Effects of Acute Stress on Insight: How Does Stress Influence Creativity?

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ABSTRACT
Previous studies indicate that stress exerts various influences on multiple cognitive functions, but the correlation between stress and creativity was scarcely involved, as creativity is commonly acknowledged as a relatively stable psychological trait. Insight, a significant component of creativity, however, shares the feature of the suddenness with emotion, which may be potentially sensitive to acute stress. Based on this, this study adopted Trier Social Stress Test to investigate the effect of acute psychological stress on insight, and then whether creativity is influenced by a variety of environmental, physiological, and psychological factors. The experiment improved the traditional insight paradigm and adopted more convenient materials of “brain teasers” instead of "Aha!" riddles, the manipulation test of which shows significant induced insight. The T-test between the stress group and control did not manifest significant effects of acute stress on insight, which may suggest stability of insight against environmental stressors.

Keywords: *Insight, Acute Stress, Creativity, Trier Social Stress Test*

1. INTRODUCTION

Stress is the interaction between the organism and the environment, a comprehensive reaction induced by a stressor that disrupts the homeostasis of the organism and exceeds the load and control of the body [1]. The vast majority of current research has focused on exploring the effects of stress on working memory, cognitive regulation, execution, and inhibition, whereas the effect on creativity is scarcely mentioned since creativity is usually considered a relatively stable psychological trait. A very crucial component and the basis of creativity, however, is the phenomenon of insight. Problem-solving with insight is characterized by suddenness, directness, and continuity of performance [2], where suddenness describes the sudden onset of problem-solving in a very short period, which is coherently consistent with one of the main features of emotion. Thus, even though creativity is conventionally perceived as stable, insight could still be an underlying mechanism of creativity that may (or may not) be disturbed by emotional status.

To more directly reveal the regulation of stress on the human brain, mental and behavioral activities, researchers have creatively developed a variety of experimentally induced models suitable for human stress research, including physical stress models, psychological and social stress models, and psycho-physical stress models. Physical stress models include mild electrical stimulation, cold water stress, and noise stress; psychological and social stress models include Trier Social Stress Test (TSST), which is the most well-known, cognitive challenge [3]. Some researchers have also combined horror movie clips with mild electro-stimulation as psycho-physical stress models [4]. Here the study adopted the traditional TSST paradigm, combined with the MAT test to induce acute psychological stress.

For insight investigation, the most commonly used material is the "Aha!" riddles. This paradigm, however, requires a time-consuming before measurement in which participants will have to evaluate 45 riddles for 3 min each to select 16 riddles categorized as "I find it interesting but I do not know the answer" [5]. The initial reason for this time consumption could be attributed to the complexity of the questions and answers because traditional riddles sometimes contain rhymes and equivoques that might confuse the participants. The material also shows cultural differences since the participants are expected to be familiar with the riddles for the experiment to normally function. Thus, in this study, a more convenient and common material of "brain

teasers" is adopted, which is easier to understand and saves a lot of time. Temporal control is quite important in our study because emotion is a greatly instantaneous variable.

The essential research method is a combination of the TSST & MAT stress-inducing paradigm and an original insight paradigm. The study hopes to find a link between acute stress and insight, as well as to open up new possibilities for the underlying mechanism of stress and creativity.

2. METHODS

2.1 Participants

The experiment used the Self-rating Anxiety Scale (SAS) to evaluate the current overall stress level of the subjects preliminarily, excluding subjects with high chronic stress and those suffering from depression, anxiety, and other psychological disorders for initial rough pre-screening, obtaining 8 pre-test subjects and dividing them into high-stress and low-stress groups according to their SAS scores.

An additional 40 college subjects with normal or corrected vision and no color blindness were recruited in the formal experiment. The subjects in the formal experiment were divided into 11 control group subjects and 29 stress group subjects. All subjects were brought to the preparation room for 30 minutes so that they would reach a resting state before the experiment.

2.2 Trier Social Stress Test (TSST)

The TSST is a psychological stress test designed by Kirschbaum of the University of Trier in 1993 and has considerable merit for lab studies [6]. Numerous studies using the TSST technique have found that subjects experiencing this stressful situation show not only subjective ratings of stress but also significant objective physiological responses to stress: changes in the activity of the HPA (hypothalamic-pituitary-adrenal) axis, changes in hormonal levels in the body, etc [7]. The MAT test was used to maintain the stress level of the subject and put the subject in the best stress state for the insight test.

The experimenter brought subjects of the stress group to Lab 1 and gave them the TSST and MAT tests. Two "experts" sat in the lab and the experimenter explained the task to the subjects: "Your task is to take part in a job interview for a college counselor and you will have 5 minutes to state why you are qualified for the job. Your oral statement as well as your physical performance, such as your posture and gestures, will be assessed by two senior experts in person. They will also ask you questions if necessary. Your entire interview will be filmed and recorded. You will have 3 minutes to prepare for the interview and you will be allowed to take notes during the preparation process, but you are not allowed to bring your notes into the interview room during the formal interview. You can ask me now if you have any questions. I'll start by showing you the environment. This is the interview room. These are two expert teachers in behavior analysis and recognizing nonverbal signs of stress, who will rate your performance. During the interview, you will stand behind this line so that your verbal and behavioral performance can be recorded by the camera and microphone. All right, now come with me."

Return to the preparation room and tell the participant, "You will now begin to prepare, and the interview will begin in 3 minutes." After 3 minutes, tell the participant, "Okay, time's up. Now follow me." The experimenter leads the subject back to the lab room and turns on the video and microphone, stands where the subject can see her in his or her peripheral vision, presses the timer, and takes notes in a book. If the presentation time is less than 5 minutes, the expert first behaves calmly and then says, "You still have some time, please continue"; if the 5-minute presentation time is up and the subject is still speaking, the expert asks the subject to stop [8].

After the interview, the MAT test was conducted. The "expert" tells the subject, "Your next task is to do oral calculations, starting with 1022, subtracting 13 in order, as fast as possible, and as accurate as possible, please begin." At this point, the experimenter presses the timer. As soon as the subject reports an incorrect answer, the "expert" says "Stop, start from 1022". No verbal or non-verbal encouragement was provided throughout the process, and when the 3 minutes were up, the subject was taken back to the preparation room.

For the control subjects, they were asked to look at a theoretical book and read it silently for 3 minutes, then they were asked to read it aloud for 5 minutes, followed by a 3-minute oral arithmetic task: "Start from 0 and add 15 in order, the faster the better, the more accurate the better, please start." When the 3-minute time was up, the subject was taken back to the preparation room.

2.3 Insight task

After selection and pre-testing, 30 self-made "brain teaser" materials were selected to trigger the insight state of the subjects, including 10 trials for which the subjects could easily guess the answers after pre-testing and 20 trials for which the subjects had difficulty in guessing the answers and had a strong sense of epiphany after pre-testing. The experimental task was written with MATLAB, and the stimuli were presented on a 17-inch computer monitor with the subjects at a distance of approximately 60 cm from the monitor.

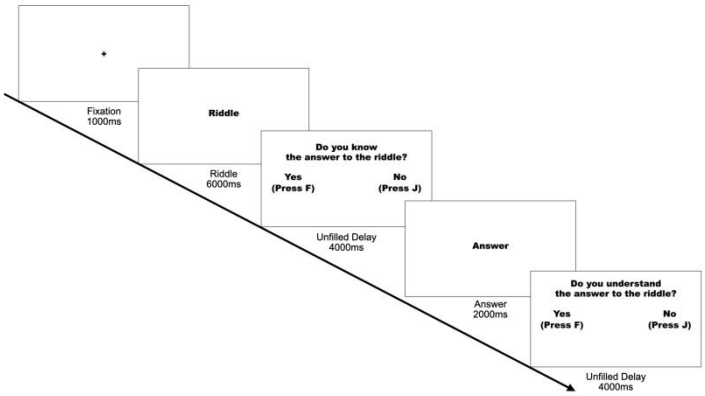

Figure 1 Task Procedure

The experimental procedure was 1 block with 30 trials. All trials were arranged in a pseudo-random sequence. No question was given to the subjects before the experiment, and each trial was programmed to consist of a 6s presentation of the riddle + 4s Unfilled Delay (during which the subjects were asked to respond with a keypress "whether they knew the answer") + 2s presentation of the riddle + 4s Unfilled Delay (during which the subjects were asked to respond with a keypress "whether they understood the answer"). The procedure is demonstrated in Figure 1 above.

2.4 Manipulation Check

In a pre-test, 8 participants were given the "brain teaser" questions used in the formal experiment to investigate the robustness of the materials. Paired-samples T-test indicates that in insight questions, compared with control questions, participants showed a significantly higher insight rate ($t=-0.200$, $p=0.017<0.05$, $df=8$), longer reaction time in thinking of the answer ($t=-0.612$, $p=0.017<0.05$, $df=8$) and understanding the answer ($t=0.207$, $p=0.005<0.05$, $df=8$). This manifests that the materials functioned well in inducing insight.

3. RESULTS

3.1 Chronic Stress

In the pre-test, the study checked the robustness of the materials and evaluated the effect of chronic stress. Three dependent variables were adopted: insight rate, the rate that participants reported ignorance of the answer and full understanding of the answer after it was shown to them; reaction time of thinking of the answer; and the reaction time of understanding the answer. Independent-samples T-test of different stress groups indicates that there is no significant difference in the insight rate ($t=-0.241$, $p=0.817>0.05$, $df=7$), the reaction time of thinking ($t=-1.719$, $p=0.129>0.05$, $df=7$), and the reaction time of understanding in insight questions ($t=-1.231$, $p=0.258>0.05$ $df=7$). This is the same with the control questions ($t=-0.707$, $p=0.502>0.05$ $df=7$; $t=-1.626$, $p=0.148>0.05$ $df=7$; $t=-1.498$, $p=0.178>0.05$ $df=7$). This demonstrates that chronic stress did not affect insight or performance in executing the task. However, as the sample was rather small and there was, indeed, a tendency showing slightly better insight performance in low-stress individuals, we could be wrong about this.

3.2 Acute Stress

In the formal experiment, the dependent variables were identical to the pre-test. Data with response rates below 90% were excluded for the stress and control groups, respectively. Independent-samples T-test of stress groups and control indicates that there is no significant difference in the insight rate ($t=-0.200$, $p=0.843>0.05$, $df=34$), the reaction time of thinking ($t=-0.612$, $p=0.544>0.05$, $df=34$), and the reaction time of understanding in insight questions ($t=0.207$, $p=0.837>0.05$ $df=34$). This is the same with the control questions ($t=-0.314$, $p=0.755>0.05$ $df=34$; $t=-0.646$, $p=0.531>0.05$ $df=11.826$; $t=-0.421$, $p=0.681>0.05$ $df=34$). This implies that acute stress does not have a significant effect on insight.

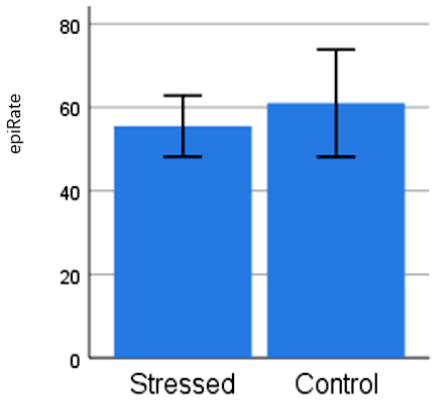

Figure 2 Insight Rate Under Acute Stress

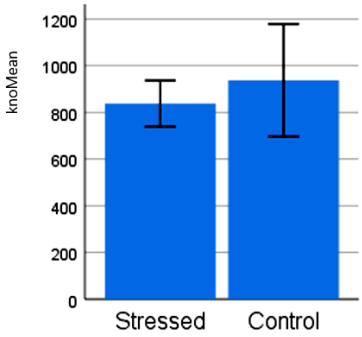

Figure 3 Thinking Reaction Time under Acute Stress

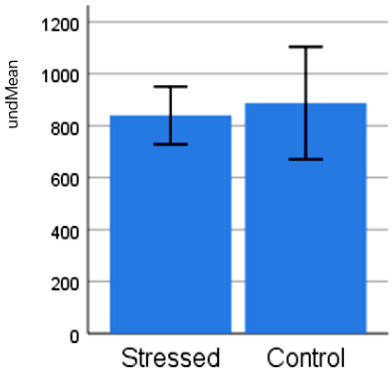

Figure 4 Understanding Answers Reaction Time under Acute Stress

4. CONCLUSION

This study shows that acute stress does not have a significant effect on insight and that creative thinking is fairly stable, but there is no further experimental data on the results of chronic stress, so we cannot conclude whether chronic stress affects creative thinking. It goes against our instinct that under acute stress, participants are still able to execute insight tasks just perfectly. When examining the results, however, we found a tendency for faster reaction and lower insight rate in the stressed group. We theorized that the stress induced in participants might actually evoke the "fight-or-flight" mechanism, causing a faster yet reckless reaction. In addition, during the TSST tress-inducing procedure, the environment of the laboratory room we used may not resemble that of an interview room enough. In addition, the cover story we used (a university instructor audition) may not be relatable enough to undergraduate students so the stress level induced could be undermined, thus polluting our results.

Our study also suggested that, in addition to the traditional "Aha!" riddle paradigm, which induces insight after prior reflection, novel insight materials such as "brain teasers" could also be adopted. The advantage of these materials is that they are easy to understand, time-saving, and have equally high stability in inducing insight. This could serve as an inspiration for upcoming studies to explore more creative materials to investigate insights. As insight exists in a broad range of cognitive activities, it is possible to develop more paradigms with better external validity and higher adaptation.

ACKNOWLEDGMENT

This work was supported by IDG/McGovern Institute for Brain Research at BNU and Faculty of Psychology of Beijing Normal University. The authors would like to thank Professor Shaozheng Qin for his useful instructions and guidance.

REFERENCES

[1] Luo, Y., Lin, W., Wu J., Qin, S (2013). Cognitive Neuroscience Research on Stress. Progress in Physiological Sciences, 2013,44(05):345-353.

[2] Luo, J (2004).The brain mechanism of insight. Acta Psychologica Sinica, 2004(02):219-234.

[3] Wang, J., Rao, H., Wetmore, G. S., Furlan, P. M., Korczykowski, M., Dinges, D. F., & Detre, J. A. (2005). Perfusion functional MRI reveals cerebral blood flow pattern under psychological stress. Proceedings of the National Academy of Sciences of the United States of America, 102(49), 17804-17809. http://dx.doi.org/10.1073/pnas.0503082102

[4] Qin, S., Hermans, E. J., van Marle, Hein J. F., & Fernández, G. (2012). Understanding low reliability of memories for neutral information encoded under stress: Alterations in memory-related activation in the hippocampus and midbrain. The Journal of Neuroscience, 32(12), 4032-4041. http://dx.doi.org/10.1523/JNEUROSCI.3101-11.2012

[5] Luo, & Niki, K. (2003). Function of hippocampus in “insight” of problem solving. Hippocampus, 13(3), 316–323. https://doi.org/10.1002/hipo.10069

[6] Duan, H., Wang, X., Wang B., Wang T., Zhang X., Wang Z., Hu W (2017). Acute Stress: Induced Paradigm, Measurement Indicators and Effect Analysis. Advances in Psychological Science,2017,25(10):1780-1790.

[7] Dickerson, S. S., & Kemeny, M. E. (2004). Acute Stressors and Cortisol Responses: A Theoretical Integration and Synthesis of Laboratory Research. Psychological Bulletin, 130(3), 355-391. http://dx.doi.org/10.1037/0033-2909.130.3.355

[8] Kirschbaum, C., Pirke, K. M., & Hellhammer, D. H. (1993). The ‘Trier Social Stress Test’–a tool for investigating psychobiological stress responses in a laboratory setting. Neuropsychobiology, 28, 76–81