongruent reaction times. An independent samples t-test on interference effects showed a significant difference between groups, $t(58) = -3.04$, $p < 0.01$, with high-creativity individuals ($M = 7$ ms, $SD = 25$ ms) showing significantly smaller interference effects than low-creativity individuals ($M = 27$ ms, $SD = 27$ ms).

Table 1 shows accuracy rates for high- and low-creativity groups across experimental conditions [M (SD)]. Analysis of accuracy data revealed: a significant main effect of stimulus type, $F(1, 58) = 11.33$, $p < 0.01$, $p^2 = 0.16$, with significantly higher accuracy under congruent than incongruent conditions; and a significant interaction between creativity group and stimulus type, $F(1, 58) = 4.74$, $p < 0.05$, $p^2 = 0.08$. Further analysis showed no significant difference in accuracy between congruent and incongruent conditions for high-creativity individuals ($p > 0.05$), whereas low-creativity individuals showed significantly lower accuracy under incongruent than congruent conditions ($p < 0.01$). Accuracy interference effect magnitude was calculated by subtracting incongruent from congruent accuracy rates. An independent samples t-test revealed a significant difference between groups, $t(58) = -2.18$, $p < 0.05$, with high-creativity individuals ($M = 0.63\%$, $SD = 3.88\%$) showing significantly smaller interference effects than low-creativity individuals ($M = 2.92\%$, $SD = 4.26\%$). The main effect of creativity group was not significant, $F(1, 58) < 1$.

Experiment 1's reaction time and accuracy results showed that, compared to low-creativity individuals, high-creativity individuals exhibited smaller interference effects in both reaction time and accuracy. These findings are consistent with previous research (Benedek et al., 2014b; Edl et al., 2014; Zmigrod, Zmigrod, & Hommel, 2015). Experiment 1 tested both the disinhibition and inhibition hypotheses of creative thinking, with results supporting the inhibition hypothesis and indicating that high-creativity individuals have stronger cognitive inhibition ability than low-creativity individuals. However, Experiment 1’ s results were not entirely consistent with Groborz and Nęcka’ s (2003) study, which only found that high-creativity individuals showed more regular responses under incongruent conditions. This discrepancy may be related to differences in experimental materials and procedures between the two studies. In contrast, Experiment 1 used simpler experimental materials and procedures, with a Stroop stimulus set of only two color words (red and green) and requiring only color naming. Groborz and Nęcka’ s (2003) study used a stimulus set of five items and required participants to determine whether to name color or word meaning based on cue prompts at the bottom of the screen, making their procedure more difficult. Therefore, using a simple Stroop task alone is insufficient to fully reveal the relationship between cognitive inhibition and creative thinking.

Consequently, Experiment 2 increased stimulus set size, adopted a more flexible Stroop word-color naming switching task with three color words (red, green, yellow), manipulated time pressure versus no time pressure conditions, and further tested the adaptive inhibition hypothesis. Since reaction time measures only reflect external responses, Experiment 2 added electrodermal physiological measures to reflect internal physiological arousal differences during inhibition processes between individuals with different creative thinking levels.

3.1.1 Participants

From the total sample of Experiment 1 who completed the TTCT, 26 high-creativity and 26 low-creativity individuals who had not participated in Experiment 1 were selected based on TTCT total scores. Four participants were excluded due to excessive skin conductance interference and flat lines. The final sample consisted of 48 participants: 24 in the high-creativity group (11 males, 13 females) with a mean age of 19.33 years, and 24 in the low-creativity group (12 males, 12 females) with a mean age of 19.21 years. TTCT scores differed significantly between high-creativity ($M = 301.43$, $SD = 50.71$) and low-creativity groups ($M = 130.17$, $SD = 24.64$), $t(46) = 14.88$, $p < 0.001$. Intelligence measured by Raven’ s test showed no significant difference between high-creativity (M = 54.17, SD = 3.52) and low-creativity groups (M = 51.58, SD = 5.57), t(46) = 1.92, $p > 0.05$. All participants had no intellectual disabilities, color blindness, or color weakness, and received modest compensation after completing the experiment.

3.1.2 Experimental Design

A 2 (creativity group: high-creativity vs. low-creativity) × 2 (time pressure condition: time pressure vs. no time pressure) × 2 (task type: word naming vs. color naming) × 2 (stimulus type: congruent vs. incongruent) mixed design was employed, with creativity group and time pressure condition as between-subjects variables and task type and stimulus type as within-subjects variables.

3.1.3 Apparatus and Materials

The experiment used Superlab 4.5 stimulus presentation system to present stimuli and record responses, with stimulus presentation and timing precision of 1 ms. Stimuli were presented on a Dell 23-inch monitor, with participants seated 1 m from the screen at a resolution of 1024 × 768 with a black background.

A BIOPAC MP150 16-channel wireless physiological recording system with signal detectors, converters, and amplifiers recorded participants’ electrodermal activity during rest and experimental phases. Specific parameters included 16 analog input channels, 2 analog output channels, and 16 digital input channels; maximum input voltage: ±12 V; input impedance: 1 MΩ; A/D conversion rate: 16 Bits. Skin conductance values were measured in microsiemens.

Experimental materials consisted of the Chinese characters for “blue,” “red,” and “green” printed in blue, red, and green colors. Each character measured 1.1° × 1.1°. There were 96 trials total, with 48 congruent and 48 incongruent trials divided into four blocks of 24 trials each (half congruent, half incongruent). The first and third blocks required word naming responses, while the second and fourth blocks required color naming responses. Practice materials consisted of 24 color word stimuli requiring word naming.

3.1.4 Experimental Procedure

The experiment was administered individually as follows:

Step 1: Participants sat in a chair approximately 1 m from the computer display. The experimenter briefly introduced the task and attached sensors for recording electrodermal responses.

Step 2: Baseline collection. Participants were instructed to calm down, think of nothing, and remain as still as possible while 5 minutes of physiological data were collected as baseline values.

Step 3: After detailed instructions, participants completed practice trials. Following practice, they rated their current perceived time pressure on a scale where "1" represented "none at all" and "5" represented "very strong." The formal experiment then began.

Step 4: Formal experiment. High- and low-creativity participants were randomly assigned to time pressure or no time pressure conditions. Time pressure was operationalized based on reaction times, with the critical value for "too slow" feedback set at 550 ms, referencing Kobayashi et al. (2007).

Participants completed tasks in the order: word naming, color naming, word naming, and color naming. Specific procedures for different time pressure conditions are shown in Figure 3 [Figure 3: see original paper].

Time pressure condition: A fixation cross "+" appeared for 500 ms, followed by an experimental stimulus (color word). The program allowed 3000 ms for responses. If responses exceeded 550 ms, feedback "too slow" appeared on screen. Error feedback "wrong response" appeared for incorrect responses. The interval between trials was 10–12 s after correct responses. Word naming tasks required participants to ignore color and respond quickly and accurately to word meaning via button press. Participants responded using their right index, middle, and ring fingers on an external response box with color-labeled keys: green word = first key, red word = second key, blue word = third key. Color naming tasks required quick and accurate responses to the color of the words.

No time pressure condition: No "too slow" feedback was provided; other procedures were identical.

Step 5: All participants rated their perceived time pressure immediately after completing the experiment using the same 1–5 scale.

3.1.5 Physiological Data Collection and Analysis

Electrodermal activity collection: After disinfecting the distal phalanges of participants' left index and middle fingers with alcohol, electrodes were attached. Electrode wires connected to the electrodes at one end and to a wireless transmitter' s EDA port for measuring electrodermal responses at the other, with signals transmitted to the physiological recorder' s GSR100C module at a sampling rate of 1000 Hz.

Following Kobayashi et al. (2007), the maximum electrodermal activity value detected 1–4 s after stimulus presentation was taken as the trial' s skin conductance response value. Electrodermal activity change for each condition was calculated as the maximum skin conductance response minus baseline value.

To reduce data distribution skewness, a logarithmic transformation was applied after adding 1 to skin conductance values before statistical analysis.

For reaction time data analysis, extreme values exceeding 2000 ms were excluded, as were outliers beyond 3 standard deviations from the mean. Incorrect responses accounted for 8.31% of data, with excluded data totaling 10.33% of all data.

Physiological data were processed using Acqknowledge 4.2 software. Following Kobayashi et al. (2007), the minimum SCR amplitude was set at 0.05 microsiemens, with data not meeting this criterion excluded. Excluded data accounted for 7.82% of total data. Statistical analysis was conducted using SPSS 18.0.

An independent samples t-test on subjective time pressure ratings showed significant differences between groups, $t(46) = 14.86$, $p < 0.001$, with the time pressure group ($M = 3.83$, $SD = 0.48$) reporting significantly higher time pressure than the no time pressure group ($M = 1.21$, $SD = 0.51$). These results confirm that the experimental time pressure manipulation successfully induced stronger time pressure perception.

3.2.1 Reaction Times of High- and Low-Creativity Groups Under Different Time Pressure Conditions

Reaction times for high- and low-creativity groups on Stroop word naming and color naming tasks under different time pressure conditions are shown in Figure 4 [Figure 4: see original paper].

A 2 (creativity group: high-creativity vs. low-creativity) × 2 (time pressure condition: time pressure vs. no time pressure) × 2 (task type: word naming vs. color naming) × 2 (stimulus type: congruent vs. incongruent) repeated measures ANOVA on reaction times revealed: significant main effects of task type, $F(1, 44) = 4.56$, $p < 0.05$, $p^2 = 0.09$, with word naming faster than color naming; stimulus type, $F(1, 44) = 127.82$, $p < 0.001$, $p^2 = 0.74$, with congruent conditions faster than incongruent; and time pressure condition, $F(1, 44) = 34.12$, $p < 0.001$, $p^2 = 0.44$, with faster responses under time pressure. The main effect of creativity group was not significant, $F(1, 44) = 2.12$, $p > 0.05$.

Focusing on significant interactions involving creativity group, results showed a significant three-way interaction between stimulus type, time pressure condition, and creativity group, $F(1, 44) = 6.31$, $p < 0.05$, $p^2 = 0.13$.

Further analysis revealed that for high-creativity individuals, main effects of stimulus type, $F(1, 23) = 70.59$, $p < 0.001$, $p^2 = 0.75$, and time pressure condition, $F(1, 23) = 22.99$, $p < 0.001$, $p^2 = 0.50$, were significant, as was the interaction between time pressure condition and stimulus type, $F(1, 23) = 25.19$, $p < 0.001$, $p^2 = 0.52$. An independent samples t-test on interference effects for high-creativity individuals under time pressure versus no time pressure showed that interference effects were significantly smaller under time pressure (50 ms) than no time pressure (197 ms), $t(23) = -5.02$, $p < 0.001$.

For low-creativity individuals, main effects of stimulus type, $F(1, 21) = 101.86$, $p < 0.001$, $p^2 = 0.83$, and time pressure condition, $F(1, 21) = 19.23$, $p < 0.001$, $p^2 = 0.48$, were significant, but the interaction between time pressure condition and stimulus type was not significant, $F(1, 21) = 1.24$, $p > 0.05$, $p^2 = 0.06$. An independent samples t-test showed no significant difference in interference effects for low-creativity individuals between time pressure (133 ms) and no time pressure (166 ms) conditions, $t(21) = -1.11$, $p > 0.05$.

Additionally, the interaction between stimulus type and time pressure condition was significant, $F(1, 44) = 15.44$, $p < 0.001$, $p^2 = 0.26$, and the interaction between task type and stimulus type was significant, $F(1, 44) = 10.92$, $p < 0.01$, $p^2 = 0.20$, but these were unrelated to the research purpose and not analyzed further. The interaction between stimulus type and creativity group was not significant, $F(1, 44) = 1.61$, $p > 0.05$, and all other interactions were non-significant, $Fs(1, 44) < 1$.

3.2.2 Accuracy Rates of High- and Low-Creativity Groups Under Different Time Pressure Conditions

Accuracy rates for high- and low-creativity groups on Stroop word naming and color naming tasks are shown in **Table 2** .

A 2 (creativity group: high-creativity vs. low-creativity) × 2 (time pressure condition: time pressure vs. no time pressure) × 2 (task type: word naming vs. color naming) × 2 (stimulus type: congruent vs. incongruent) repeated measures ANOVA on accuracy rates revealed: significant main effects of stimulus type, $F(1, 44) = 58.78$, $p < 0.001$, $p^2 = 0.57$, with higher accuracy under congruent than incongruent conditions; and time pressure condition, $F(1, 44) = 36.12$, $p < 0.001$, $p^2 = 0.45$, with lower accuracy under time pressure. Main effects of task type, $F(1, 44) < 1$, and creativity group, $F(1, 44) < 1$, were not significant.

The interaction between stimulus type and time pressure condition was significant, $F(1, 44) = 12.39$, $p = 0.001$, $p^2 = 0.22$, but was unrelated to the research purpose and not analyzed further. The interaction between stimulus type and creativity group, task type and stimulus type, task type × time pressure condition × creativity group, task type × stimulus type × time pressure condition, and task type × stimulus type × creativity group were all non-significant, $Fs(1, 44) > 1.03$, $ps > 0.10$. All other interactions were also non-significant, $Fs(1, 44) < 1$.

3.2.3 Skin Conductance Results for High- and Low-Creativity Groups Under Different Time Pressure Conditions

Analysis of electrodermal activity changes for correct responses is shown in Figure 5 [Figure 5: see original paper].

A 2 (creativity group: high-creativity vs. low-creativity) × 2 (time pressure condition: time pressure vs. no time pressure) × 2 (task type: word naming vs. color naming) × 2 (stimulus type: congruent vs. incongruent) repeated measures ANOVA on electrodermal activity changes revealed: no significant main effects of task type, $F(1, 44) = 2.20$, $p > 0.05$, $p^2 = 0.05$; stimulus type, $F(1, 44) < 1$; time pressure condition, $F(1, 44) < 1$; or creativity group, $F(1, 44) < 1$.

Focusing on significant interactions involving creativity group, results showed a marginally significant interaction between time pressure condition and creativity group, $F(1, 44) = 3.14$, $p < 0.10$ ($p = 0.08$), $p^2 = 0.07$. Further analysis revealed no significant differences in electrodermal activity changes for high-creativity individuals between no time pressure (0.75) and time pressure (0.66) conditions, $p > 0.05$, and no significant differences for low-creativity individuals between no time pressure (0.57) and time pressure (0.73) conditions, $p > 0.05$.

The three-way interaction between task type, stimulus type, and creativity group was marginally significant, $F(1, 44) = 3.33$, $p < 0.10$ ($p = 0.08$), $p^2 = 0.07$. Further analysis showed that high-creativity individuals exhibited significantly greater electrodermal activity changes under incongruent (0.74) than congruent (0.71) conditions in the color naming task, $p < 0.05$, but showed no significant differences between congruent and incongruent conditions in the word naming task, $p > 0.05$. Low-creativity individuals showed no significant differences between congruent and incongruent conditions in either word or color naming tasks, $p > 0.05$.

Additionally, the interaction between task type and stimulus type was significant, $F(1, 44) = 7.38$, $p < 0.01$, $p^2 = 0.14$, but was unrelated to the research purpose and not analyzed further. The interaction between stimulus type and time pressure condition, task type × time pressure condition × creativity group, and task type × stimulus type × time pressure condition were all non-significant, $Fs(1, 44) > 1.10$, $ps > 0.10$. All other interactions were also non-significant, $F(1, 44) < 1$.

4 General Discussion

Experiment 2' s reaction time results showed that high-creativity individuals exhibited significantly smaller interference effects under time pressure than no time pressure, while low-creativity individuals showed no significant difference in interference effects between time pressure conditions. This indicates that high-creativity individuals possess more flexible cognitive inhibition ability than low-creativity individuals. These results are consistent with research expectations and previous findings that time pressure promotes creativity (Darini et al., 2011; Zhang et al., 2011). Time pressure enhances fluency dimensions of creative thinking. When facing time pressure, individuals strive to complete tasks within limited time, substantially improving fluency and consequently creativity. Therefore, compared to no time pressure, high-creativity individuals showed smaller interference effects under time pressure, demonstrating higher cognitive inhibition ability. These results can also be explained by the attentional focus model (Karau & Kelly, 1992), which posits that time pressure narrows attention, making task-relevant features more salient while less relevant features are ignored. As previously discussed, high-creativity individuals can regulate their attention to better adapt to different time pressure situations, focusing more on task-relevant features and more effectively inhibiting interfering features, thus showing more flexible cognitive inhibition than low-creativity individuals. These findings support the adaptive cognitive inhibition hypothesis.

Autonomic arousal is primarily associated with the ventromedial prefrontal cortex, anterior cingulate cortex, amygdala, and thalamus (Patterson, Ungerleider, & Bandettini, 2002), while research also indicates that the dorsal anterior cingulate cortex plays a crucial role in inhibition (MacDonald, Cohen, Stenger, & Carter, 2000). Inhibition requires mental effort and enhances sympathetic activity in the peripheral nervous system. Experiment 2’ s skin conductance results showed that high-creativity individuals exhibited significantly greater electrodermal activity changes under incongruent than congruent conditions in the color naming task, whereas low-creativity individuals showed no significant differences between congruent and incongruent conditions in the color naming task. These results indicate that high-creativity individuals show variable physiological arousal levels across different inhibition conditions, while low-creativity individuals maintain essentially fixed physiological arousal levels across conditions. This aligns with Martindale’ s (1999, 2007) theoretical assumption that high-creativity individuals vary their physiological arousal levels according to task demands, supporting the adaptive cognitive inhibition hypothesis of creative thinking. Other physiological research also supports that high-creativity individuals show greater physiological variability than low-creativity individuals. High-creativity individuals exhibit substantial alpha wave activity during creative tasks requiring creativity alone, but minimal alpha wave activity during intelligence tasks requiring intellect alone, while low-creativity individuals show consistent alpha wave activity levels across different tasks (Martindale, 1999). Kwiatkowski (2002) also found that high- and low-creativity individuals showed different patterns during oddball tasks, with high-creativity individuals showing higher right hemisphere activation (P300 amplitude) than left hemisphere, while low-creativity individuals showed lower right hemisphere activation than left hemisphere.

Although the interaction between time pressure condition and creativity group on electrodermal activity changes was only marginally significant, simple effects analysis showed a trend for low-creativity individuals to show greater electrodermal activity increases under time pressure than no time pressure (see Figure 5). This may be because low-creativity individuals are less able to adapt to tasks under time pressure and require greater inhibitory effort. Indirect evidence comes from alpha synchronization research. Researchers tend to believe that increased alpha synchronization reflects top-down control of external stimuli to achieve task-related internal attentional orientation (Fink & Benedek, 2014). Gu et al. (2015) found that when exhibiting high-state social creativity, individuals with high creative traits showed higher alpha synchronization than those with low creative traits, and that low creative trait individuals showed higher right-brain than left-brain alpha synchronization when exhibiting high-state social creativity, indicating that low creative trait individuals require stronger inhibitory ability when exhibiting high-state creativity. Researchers have noted that SCRs may also reflect unconscious evaluation processes and unconscious affective processing (Dawson et al., 2011). In Experiment 2, individuals needed to respond quickly under time pressure or receive "too slow" feedback. If low-creativity individuals received negative feedback after responding, they might anticipate negative outcomes for subsequent responses or perceive future tasks as uncertain situations, potentially leading to higher electrodermal activity changes under time pressure than no time pressure. Future research should increase sample sizes to verify these effects.

A limitation of this study is that high-creativity individuals were selected based on high scores on the Torrance Tests of Creative Thinking without involving other domains. Some research has found that cognitive inhibition ability negatively correlates with artistic creativity (Cheng, Hu, & Jia, 2015), which is inconsistent with our findings. This inconsistency may be because the relationship between cognitive inhibition and creative thinking may differ across domains. The psychological processing of creativity is complex and requires coordinated work across multiple brain regions. Research has found that the left frontal lobe inhibits right hemisphere activity during graphic creative thinking tasks in non-artists, and that eliminating this inhibition through practice techniques or special damage to the left frontal lobe can promote artistic creativity (Huang et al., 2013). That is, left frontal inhibition enables better performance in graphic creativity, but reduced left frontal inhibition can promote artistic creativity. Thus, different inhibition levels may indeed affect creativity differently across domains. Future research should design sophisticated experiments to verify the moderating role of domain in the relationship between cognitive inhibition and creative thinking.

Additionally, this study has several limitations. First, when selecting high- and low-creativity individuals, only the TTCT Verbal and Figural forms were used, providing a relatively single assessment. Future research could use multiple tests for comprehensive evaluation. For example, some studies have used both the Alternative Uses Test and Torrance Tests, using the sum of Z-scores from originality and fluency dimensions as an index of creative thinking level (Rominger et al., 2017). Second, this study examined creative thinking only from the perspective of divergent thinking without involving convergent thinking. Generally, creative thinking includes both divergent and convergent thinking as basic forms. Future research could combine divergent thinking tests, convergent thinking tests, and intelligence tests to more comprehensively assess individual creative ability (Wo, Chen, Liu, & Lin, 2010). Finally, this study only divided participants into high- and low-creativity groups without a medium-creativity group, making it impossible to determine whether changes in sympathetic function during inhibition tasks were caused by one group or the sum of both groups' effects. Future research should add a medium-creativity group to provide stronger evidence for reliability.

Under the conditions of this experiment, the following conclusions can be drawn: (1) High-creativity individuals showed significantly smaller interference effects in both reaction time and accuracy than low-creativity individuals; (2) Time pressure moderates the relationship between cognitive inhibition and creative thinking, with high-creativity individuals showing significantly smaller interference effects under time pressure than no time pressure, while low-creativity individuals showed no significant difference between conditions; (3) High-creativity individuals showed no significant difference in electrodermal activity changes between time pressure and no time pressure conditions, while low-creativity individuals showed significantly greater electrodermal activity changes under time pressure than no time pressure; (4) High-creativity individuals exhibited significantly greater electrodermal activity changes under incongruent than congruent conditions in color naming tasks, but no significant differences in word naming tasks, while low-creativity individuals showed no significant differences in either task. These results support the adaptive cognitive inhibition hypothesis of creative thinking.

References

Ansburg, P. I., & Hill, K. (2003). Creative and analytic thinkers differ in their use of attentional resources. *Personality and Individual Differences*, 34(7), 1141-1152.

Amabile, T. M., Hadley, C. N., & Kramer, S. J. (2002). Creativity under the gun. *Harvard Business Review*, 80(8), 52-61.

Bach, D. R., & Friston, K. J. (2013). Model-based analysis of skin conductance responses: Towards causal models in psychophysiology. *Psychophysiology*, 50(1), 15-22.

Bai, X. J., Gong, Y. B., Hu, W. P., Han, Q., & Yao, H. J. (2014). The inhibitory mechanism of individuals with different scientific creativity. *Studies of Psychology and Behavior*, 12(2), 151-155. [白学军, 巩彦斌, 胡卫平, 韩琴, 姚海娟. (2014). 不同科学创造力个体干扰抑制机制的比较. 心理与行为研究, 12(2), 151-155.]

Beaty, R. E., Silvia, P. J., Nusbaum, E. C., Jauk, E., & Benedek, M. (2014). The role of associative and executive processes in creative cognition. *Memory & Cognition*, 42(7), 1186-1197.

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.

Benedek, M., Jauk, E., Fink, A., Koschutnig, K., Reishofer, G., Ebner, F., & Neubauer, A. C. (2014a). To create or to recall? Neural mechanisms underlying the generation of creative new ideas. *NeuroImage*, 88, 125-133.

Benedek, M., Jauk, E., Sommer, M., Arendasy, M., & Neubauer, A. C. (2014b). Intelligence, creativity, and cognitive control: The common and differential involvement of executive functions in intelligence and creativity. *Intelligence*, 46, 73–83.

Boucsein, W., Fowles, D. C., Grimnes, S., Ben-Shakhar, G., Roth, W. T., Dawson, M. E., & Filion, D. L. (2012). Publication recommendations for electrodermal measurements. Society for psychophysiological research Ad Hoc committee on electrodermal measures. *Psychophysiology*, 49(8), 1017–1034.

Burch, G. S. J., Hemsley, D. R., Pavelis, C., & Corr, P. J. (2006). Personality, Creativity and Latent Inhibition. *European Journal of Personality*, 20(2), 107–122.

Carson, S. H., Peterson, J. B., & Higgins, D. M. (2003). Decreased latent inhibition is associated with increased achievement in high-functioning individuals. *Journal of Personality and Social Psychology*, 85(3), 499–506.

Cheng, L. F., Hu, W. P., & Jia, X. J. (2015). Cognitive inhibition and artistic creativity: The moderating effect of cognitive style. *Psychological Development and Education*, 31(3), 287–295. [程丽芳, 胡卫平, 贾小娟. (2015). 认知抑制对艺术创造力的影响：认知风格的调节作用. 心理发展与教育, 31(3), 287–295.]

Cheng, L. F., Hu, W. P., Jia, X. J., & Runco, M. A. (2016). The different role of cognitive inhibition in early versus late creative problem finding. *Psychology of Aesthetics, Creativity, and the Arts*, 10(1), 32–41.

Chirila, C., & Feldman, A. (2012). Study of latent inhibition at high-level creative personality: The link between creativity and psychopathology. *Procedia-Social and Behavioral Sciences*, 33, 353–357.

Colombo, B., Bartesaghi, N., Simonelli, L., & Antonietti, A. (2015). The combined effects of neurostimulation and priming on creative thinking. A preliminary tDCS study on dorsolateral prefrontal cortex. *Frontiers in Human Neuroscience*, 9, 403–414.

Darini, M., Pazhouhesh, H., & Moshiri, F. (2011). Relationship between employee’ s innovation (creativity) and time management. *Procedia-Social and Behavioral Sciences*, 25, 201–213.

Dawson, M. E., Schell, A.M., & Courtney, C.G. (2011). The skin conductance response, anticipation, and decision-making. *Journal of Neuroscience, Psychology, and Economics*, 4(2), 111–116.

Demaree, H. A., Schmeichel, B. J., Robinson, J. L., Pu, J., Everhart, D. E., & Berntson, G. G. (2006). Up- and down regulating facial disgust: Affective, vagal, sympathetic, and respiratory consequences. *Biological Psychology*, 71(1), 90–99.

Dorfman, L., Martindale, C., Gassimova, V., & Vartanian, O. (2008). Creativity and speed of information processing: A double dissociation involving elementary versus inhibitory cognitive tasks. *Personality and Individual Differences*, 44(6), 1382–1390.

Edl, S., Benedek, M., Papousek, I., Weiss, E. M., & Fink, A. (2014). Creativity and the Stroop interference effect. *Personality and Individual Differences*, 69, 38–42.

Eysenck, H. J. (1995). *Genius: The natural history of creativity.* New York, NY, US: Cambridge University Press.

Fink, A., & Benedek, M. (2014). EEG alpha power and creative ideation. *Neuroscience & Biobehavioral Reviews*, 44, 111–123.

Friedman, N. P., & Miyake, A. (2004). The relations among inhibition and interference control functions: A latent-variable analysis. *Journal of Experimental Psychology: General*, 133(1), 101–135.

Galang, A. J. R., Castelo, V. L. C., Santos, L. C., Perlas, C. M. C., & Angeles, M. A. B. (2016). Investigating the prosocial psychopath model of the creative personality: Evidence from traits and psychophysiology. *Personality and Individual Differences*, 100, 28–36.

Gendolla, G. H. E., Wright, R. A., & Richter, M. (2012). Effort intensity: Some insights from the cardiovascular system. In R. M. Ryan (Ed.), *The Oxford handbook of human motivation* (pp. 420–438). New York: Oxford University Press.

Groborz, M., & Necka, E. (2003). Creativity and cognitive control: explorations of generation and evaluation skills. *Creativity Research Journal*, 15(2-3), 183–197.

Gu, C. H., Wang, Y. L., Wu, C. F., Xie, X. L., Cui, C. Z., Wang, Y. X., ···Zhou, Z. K. (2015). Brain correlates underlying social creative thinking: EEG Alpha activity in trait vs. state creativity. *Acta Psychologica Sinica*, 47(6), 765–773. [谷传华, 王亚丽, 吴财付, 谢祥龙, 崔承珠, 王亚娴, ···周宗奎. (2015). 社会创造性的脑机制：状态与特质的 EEG 波活动特点. 心理学报, 47(6), 765–773.]

Harnishfeger, K. K. (1995). The development of cognitive inhibition: Theories, definitions, and research evidence. In F. N. Dempster & C. J. Brainerd (Eds.), *Interference and inhibition in cognition* (pp.175–204). San Diego, CA, US: Academic Press.

Hu, W. P., Cheng, L. F., Jia, X. J., Han, M., & Chen, Y. H. (2015). The influence of cognitive inhibition to creative scientific problem finding: Mediating effect of field cognitive style. *Studies of Psychology and Behavior*, 13(6), 721–728. [胡卫平, 程丽芳, 贾小娟, 韩蒙, 陈英和. (2015). 认知抑制对创造性科学问题提出的影响：认知风格的中介作用. 心理与行为研究, 13(6), 721–728.]

Huang, P. H., Qiu, L. H., Shen, L., Zhang, Y., Song, Z., Qi, Z. Q., ···Xie, P. (2013). Evidence for a left-over-right inhibitory mechanism during figural creative thinking in healthy nonartists. *Human Brain Mapping*, 34(10), 2724–2732.

Jauk, E., Benedek, M., Dunst, B., & Neubauer, A. C. (2013). The relationship between intelligence and creativity: New support for the threshold hypothesis by means of empirical breakpoint detection. *Intelligence*, 41(4), 212–221.

Jauk, E., Benedek, M., & Neubauer, A. C. (2014). The road to creative achievement: A latent variable model of ability and personality predictors. *European Journal of Personality*, 28(1), 95–105.

Karau, S. J., & Kelly, J. R. (1992). The effects of time scarcity and time abundance on group performance quality and interaction process. *Journal of Experimental Social Psychology*, 28(6), 542–571.

Kobayashi, N., Yoshino, A., Takahashi, Y., & Nomura, S. (2007). Autonomic arousal in cognitive conflict resolution. *Autonomic Neuroscience*, 132(1–2), 70–75.

Kris, E. (1952). *Psychoanalytic exploration in art.* New York: International Universities Press.

Kwiatkowski, J. (2002). *Individual differences in the neurophysiology of creativity* (Unpublished doctoral dissertation). The University of Maine.

Lemche, E., Sierra-Siegert, M., David, A. S., Phillips, M. L., Gasston, D., Williams, S. C. R., & Giampietro, V. P. (2016). Cognitive load and autonomic response patterns under negative priming demand depersonalization-derealization disorder. *European Journal of Neuroscience*, 43(7), 971–978.

MacDonald, A. W., Cohen, J. D., Stenger, V. A., & Carter, C. S. (2000). Dissociating the role of the dorsolateral prefrontal and anterior cingulate cortex in cognitive control. *Science*, 288(5472), 1835–1838.

Martindale, C. (1999). Biological basis of creativity. In R. J. Sternberg (Ed.), *Handbook of creativity* (pp. 137–152). New York: Cambridge University Press.

Martindale, C. (2007). Creativity, primordial cognition, and personality. *Personality and Individual Differences*, 43(7), 1777–1785.

Mayseless, N., & Shamay-Tsoory, S. G. (2015). Enhancing verbal creativity: Modulating creativity by altering the balance between right and left inferior frontal gyrus with tDCS. *Neuroscience*, 291, 167–176.

Patterson, J. C., Ungerleider, L. G., & Bandettini, P. A. (2002). Task-independent functional brain activity correlation with skin conductance changes: An fMRI study. *Neurolmage*, 17(4), 1797–1806.

Pennebaker, J. W., & Chew, C. H. (1985). Behavioral inhibition and electrodermal activity during deception. *Journal of Personality and Social Psychology*, 49(5), 1427–1433.

Peterson, J. B., & Carson, S. H. (2000). Latent inhibition and openness to experience in a high-achieving student population. *Personality and Individual Differences*, 28(2), 323-332.

Peterson, J. B., Smith, K. W., & Carson, S. (2002). Openness and extraversion are associated with reduced latent inhibition: Replication and commentary. *Personality and Individual Differences*, 33(7), 1137-1147.

Posada-Quintero, H. F., Florian, J. P., Orjuela-Cañón, A. D., Aljama-Corrales, T., Charleston-Villalobos, S., & Chon, K. H. (2016). Power spectral density analysis of electrodermal activity for sympathetic function assessment. *Annals of Biomedical Engineering*, 44(10), 3124-3135.

Radel, R., Davranche, K., Fournier, M., & Dietrich, A. (2015). The role of (dis)inhibition in creativity: Decreased inhibition improves idea generation. *Cognition*, 134, 110-120.

Rominger, C., Fink, A., Weiss, E. M., Bosch, J., & Papousek, I. (2017). Allusive thinking (remote associations) and auditory top-down inhibition skills differentially predict creativity and positive schizotypy. *Cognitive Neuropsychiatry*, 22(2), 108-121.

Silvia, P. J., Beaty, R. E., Nusbaum, E. C., Eddington, K. M., & Kwapil, T. R. (2014). Creative motivation: Creative achievement predicts cardiac autonomic markers of effort during divergent thinking. *Biological Psychology*, 102, 30-37.

Sternberg, R. J., & Lubart, T. I. (1996). Investigating in creativity. *American Psychologist*, 51(7), 677-688.

Storm, B. C., & Patel, T. N. (2014). Forgetting as a consequence and enabler of creative thinking. *Journal of Experimental Psychology*, 40(6), 1594-1609.

Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, 18(6), 643-662.

Szollos, A. (2009). Toward a psychology of chronic time pressure: Conceptual and methodological review. *Time & Society*, 18(2-3), 332-350.

Vartanian, O. A. (2002). *Cognitive disinhibition and creativity* (Unpublished doctoral dissertation). The University of Maine, Orono, The United States of America.

Vartanian, O. (2009). Variable attention facilitates creative problem solving. *Psychology of Aesthetics, Creativity, and the Arts*, 3(1), 57-59.

Vartanian, O., Martindale, C., & Kwiatkowski, J. (2007). Creative potential, attention, and speed of information processing. *Personality and Individual Differences*, 43(6), 1470-1480.

Wo, J. Z., Chen, W. R., Liu, Y., & Lin, C. D. (2010). The eye movements differences during category learning process between high and low creativity students. *Acta Psychologica Sinica*, 42(2), 251-261. [沃建中, 陈婉茹, 刘杨, 林崇德.(2010). 创造能力不同学生的分类加工过程差异的眼动特点. 心理学报, 42(2), 251-261.]

Yao, H. J., & Bai, X. J. (2014). The relationship between creative thinking and cognitive inhibition. *Journal of Psychological Science*, 37(2), 316-321. [姚海娟, 白学军. (2014). 创造性思维与认知抑制的关系. 心理科学, 37(2), 316-321.]

Ye, R. M., Hong, D. H., & Torrance, P. E. (1988). Cross cultural comparison of creative thinking between Chinese and American students using Torrance Test. *Chinese Journal of Applied Psychology*, 3(3), 22-29. [叶仁敏, 洪德厚, 保尔 . 托兰斯. (1988). 《托兰斯创造性思维测验》(TTCT) 的测试和中美学生的跨文化比较. 应用心理学, 3(3), 22-29.]

Zabelina, D. L., & Robinson, M. D. (2010). Creativity as flexible cognitive control. *Psychology of Aesthetics, Creativity, and the Arts*, 4(3), 136-143.

Zabelina, D. L., Robinson, M. D., Council, J. R., & Bresin, K. (2012). Patterning and nonpatterning in creative cognition: Insights from performance in a random number generation task. *Psychology of Aesthetics, Creativity, and the Arts*, 6(2), 137-145.

Zabelina, D. L., & Beeman, M. (2013). Short-term attentional perseveration associated with real-life creative achievement. *Frontiers in Psychology*, 4(191), 1-8.

Zhang, K., Du, X. M., Tong, Y. G. (2017). The Differences between High Creative Persons and Low Creative Persons in Directing Forgetting Effects. *Journal of Psychological Science*, 40(3), 514-519. [张克, 杜秀敏, 仝宇光. (2017). 高低创造性思维水平者定向遗忘效应的差异研究. 心理科学, 40(3), 514-519.]

Zhang, L. J., Qiao, L., Chen, Q. L., Yang, W. J., Xu, M. S., Yao, X. N., ···Yang, D. (2016). Gray matter volume of the lingual gyrus mediates the relationship between inhibition function and divergent thinking. *Frontiers in Psychology*, 7, 1532-1541.

Zhang, H-C., & Wang, X-P. (1989). Standardization research on RAVEN' s standard progressive matrices in China. *Acta Psychologica Sinica*, 2, 113-121. [张厚粲, 王晓平. (1989). 瑞文标准推理测验在我国的修订. 心理学报, 2, 113-121.]

Zhang, J. H., Wang, Y. N., Chu, Y. X., & Xu, X. Z. (2011). The effects of three pressures and creative self-efficacy on creativity. *Journal of Psychological Science*, 34(4), 993-998. [张景焕, 王亚男, 初玉霞, 徐希铮. (2011). 三种压力与创意自我效能感对创造力的影响. 心理科学, 34(4), 993-998.]

Zhou, Y. (2013). The effects of emotional states on executive functioning. *Advances in Psychological Science*, 21(7), 1186-1199. [周雅. (2013). 情绪唤起对执行功能的作用. 心理科学进展, 21(7), 1186-1199.]

Zmigrod, S., Zmigrod, L., & Hommel, B. (2015). Zooming into creativity: Individual differences in attentional global-local biases are linked to creative thinking. *Frontiers in Psychology*, 6, 1647-1654.

Zvi, L., Nachson, I., & Elaad, E. (2012). Effects of coping and cooperative instructions on guilty and informed innocents' physiological responses to concealed information. *International Journal of Psychophysiology*, 84(2), 140-148.

Note: Figure translations are in progress. See original paper for figures.