The Effects of Stereotype Threat in Female's State Anxiety and Underperformance

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Abstract. Females with introverted or sensitive personalities could be primarily affected by gender discrimination toward them, and stereotypes often give rise to discrimination. The purpose of this article is to study stereotype threats on females' state anxiety and underperformance on working memory tests by using the N-Back Task. A total of 50 female middle school students were recruited. The mixed design of 2 (group: priming group/control group) × 3 (N-back difficulty: low/medium/high) was adopted to explore the state anxiety level and N-back task performance of participants with different difficulties under stereotype threat. The results show that there are obviously differences between the stereotype threat group and the non-threat group in the level of state anxiety and N-back task performance. The level of state anxiety in the threat group will be significantly higher than that in the non-threat group; the accuracy rate on the memory task in the threat group will be significantly lower than that of the non-threat group. This study focuses on females and establishes a connection between stereotype threat and working memory capacity, which illustrates a significant phenomenon in the workplace. It is believed that this study is of great inspiration to the future teaching methods in middle schools and also has an urging effect on providing better guidance of public opinion for females.

Keywords: Stereotype Threat · Anxiety · Female Middle School Students · Cognitive Psychology

1 Introduction

Stereotype threat is a risk experienced by individuals concerned that they will validate negative stereotypes of their group. It has been shown that stereotype threat impacts female performance in several circumstances [1]. There is a lingering misinterpretation that female is not match for male in certain subjects or aspects such as working memory ability. It is believed that such gender stereotype can generate females to avert participating in memory-related projects and activities, which could ultimately lead to their underrepresentation in many professions. Therefore, it is indispensable to investigate

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Z. Zhan et al. (Eds.): SEAA 2022, ASSEHR 675, pp. 345–354, 2023.
https://doi.org/10.2991/978-2-494069-05-3_43

how the threat prejudices female performance and how its effects might be ameliorated. It may be helpful for educators to facilitate educators better preparing the female for success in both profession and academia fields when comprehending this series of researches. Stereotypes often give rise to discrimination, which unfairly treats those who degrade their status, reflecting a negative state [2]. As a response to the experiences of unfair treatment, information related to discrimination tends to induce negative psychological states of individuals [3]. Social pain is linked to discrimination, and a study has been shown that people who experience prejudice are more likely to struggle with it [4]. In a study [5], it showed that such stereotypes translate into unfair treatment of people, and that threatening messages often trigger negative psychological states in individuals, associated with social pain. Especially, gender discrimination has been proven to aggravate negative consequences, which is always a serious social issue, experiencing social pain through discrimination can rise individuals' evaluation of induced physical pain. The researchers used a gender discrimination fMRI paradigm with thermal pain stimulation to explore this issue. They found that discrimination indeed affected participants' behavioral self-assessment of detrimental stimuli. Due to gender discrimination, females afraid that they will validate negative stereotypes of their group and become more anxious than usual with physical pain. Therefore, this present study decides to research whether females' memory and cognitive abilities will reduce under gender stereotype threat and whether anxiety levels will increase, not just physical pain.

A study investigated the impact of female stereotypes and teacher gender on student achievement [6]. Researchers found that in some ways, endorsers for stereotype statement were more anxious than non-endorsers and were inclined to drop classes more frequently, particularly in classes instructed by male teachers. Moreover, the overall GPA of girls in the male teacher class was slightly higher than that in the female teacher class, which was one of the results of female stereotypes. If their teacher was a female rather than a male, more female students approved of the stereotype viewpoints and performed worse on the first test. Initially, female students tended to make upward social comparisons, so worrying about past statistics leaded them to feel inferior and different from their teachers. This shows that stereotypes about threatened females will affect the level of anxiety, resulting in female counselors do not play positive role models. Vermeulen et al. [7] also tried to figure out the effect of stereotype threat to females on playing evaluative games based on expected performance and anxiety level. They found that the people in the non-threat group had a higher expectation of performance than those in the threat group. Also, the more they felt the threat, their anxiety level was the higher. The limitation is that the perspective of this study is only a small portion of the stereotype threat, which expect to expand to other aspects of daily life. Brown et al. [4] demonstrated that the psychological stress caused by discrimination may relate to chronic pain. The authors examined discrimination from various aspects, such as gender, race, and weight. The current study focuses more on how the stereotype threat affects females' working memory capacity. Kapitanoff and Pandey [6] investigate the impact of female stereotypes and teacher gender on student achievement. They elaborate on more possible factors, such as the role model for females and a particular environment. The method the current study applied is more theoretical. A study done by Vermeulen et al. [7] examined how the stereotype may affect females' performance in playing evaluative

games based on their anxiety level. In this case, Vermeulen and their colleagues experimented on an actual game that is more common in daily life than the N-back test. Also, the researchers might receive a slightly more accurate result because they divided the experiment group into two levels (Stereotype Neutral and Stereotype Boost) compared to the one level (threat group) the current study did.

In another study on gender stereotypes of middle school students, Wilson and Lindsey [8] pointed out in relevant studies that students have internal and external views on gender, and their structures and characteristics are different. Xiao fang et al. [9] pointed out in their related exploration that feminized and undifferentiated persons were relatively serious anxiety and depression are milder in male and bisexuals, which may be related to the research's appreciation of male traits. In the study on the gender stereotype of middle school students and its relationship with gender identity and mental health [10], 216 male middle school students and 226 female middle school students were selected. The results showed that there is a significant negative correlation between implicit mental health-gender stereotypes and mental health, and there is no significant correlation between explicit mental health-gender stereotypes and mental health. Therefore, middle school students generally have implicit mental health-gender stereotypes, but females have a higher level of stereotypes than males.

The overall objective of this study will be to research the effects of stereotype threat in female processing within the context of the working memory capacity test. This study employs the N-back task paradigm from an article written by Sui Ling. [11], hypothesizing that based on the N-back working memory task paradigm, the effect of gender stereotype threat is valid, and significantly, there are differences between the stereotype threat group and the non-threat group in the level of state anxiety and N-back task performance. This study predicts that the participants will feel more anxious after they see the threat sentences on the screen, that is, the level of state anxiety in the threat group will be significantly higher than that in the non-threat group. Their test performance will also be influenced and turns worse in the threat group, that is, the non-threat group's accuracy will be observably higher than the threat group.

2 Methods

2.1 Participants

Based on previous experience, less than 30 participants are considered as small samples. Therefore, this research chose a total of 75 participants, 50 females and 25 males (25 in the female threat group, 25 in the female non-threat group, and 25 in the male non-threat group as the control group). They were all middle school students with normal vision or corrected vision and no physical illness or mental abnormality. They were all of Han nationality (to avoid the dual impact of the ethnic stereotype threat effect) and had never participated in similar experiments before. The age of the participants was 15.78 ± 0.93.

2.2 Materials

2.2.1 Gender Stereotype Threat Priming Material

For the manipulation of gender stereotype variables, different threat conditions provided different instructions, referring to the previous study [12]. The instructions for

the threat group were "There is close relationship between working memory ability and sex physiological structure. The next task is an experimental task to diagnose working memory capacity. The idea that there are gender differences in memory, has been repeatedly confirmed by psychologists. A recent study of gender differences found that: Male performed better on working memory tasks than females. The purpose of the study was to find why males performed better on working memory tasks than females." The instructions for the non-threat group were "In the early stage of Chinese characters, pictographic characters. Directly related to the morpheme meaning it represents. Although each word has its pronunciation, the glyphs themselves are not phonetic symbols, the nature of the alphabet is different from that of pinyin. The pronunciation of a pictograph is transferred to it by the morpheme it represents. As the glyphs changed, pictographs became less and less pictographic, which causes a glyph and the morpheme it represents. In the sense of losing the original connection. The glyph becomes abstract notation."

2.2.2 Self-rating Anxiety Scale (SAS)

The self-rating anxiety scale was developed by Zung, W. W. K. [13]. It contained 20 items and was divided into 4 levels. SAS was used to evaluate the participants' anxiety level. Higher scores indicate more severe levels of anxiety.

2.2.3 Working Memory Task

Ten basic geometric shapes such as triangle, circle, and square were selected to design the N-back task, three tasks as 0-task, 1-task, and 2-back with different degrees of difficulty. N-back tasks were sequential recognition measures, presenting sequences of stimulus, such as letters, words or pictures; for each last item in each sequence, participants judged whether it matched the item that appeared first time.

2.3 Procedure

The research experimental procedure included two stages: the start-up stage and the evaluation and measurement stage [14]. SAS was used by Questionnaire Stars to answer the items. The working memory N-back task ran in PsychoPy software. This study obtained informed consent from all participating individuals, and this study was conducted following the statement of ethical principles according to the responsible committee on human experimentation. After the whole experiment, the threat group was instructed that it was only a threat experiment and there was no scientific evidence that males had better working memory than females.

First, the start-up stage: participants were randomly allocated to two groups, the threat or non-threat group. In the threat group, the participants read the stereotype threat priming material, while the non-threat group read the unrelated material about the origin of Chinese characters. After reading, SAS was used for the anxiety level test, namely the threat level test.

Next, the evaluation and measurement stage: participants in different groups completed the same N-back working memory task. The experimental guide was as follows "Hello, welcome to the psychology experiment! Here's a test of working memory, it

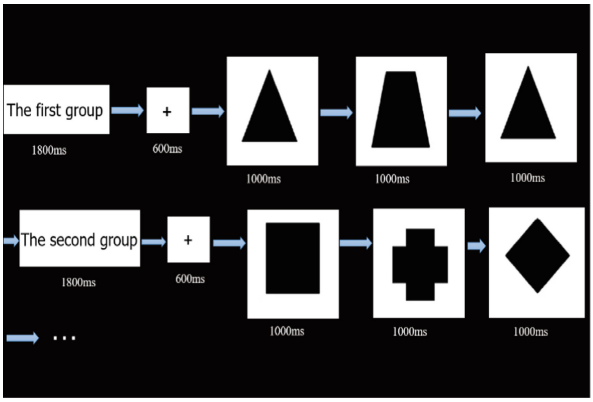

Fig. 1. The 1-back task with PsychoPy.

can better predict individual learning ability. The experiment consisted of three phases, please read the instructions for each stage carefully and respond to the key. If you understand the instructions above, please press the space to enter the experiment." In the n-back task program, the general instruction was presented first, followed by 0-back simple task, 1-back medium difficulty task, and 2-back complex task. In each stage, task instructions were presented first, and finally, the formal experiment stage began (Fig. 1).

2.4 Data Analysis

Descriptive statistical analysis was used for participant characteristics, and one-way analysis of variance was used for comparisons between groups. The t-tests were used to compare the differences between the two samples. A 2×3 repeated analysis of variance (ANOVA) was used to assess the interaction effects of training conditions and three difficulty levels on N-back (0-back, 1-back, 2-back) on average accuracy rate and reaction times. All analyses were used with non-female threat group and female threat group or male non-threat group respectively.

Following previous studies [11], trials with response time increased with the difficulty of tasks. The average response time is from 546.83 ms to 835.36 ms. However, in this study, the exercise stage was removed, and the participants needed to adapt to the 0-back at the beginning, so the reaction time increased. Moreover, the previous study didn't use the t-test for multiple comparisons, which can improve the precision to some degree.

3 Results

The difference in state anxiety level between stereotype threat priming and non-stereotype threat priming groups: The anxiety level of participants in the threat group and the non-threat group was analyzed, and the results showed that the state-level score of participants in the female threat group was 38.00 ± 7.77, the state-level score of participants in the non-threat group (female and male) was 31.60 ± 4.16. The group effect of state anxiety level was significant, $F(1,48) = 13.18$, $p < 0.05$. Stereotype threat

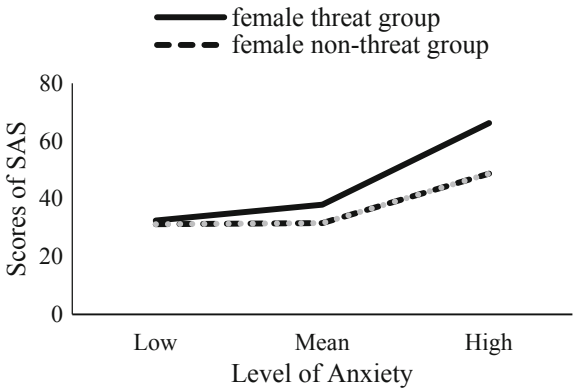

Fig. 2. Simple slopes for the effect of anxiety in the threat/non-threat group.

priming led to an increase in state anxiety. Figure 2 presents simple slopes for the effect of anxiety in the different groups.

Differences in n-back task performance between stereotype threat priming and non-stereotype threat priming groups: In terms of accuracy rate, the results of one-way ANOVA showed that in the 0-back task, the accuracy effect of the female threat group and the female non-threat groups not visible, $F(1,48) = 3.57$, $p > 0.05$; the female non-threat group and the male non-threat groups not visible, $F(1,48) = 0.06$, $p > 0.05$. Figure 3 shows the correct rate for the different groups. In the 1-back task, the accuracy effect of the female threat group and the female non-threat group was significant, $F(1,48) = 7.86$, $p < 0.05$; the female non-threat group and the male non-threat group was not significant, $F(1,48) = 0.63$, $p > 0.05$. In the 2-back task, the accuracy effect of the female threat group and the female non-threat group was significant, $F(1,48) = 10.34$, $p < 0.05$; the female non-threat group and the male non-threat group was not significant, $F(1,48) = 0.67$, $p > 0.05$. The main effect of different difficulty tasks was significant, $F(2,72) = 54.13$, $p < 0.05$. Multiple comparison results showed that the accuracy of the first task was the highest, and the accuracy of the third task was significantly lower than that of the second task. However, there was no significant interaction between threat priming and the difficulty of the n-back task ($p > 0.05$). In terms of reaction time, the results of one-way ANOVA showed that the group with or without stereotype threat had no significant main effect, that is, there was no significant difference in response time between the female threat group and the female non-threat group, $F(1,148) = 0.50$, $p > 0.05$; the difference in response time between the female non-threat group and the male non-threat group was not significant, $F(1,148) = 4.35 \times 10^{-4}$, $p > 0.05$. However, multiple comparison results showed that the reaction time of the 0-back task was highest and of the 1-back task was greater than 2-back task significantly. Figure 4 shows the reaction time for the different groups.

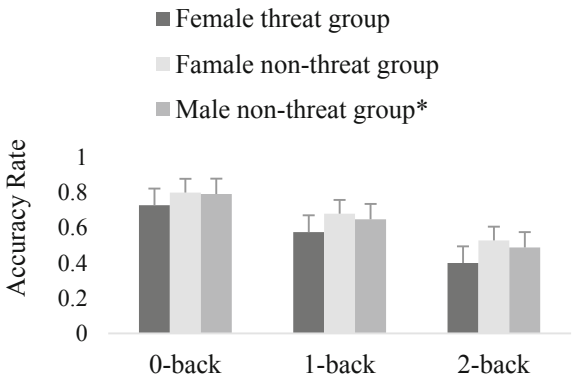

Fig. 3. The accuracy rate for the threat/non-threat N-back difficulty levels.

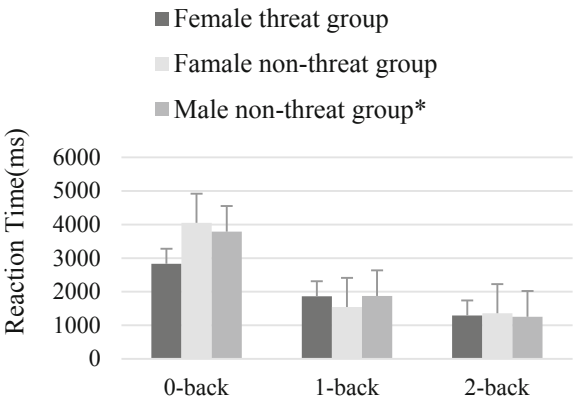

Fig. 4. The reaction time for the threat/non-threat N-back difficulty levels.

4 Discussion

The present study investigates the effects of stereotype threat on females' state anxiety and underperformance on working memory tests by using the N-Back Task. The group effect on state anxiety level is obvious, and the priming of stereotype threat leads to the increase of state anxiety level. Whether females threaten in 0-back accuracy difference is not obvious, in 1-back and the 2-back difference is obvious. There was no significant difference in accuracy between males' and females' non-threat tasks. The main effect of n-back with different difficulties is distinct, the accuracy of 0-back is greater than 1-back and 2-back, and the accuracy of 1-back is greater than 2-back. The difference in response time between males and females was not significant. The reaction time of 0-back was significantly greater than 1-back and 2-back, and the reaction time of 1-back was significantly greater than 2-back.

At the level of state anxiety, under the threat of gender stereotype, the female middle school students in the threat group have higher anxiety levels than the non-threat group.

The influence of stereotypes on females can induce anxiety, which is consistent with the results of Susan Kapitanoff and Carol Pandey [6]. This study used SAS self-rating anxiety scale to measure anxiety levels and used self-made threatening words to threaten subjects. The results were consistent with expectations. Negative gender meta stereotype is an important factor in intergroup relationships [15], with the female having higher intergroup anxiety than males. Under the threat of stereotype threat, female is under the threat pressure situation, and have a negative expected evaluation of the subsequent N-back task, which leads to the awakening of their state anxiety level [16].

This paper used N-back task to study working memory under stereotype threat. In N-back task performance, the accuracy of non-threat group was significantly higher than that of threat group, and there was no difference in reaction time between two groups, indicating that the experimental manipulation of stereotype threat effect based on N-back task was effective. The initiation of stereotype threat triggers females' monitoring of their behaviors, increases the workload of working memory, and leads to a decline in working memory performance [11]. Activating negative stereotypes (i. e., the activation of stereotype threat effect) will damage related tasks, especially the performance in cognitive processing tasks [17]. Stereotype threat will cause stress responses such as elevated blood pressure and increased cardiovascular resistance [18]. Stress can lead to impaired functions of the prefrontal lobe and hippocampus, so the cognitive activities related to these two parts will also be damaged. Such as working memory and long-term memory [16]. Therefore, stereotype threat priming has a direct threat effect on female N-back task performance.

Like any other study, this study is not free from limitations. Taken together, it provides some compelling initial evidence for stereotype threat in females' state anxiety and underperformance on working memory tests by using N-Back Task; however, further work is needed in several areas. Furthermore, these data are gathered from only one city in China, these data come from different grades, and there are also significant differences in class performance, half from top classes and a half from top-down classes. Another limitation is that the sample size of the experiment was small, only emphasizing the individual level and reducing the focus on general ability. Future research should consider the potential effects of research sample number and research sample achievement level more carefully. Regardless, future researches are expected to continually explore stereotype threats in females' state anxiety and underperformance on working memory tests.

5 Conclusion

The study surveys the effects of stereotype threat on female state anxiety and underperformance on working memory tests by using the N-Back Task. The results show that the differences between the stereotype threat group and the non-threat group were significant in the level of state anxiety and N-back task performance. This study can provide some important practical implications for middle school students' teaching. Female middle school students are the same working memory effect as male middle school students when they are not threatened by stereotypes. Therefore, there should be no gender discrimination in teaching, nor should stereotypes be raised in front of female middle

school students. The present work has made several theoretical contributions to the field of middle school students' teaching. This study can provide some important practical implications for middle school students' teaching under gender equality. Stereotype threats can affect females' anxiety levels, which also prompts society to provide better guidance of public opinion for them.

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