Power Posing and Choking Under Pressure: The Effects Power Posing Can Have on Performance in High Pressure Mathematical Tasks

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The study was run at the Harvard Decision Science Laboratory. Special thank you to Dr. Amy Cuddy for her support and help throughout the project, and the Dr. Samuel Sommers for his guidance and encouragement. Finally I would like to thank Jack Schultz for his assistance with the study. I would also like to thank Dr. Kelly McGonigal for her insights and guidance on the video portion of the study.

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Abstract

Research has suggested that high pressure situations lead to a decrease in performance in both academic and sport-related settings. Different theories have been used to describe the processes that result in the suffering of the individual's performance. The stress of the situation results in an alteration of the cognitive process that consequently leads to a worsening of the performance. There have been studies looking at how power posing can help relieve stress from high pressure situation and thus improve performance. This study focuses on how power posing can affect performance on high pressure math tasks and whether power posing mitigates the effects of choking. Even though the results of this study were not significant, they suggest a positive relation between high power poses and performance. These statistically insignificant results can be a stepping stone for future research, which can help shed more light on how to reduce the negative effects that pressure often has on performance.

Introduction

Throughout our lives we are subjected to high pressure exams that often determine our future; however, our performance is not always what we expect it to be. In this paper, I seek to explain the underlying cognitive processes that are responsible for our performance on mathematical tasks and how we can try to mitigate the negative effect pressure has on our performance. Based on past research, the same cognitive functions that suffer from the stress caused by pressure are also affected by power posing. This suggests that power posing may offer a way to mitigate and counteract the effects pressure has on performance. Understanding how pressure affects performance and ways through which we can reduce these negative consequences can help more accurately represent one's abilities in high pressure situations. In order to best understand how past theories come together to inform the current study, it is important to understand the underlying cognitive functions that affect our performance on novel tasks.

Working Memory, Stress & Performance

The term working memory has evolved from the concept of a single short-term memory system and it "refers to a brain system that provides temporary storage and manipulation of the information necessary for complex cognitive tasks" (Baddeley, 1992). We use our working memory when trying to solve complex problems, or when we're trying to recall information while concurrently attending to a different task. It is the system that allows us to simultaneously store and process information. There is a distinction, however, between learned knowledge that is being processed and the sheer speed of processing information. Different mental processes, such as reading comprehension (Just & Carpenter, 1992), and reasoning (Baddeley & Hitch, 1974; Kyllonen & Christal, 1990) use one of the three components – the central executive system, the visuospatial sketchpad and the phonological loop – as proposed in Baddeley's model of working memory. The central executive system functions as the attention control system, and supervises the other two systems. The phonological loop on the one hand is used to manipulate and store speech-based information, while on the other hand the visuospatial sketchpad processes and stores visual and spatial information (Baddeley & Hitch, 1994). The importance of these systems is made clear when studying people with central executive deficits, such as Alzheimer's patients (Baddeley et al., 1991). Baddeley et al.'s study concluded that while single task performance was maintained, as the disease progressed, the patients' performance on combined tasks worsened. These findings support the importance of working memory in performing multiple tasks simultaneously.

Even though individuals with higher levels of working memory capacity have been found to perform better on tests that rely on cognitive ability (Turner & Engle, 1989), working memory capacity is not constant and can be altered temporarily or long term by manipulating the situation (Ashcraft & Kirk, 2001). Long-term life stress can lead people to constantly use up some mental power to suppress negative thoughts, leading to a reduced working memory capacity and increased intrusion errors (Klein & Boals, 2001). Stress can also have short-term effects on working memory capacity, reducing the cognitive resources available by occupying part of the brain with intrusive thoughts (Aschcarft &Kirk,2001).

Stress has biological effects on our cognitive functions and can be very disruptive to our working memory, making it harder to perform tasks that highly depend on working memory. Stress blocks hippocampal primed-burst potentiation, suggesting that it should also affect working memory (Diamond et al., 1996). Working memory is hippocampal-dependent and thus a blockage in the functions of the hippocampus caused by stress can impede working-memory intensive performance. After studying how stress affects memory in rats, Diamond et al. found that stress causes temporary disruption in the hippocampal function, impairing their working memory (1996).

Schmader and Johns studied the effect that the stress caused by stereotype threat has on performance (2003). Stereotype threat manifests itself in groups that are aware of their assumed disadvantage in a particular situation, and are afraid of confirming that stereotype. There have been multiple studies that report the important role working memory plays in solving mathematical tasks. Carry operations while calculating sums heavily rely on the central executive system and working memory, with higher working memory capacity leading to faster responses (Geary & Widaman, 1992). Stress can lead to decreased performance on cognitively demanding tasks as it preoccupies part of the working memory that should be dealing with the task at hand. Through a series of three experiments Schmader and Johns found evidence that supports the hypothesis that "stereotype threat reduces an individual's performance on a complex cognitive test because it reduces the individual's working memory capacity" (2003). The anxiety and pressure caused by stereotype threat, interferes with performance on cognitive tasks. While the cognitive system should be dedicated to solving the task at hand it is compromised by also trying to suppress intrusive and irrelevant thoughts (Engle, 2001). This effect stress has on performance and working memory capacity can lead to sub-optimal performance, even given an advanced skill level.

When pressure and the stress caused by it interfere with working memory, performance suffers. Anxiety generates intrusive thoughts about the situation that occupy part of the working memory capacity normally devoted to skill execution, consuming part of the limited resources of working memory that can result in choking. (Ashcraft & Kirk, 2001; Eysenck & Calvo, 1992). Choking is defined as "performing more poorly than expected given one's skill level, [and] is thought to occur across diverse task domains where incentives for optimal performance are at a maximum (p. 584)" (Beilock, Kulp, Holt & Carr, 2004).

Two conflicting theories have been created to explain why highly skilled individuals choke under pressure. On the one hand, the explicit monitoring theory (also known as the self-focus theory) suggests that "performance pressure increases anxiety and self-consciousness about performing correctly, which in turn enhances the attention paid to skill processes and their step-by-step control (p. 584)" (Beilock, Kulp, Holt & Carr, 2004). This return of focus to the detailed steps necessary to perform the task is believed to disrupt the more automated process that usually runs outside of the control of one's working memory. More skilled individuals may be harmed by this process and perform more poorly by paying attention to more specific components, which disrupts the proceduralized processes that run outside of their working memory. This form of choking is mostly found in sports, where athletes are accustomed to the automated motions and are unable to perform as well when they return to the component-specific execution (Beilock, Kulp, Holt & Carr, 2004). Skill training that induces attention to performances may protect individuals from the negative effects of pressure.

On the other hand, the distraction theory proposes that "pressure fills working memory with thoughts about the situation and its importance that compete with the attention normally allocated to execution (p.584)" (Beilock, Kulp, Holt & Carr, 2004). This theory describes the effect that choking has in more academic, memory-intensive settings. Anxiety dominates our thoughts and fills up our working memory, leaving us with less available resources to dedicate to the task at hand. This decrease is working memory capacity leads to sub-optimal performance, especially when there is increased desire for high level performance. Beilock et al. (2004) found that performance on novel modular arithmetic problems, the solutions for which require the use of working memory, declined under pressure when the problems required high use of working memory. Well-learned modular arithmetic problems, the solutions for which did not rely on working memory, showed no signs of performance failure under pressure. This suggests that working memory plays a crucial role in the execution of novel tasks, and when anxiety dominates our thoughts, performance tends to suffer. Pressure creates mental distractions that reduce the working memory capacity that would otherwise be allocated to skill execution. Situational pressure imposes constraints on tasks that demand high working memory.

Through a series of experiments Beilock et al. found evidence supporting the distraction theory while disproving the explicit monitoring theory on high pressure mathematical tasks (2004). Performance in solving novel high-demand, high-pressure problems suffered in the high pressure scenario that increased feelings of worry and anxiety. Moreover, participants' performance did not suffer in the high pressure situation when the problems were practiced 50 times each. In this case, the problems were more automated and did not rely as heavily on working memory making performance less susceptible to anxiety and stress. The outcome of this study is not compatible with the explicit monitoring theory that supports that pressure causes the breakdown of proceduralized algorithms. These findings underline the importance of working memory in novel tasks, and helped guide the design of the present study. Novelty of the task was critical in being able to demonstrate the effect power posing has on performance on high pressure tasks.

Further looking into what affects performance on tasks with high working memory intensity, Beilock and Carr studied the effect individual differences in working memory capacity have on performance under pressure (2005). As expected, individuals with low working memory capacity performed less well than those with high working memory capacity on high demand tasks in a no-pressure situation. However, when pressure was applied their performance did not decline under pressure, and the high working memory group lost its advantage. Individuals with high working memory have superior allocational capacities, and thus have an advantage when solving high demand problems. But when pressure is introduced, these individuals lose their advantage as their extra cognitive capacity is now consumed by anxiety and stress. Individuals that have the highest capacity for success in the absence of pressure are the ones most likely to experience a decrease in their performance (Beilock & Carr, 2005). Understanding the way working memory functions and how stress affects performance is crucial, but it is also important to look at ways to mitigate and deal with these negative effects.

Power, Nonverbal Behavior & Performance

Social power, and the sense of being more or less powerful, has been found to affect executive function; lack of power increases vulnerability, leading to a decrease in performance during complex tasks (Smith et al., 2008). Low power individuals have an altered mental world, and are less cognitively flexible than high power ones (Guinote, 2007). Less successful individuals are not less capable or less motivated than powerful people by nature. Their lack of power makes it harder for them to maintain focus on their goals, by consuming their cognitive functions, while on the contrary high psychological power enhances executive function (Smith et al., 2008). Perceived or actual social status can also affect the way individuals experience stress. The relative cortisol level exhibited by subordinate primates was higher when their social structure exposed them to highly stressful situations (Abbott et al., 2003). Sapolsky et al. (1997) suggest in their study of baboons, that higher ranking baboons produce significantly less cortisol than the lowest rank ones. These findings suggest that social dominance and a sense of power leads to lower levels of cortisol, and consequently lower levels of stress.

Social rank and power can be identified by the posture, nonverbal behavior and the amount of space occupied by an individual. High social standing is associated with less relaxed, more erect postures (Hall, Coats & Smith LeBeau, 2005). Expansive postures, occupying an enlarged space by spreading the limbs, project high power while contracting and closed positions that take up little space project low power. This has been found to be true both for humans and primates (Hall, Coats, & Smith LeBeau, 2005; Darwin, 1872/2009). While these positions demonstrate power and high rank, they can also elicit feelings of power. Research has suggested that assuming a high-power pose causes a number of changes in our physiology and psychology. The levels of testosterone in the body rise while cortisol levels decrease (Carney, Cuddy & Yap, 2010). The higher testosterone levels are connected to an increased feeling of power, while the lower cortisol levels are related to decreased stress.

Power induces feelings of positivity, control and optimism about the future making the individuals more goal-oriented (Anderson & Galinsky, 2006). Moreover, power has been found to increase confidence and reduce stress, anxiety and negative affect (Anderson & Berdahl, 2002).

Bodily movement has been found to alter emotional states. Tilting the head upward elicits feelings of pride (Stepper & Strack, 1993) while hunched postures induce feelings of depression (Riskind & Gotay, 1982). Thus, assuming a posture for a few minutes can result in a modification of one's emotional state. Assuming a high power pose before a high pressure situation can help one perform better in the immediate future. Participants that stood in a high-power pose before a job interview were more composed during the interview emitting confidence and enthusiasm which resulted in higher overall performance (Cuddy, Wilmuth & Carney, 2012).

Current Study

The current study aims to bring these findings together, and suggest a way to reduce the effect stress and pressure have on performance. Pairing the increase in stress that is caused by pressure on a cognitively demanding task (Beilock et al., 2004) and the decrease in the level of cortisol (the stress hormone) after high power posing (Carney, Cuddy & Yap, 2010), I am hoping to suggest a way to mitigate the burden pressure places on working memory. The hypothesis suggests that individuals who assume a high power pose before a high pressure task will perform better than those who assume a low power pose. Such findings could help test-takers mitigate the effect of stress before high pressure exams leading to a better performance that more accurately represented their abilities. Moreover, since many standardized tests are used to determine one's cognitive abilities and are more often than not taken in high pressure conditions, these findings could help the test-takers perform better and get results that are more representative of their actual abilities.

Method

Participants

The participants were recruited from the Harvard Decision Science Laboratory participant pool. 93 participants took the study, and two were excluded from the analysis because they did not finish the task. All participants were randomly assigned to either the high-power-pose or the low-power-pose condition. All participants were exposed to the same amount of pressure. They were told that depending on their performance on the mathematical task they could make up to twice the sign-up fee ($14). This was meant to increase the pressure they felt to perform better. At the end of the study they all got $14 regardless of their performance.

Apparatus & Materials

Power Posing

A video was presented to the participants to guide them through the power posing section of the study. The traditional, more static power pose was adapted into a more active posture that was demonstrated in the videos. In both the low and high power poses, this more active version was meant to keep the participants engaged and thinking about the posture throughout. Moreover, it was meant to make the power posing experience less uncomfortable for the participants as they no longer had to stand still for a few minutes. Finally, these videos were meant to be easy to replicate in any setting.

Two versions of the video were made, one for the high power pose and one for the low power pose. In the videos a woman guides the participant through the high or low power posture while demonstrating the motions. The person in the video was female to ensure that there would not be any gender biases affecting the effect of the power poses (women would not feel intimidated). The woman in the video was selected based both on her appearance and her voice. She does not have a distracting appearance and her voice is level and consistent. Consequently, the participants were not distracted by the person in the video and were able to focus more on the motions and thoughts presented in the video. Moreover, the consistency of the voice served to neither increase nor decrease participant's the level of stress and confidence.

The two videos were made to be parallel in their instructions for the low and high power pose ensuring that the participants are equally engaged and affected by the postures. The high power video was initially modeled after a yoga pose (the ego eradicator), that uses expansive movements. However, this pose was altered to more effectively elicit feelings of power and the effects of power posing. The high power video emphasized being expansive and trying to occupy as much space as possible, while the low power video insisted on contracting and trying to become invisible. Both videos focused on the position of the head, shoulders, arms and legs, all of which are parts of the body that can affect one's sense of power.

There were multiple steps that led to the final video presented to the participants. Initially, a script was drafted that incorporated and pointed out the important aspects of power posing ensuring that the participants held the pose as accurately as possible. This scrip was presented the members of Dr. Amy Cuddy's lab, where they offered feedback in order to improve the positions and reduce any side effects they may have. The script tried to eliminate the relaxing effect certain movements or poses may have on the participants. Moreover, Dr. Kelly McGonigal offered insights on the biological effects certain poses and body postures have. This information was used to both make the power poses more effective but also to avoid using poses that would detract from the effect the power poses have on the participants. Dr. Amy Cuddy was consulted throughout the whole process in order to best utilize the current findings and understanding of power poses and their effect.

Picture 1: High Power Pose

Picture 2: Low Power Pose

Mathematical Task

A modular mathematical test on Qualtrics was used to test the performance of the participants. Due to the effect novelty has on performance under pressure, it was important to use a task that participants would not be familiar with. I used the modular mathematical test used by Beilock et al. used to investigate choking under pressure in mathematical problem solving (2004). This task is advantageous in a laboratory setting as it is uncommon and thus novel to most participants but it is also similar to other types of mental mathematics in the way it is learned.

In this test, equations in the form of 62= 14 (mod 3) were presented, and the participant had to judge their truth value. This can be done by subtracting the second number from the first number (“62-14”). The difference is then divided by the last number (“48/3”). If the result of this division is a whole number (in this case 16) then the equation is true, while problems with remainders are false. Both high and low difficulty equations were presented to all participants. High difficulty equations were the ones with large numbers (>10), while the low difficulty equations had smaller numbers (<10).

Other Materials

A STAI test was used to measure the anxiety level of the participants after they completed the modular arithmetic task. This aimed to offer a better understanding of the state the participants were in and how pressured they felt. A manual was used to analyze the results of the STAI test.

A questionnaire was also used to gather demographic information about the participants.

Inducing Pressure

All participants, regardless of their condition, completed the modular mathematical task in a high pressure situation. Pressure was induced in three ways: time pressure, social pressure and monetary pressure (Beilock, Kulp, Holt & Carr, 2004). The participants were told that they had 8 minutes to complete all 46 questions, making it a fast paced task. There was a table clock placed next to the computer to remind the participants of the time constraint and increase the stress. Moreover, to stress the time limit even more, all the questions were presented in one page making the task more intimidating. Furthermore, the participants were told multiple times that their responses would be reviewed and evaluated by one or more experimenters inducing social pressure. This social pressure was emphasized by the tone and body posture of the experimenter. Throughout the study the experimenter was authoritative and stood in high power positions increasing the stress of the situation. Finally, the participants were given a monetary incentive to want to perform well. They were told that depending on their performance they could double the money they got ($14). This was meant to increase the stakes of the task and increase their engagement and effort as well as the pressure to perform well.

Procedure

Participants took part in the experiment one at a time. They were led by the experimenter to the interview room where the study took place. They then watched the video and were told to follow the instructions as accurately as possible. Once the video was over, the experimenter entered the room again and presented the participant with the modular arithmetic task. The participant was then told in an authoritative manner that their work will be looked at and evaluated. They were also told that depending on their performance they could make up to double the signup fee ($14 total) and were then shown the extra $7. The experimenter then started the Qualtrics survey and left the room. Once the participant was done with the survey, they were asked to complete the demographic questionnaire and the State-Trait Anxiety

Inventory (STAI). Once the participant was done, the experimenter informed him/her that the experiment was over and escorted the participant out.

Results

Even though the results of the study did not show a statistical significance, there are things we can learn from the findings. Understanding the direction of the effect power posing had on performance and on the anxiety levels can help inform future research.The results of the independent sample T-test, suggest that even though there was no statistically significant effect, the high power group performed marginally better than the low power group. Moreover, the independent sample T-Test used to analyze the results of the STAI suggests that the change in stress level for the low power group was larger than that of the high power group. Even though these results are not statistically significant, they follow the direction of the effect of the hypothesis that the high power group will perform better than the low power group on a high pressure mathematical task.

An independent sample T-Test was to examine the effect power posing had on anxiety. Based on the participants' state anxiety, as measured by their self-report responses to the state portion of the State-Trait Anxiety Inventory (STAI), the difference between the high power condition (M= 41, SD= 11.312) and the low power condition (M=40.217, SD= 10.274) was not statistically significant, M=.783, 95% CI [-3.264, 5.281], $t(89)$= .346, p=.730. After excluding participants who cheated, did not follow the instructions or ran out of time the results again showed no statistically significant difference between the high power condition (M= 41.878, SD= 12.002) and the low power condition (M=41.564, SD= 9.054), M=.315, 95% CI [-4.640, 5.270], *t*(70)= .127, *p*=.900. Consequently, the two conditions did not have a statistically significant effect on the anxiety level of the participants at the time.

After examining the results of the T-Test for participants' trait anxiety, as measured by their self-report responses to the trait portion of the STAI there was a larger difference between the high power condition (*M*=41.756, *SD*= 10.741) and the low power condition (*M*=39.913, *SD*= 9.932), however, it was not statistically significant, *M*=1.843*,* 95% CI [-2.465, 6.150], *t*(89)= .850, *p*= .593. After running the same test but excluding the participants that cheated, did not follow the instructions, or ran out of time the difference between the means of the high power group (*M*= 42.363, *SD*=11.138) and the low power group (*M*=39.413, *SD*= 9.323) was again not statistically significant, *M*= 2.953, 95% CI [-1.856, 7.761], *t*(70)= 1.225, *p*=.225.

Figure 4a: Power posing and effect on state and trait anxiety of the participants.

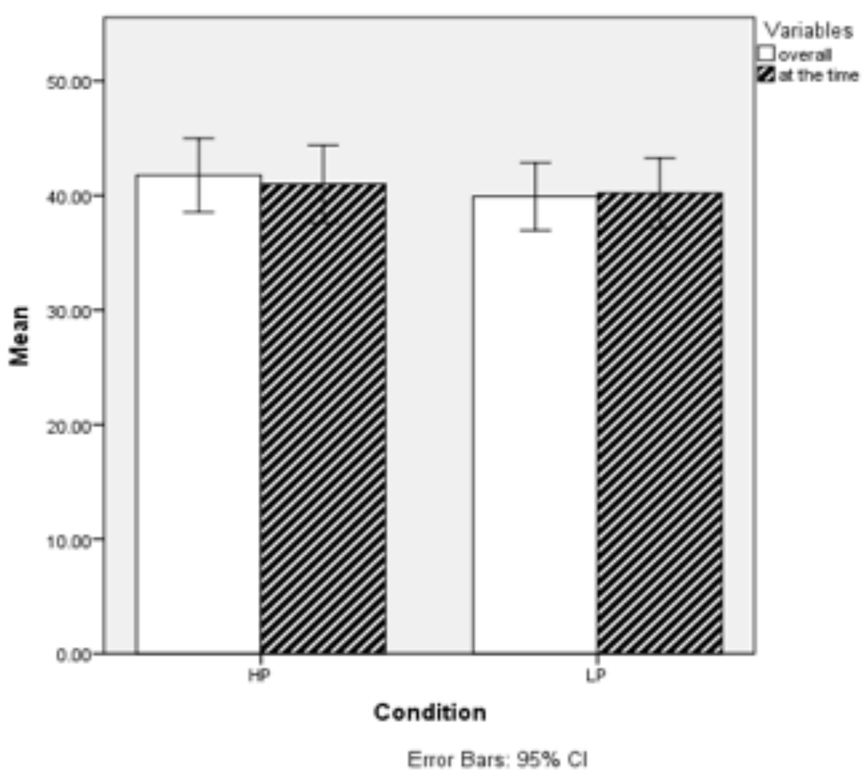
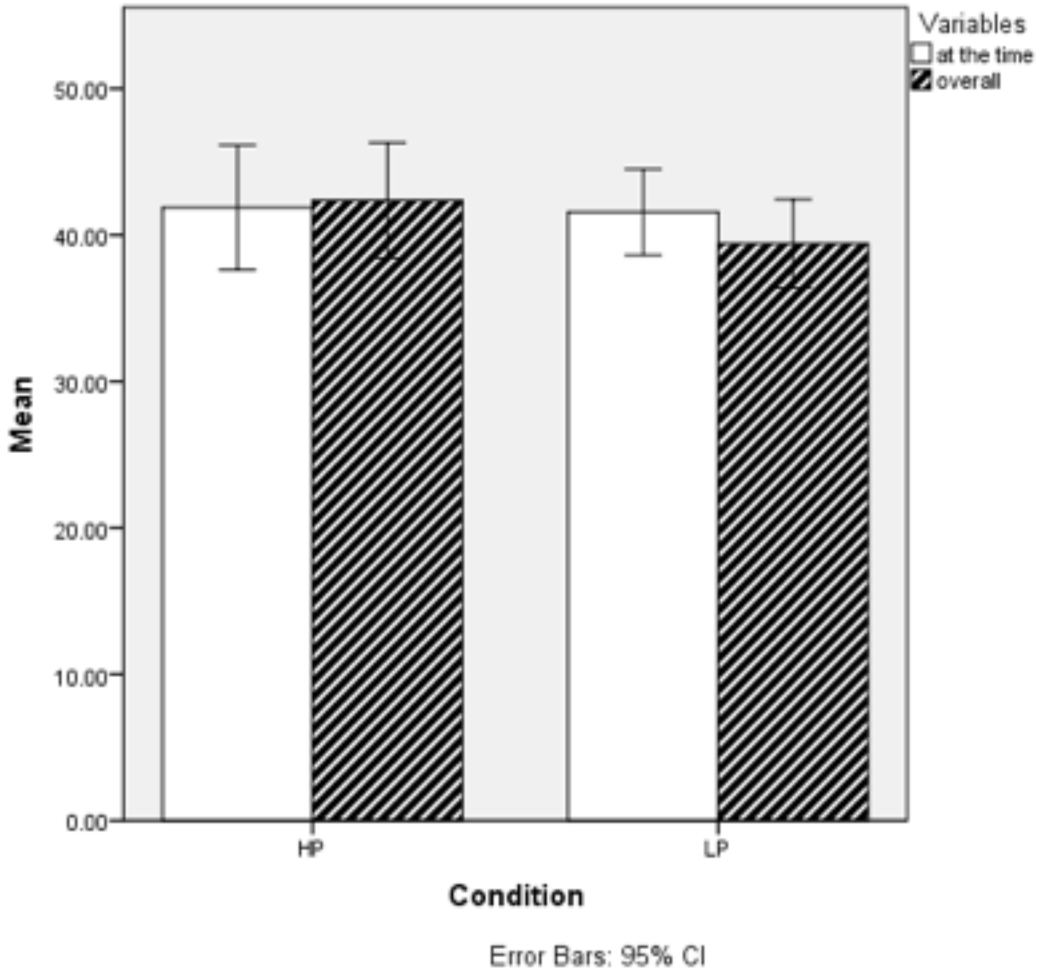


Figure 4b: Power posing and effect on state and trait anxiety of the participants (filter)



Even though the results for the mean difference between conditions for the State and the Trait responses were not statistically significant, we can still detect a change in anxiety level. The mean difference between the two conditions was lower in the state portion (*M*=.783*, SD*= 2.264) than the trait portion (*M*=1.843*, SD*= 2.168). The same type of difference was found when participants that cheated, did not follow the instructions, or ran out of time were excluded, the mean difference of the state portion (*M*=.642, *SD*=2.491) was lower than that of the trait portion

(*M*=2.758, *SD*= 2.433). Consequently, even though the difference was not significant, the data suggests that the stress level of participants in the high power condition increased less than that of the participants in the low power condition.

An independent T-Test was performed to examine the performance of the participants in each condition. Even though the high power pose was found to perform slightly better overall *M*= 22.89, *SD* = 5.436, compared to the low power group *M* = 21.96, *SD* = 4.242 the results were not statistically significant with *M* = .93, 95% CI [-1.12, 2.98], $t(87) = .902$, $p = .370$. After repeating the test having excluded 19 participants for having cheated, having gone over the time limit or for stating that they did not understand the instructions the results were still not statistically significant, with the high power group performing *M* = 23.7, *SD* = 5.114 and the low power group *M* = 21.49, *SD* = 5.370. The mean difference between the performance of the two groups was not statistically significant with *M* = 2.21, 95% CI [- .269, 4.698], $t(70) = 1.778$, *p*= . 080. Even though the results were not significant, a trend where the high power group performs better than the low power group is suggested by the data.

Figure 1a: Power Posing Condition and Performance

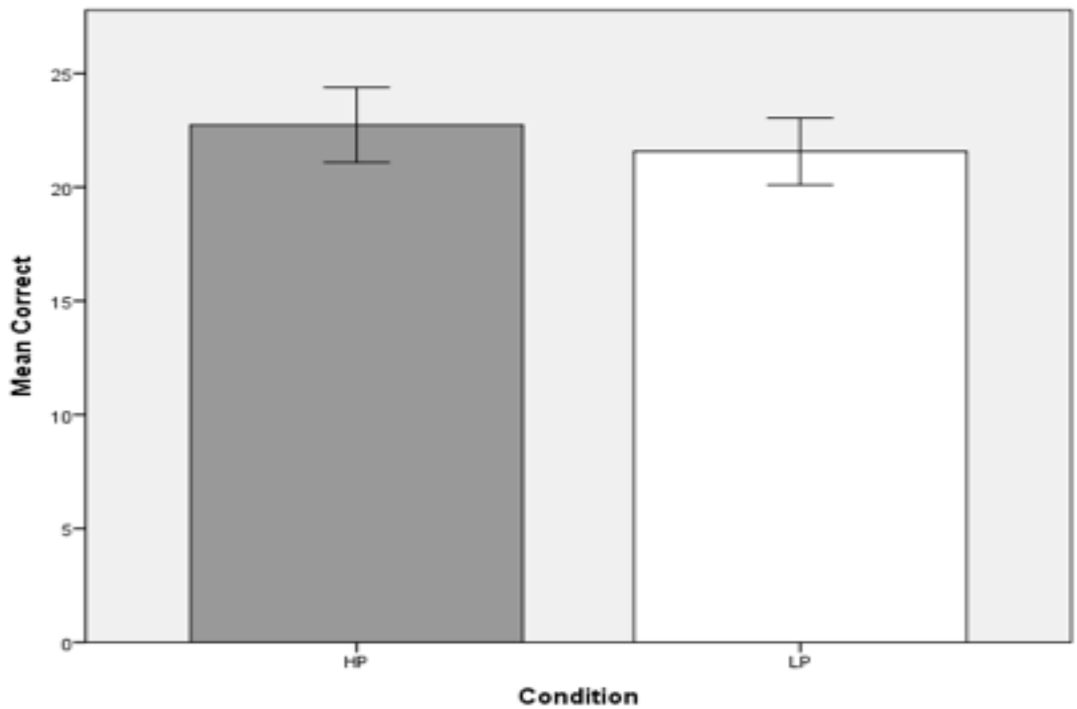
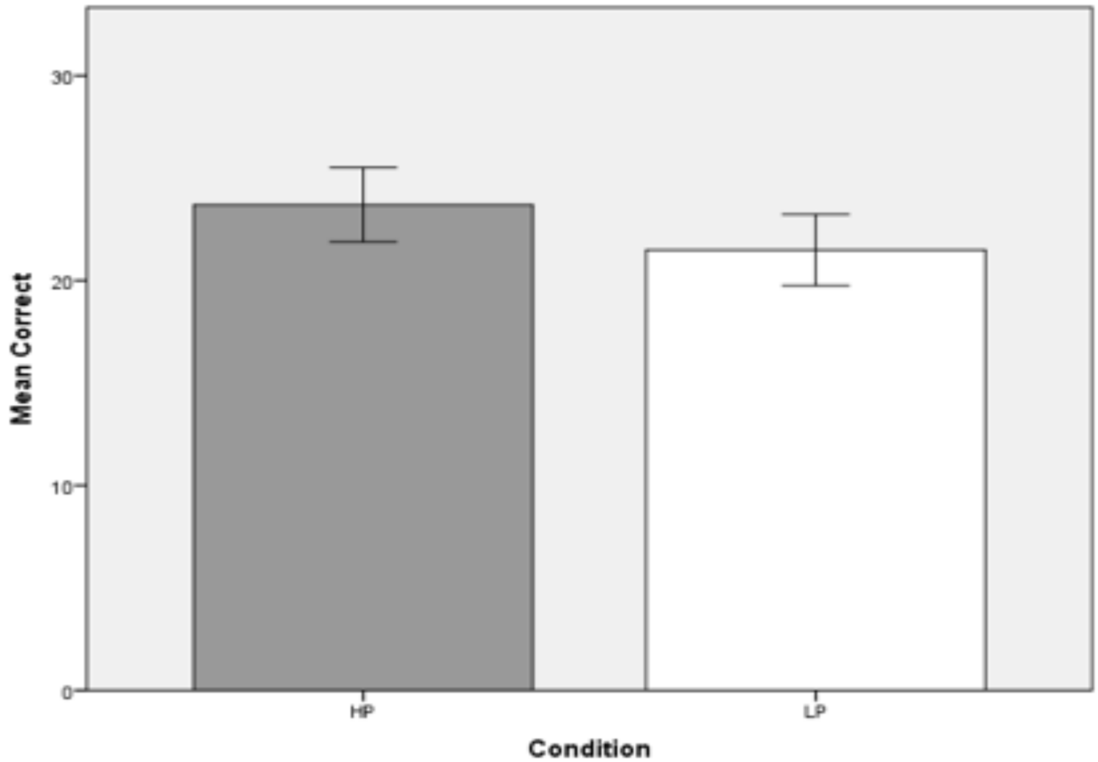


Figure 1b: Power posing and performance with filtered participants



A mixed analysis of variance (ANOVA) test examined the effect of the two power poses on high difficulty and low difficulty questions. There was no statistically significant interaction between the conditions and the level of difficulty of the questions. However, participants in the high power condition (*M = 15.31, SD* = 4.089) performed better than the low power condition (*M*= 14.39, *SD*= 3.673) on the high difficulty tasks. The same trend appeared for the low difficulty tasks, with the high power group (*M* = 6.49, *SD* = 1.561) performing slightly better than the low power group (*M* = 6.24, *SD* = 1.433). The interaction between difficulty and condition was not statistically significant, *F*= (1,89)= 1.174, *p*= .282, η^2= .013. After excluding the participants that cheated, went over time or did not understand the instructions from the analysis, the same trend was noticeable but the results were still not significant. The performance of the high power group (*M*= 15,85, *SD*= 3.858) was higher than the low power group (*M*= 14.29, *SD*= 3.986) on the high difficulty tasks. On the low difficulty tasks, again, the high power group (*M*= 6.88, *SD*=1.364) performed better than the low power group (*M* = 6.21, *SD* = 1.455). The results of the interaction between difficulty level and condition were again not statistically significant, $F(1,69) = 1.772$, $p = .181$, $\eta^2 = .25$.

Figure 2a: Power posing and effect on high & low difficulty questions

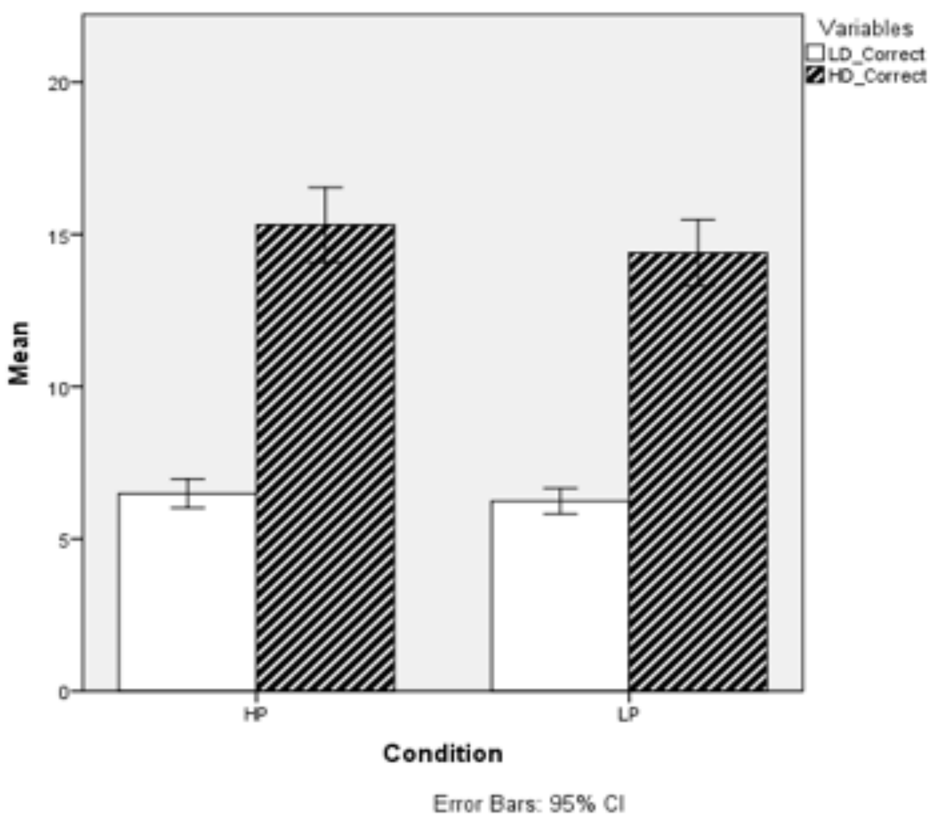
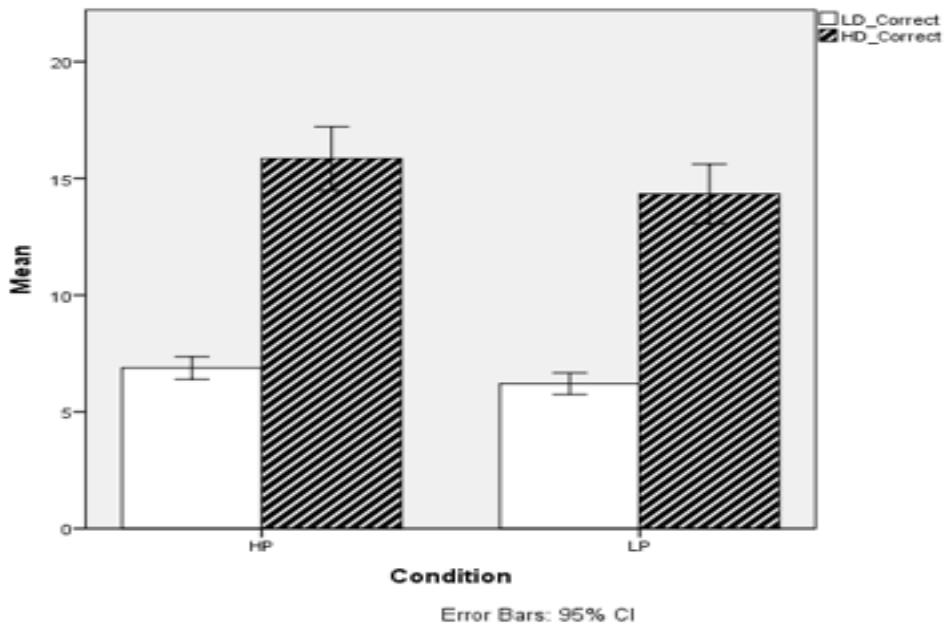


Figure 2b: Power posing & two levels of difficulty (with filter)



An independent T-Test was also used to examine the performance of the participants based on their gender. Even though the participants were not primed in terms of their gender before the mathematical task, I wanted to make sure that they did not experience the effects of stereotype threat and that their gender did not affect their performance. Male participants (*M*= 22.55) were found to perform better than female participants (*M*= 21.70). However, the mean difference between the two genders (*M*= .849) was not statistically significant, *M*= .849, 95% CI [-1.333, 3.031], *t*(89)= .773, *p*= .442. After excluding participants that cheated, ran out of time or did not understand the instructions, the difference between the means for males (*M*= 23.22, *SD*= 6.146) and females (*M*= 21.78, *SD*=4.343) was still not statistically significant, *M*= 1.444, 95% CI [-1.057, 3.946], *t*(70)= 1.15, *p*= .253. From this test we can conclude that even though males performed slightly better than females the effect was not statistically significant and thus cannot be considered to have affected the overall results of the performance of the participants.

Figure 3a: Gender & effect on performance

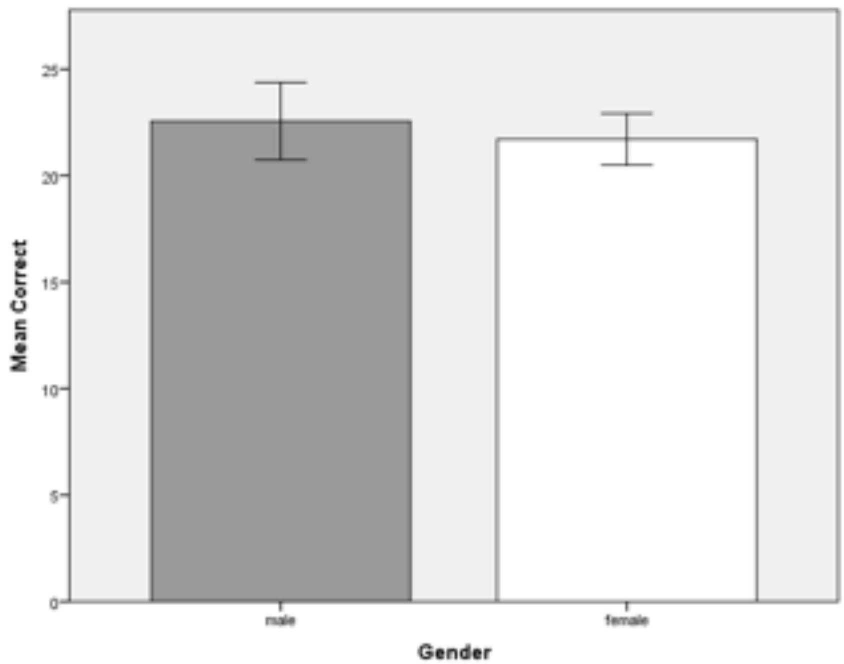
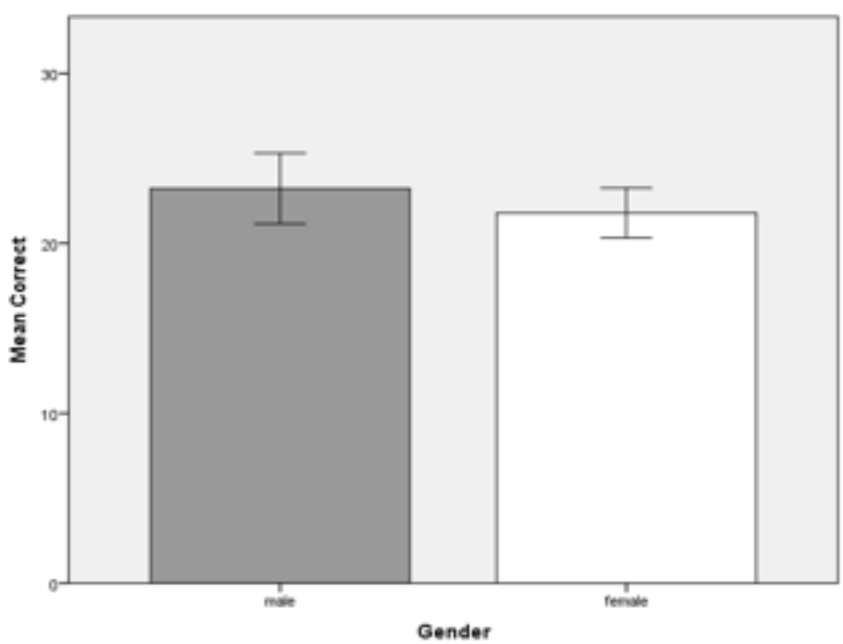


Figure 3b: Gender & effect on performance (with filter)



Chi-square tests were run to determine the effect power posing has on the participants' likelihood to cheat, run out time or ignore the instructions. In all three cases the results were not statistically significant. For cheating the results were $\chi(1) = .001$, $p = .982$, for running out of time they were $\chi(1) = .002$, $p = .967$, and for not following the instructions $\chi(1) = 1.975$, $p = .160$.

Discussion

Even though the findings of the current experiment were not statistically significant, the direction of the results can still give us an understanding of how power posing affects performance under pressure. The results were in line with the hypothesis; the participants in the high power condition performed better than the participants in the low power condition, and even though we have to accept the null hypothesis, that power posing before a high pressure task does not affect performance, the results of this experiment can serve to inform future studies.

After comparing the mean performance of the high power condition and the low power condition the results, even though they were not statistically significant, suggest that the direction of the difference of the means was similar to that stated in the hypothesis; the high power group performed slightly better than the low power group. This finding is supported by past research that has found that high power poses lead to higher overall performance during job interviews (Cuddy, Wilmuth & Carney, 2012). Even though the task was different, in both situations participants had to deal with elevated stress and perform in a high pressure environment. The lack of significant results in the case of this study may be the result of the limited time lapse between the power posing section of the study and the effect the power poses have on performance. When studying the effect power posing has on testosterone and cortisol, Carney, Cuddy & Yap measured the change in hormone levels approximately 17 minutes after the power-pose manipulation (2010). In the current study, however, in order to try to mitigate any external factors that could affect the results, the time between the power-posing and the modular arithmetic task was limited to the time it took for the experimenter to enter the room and give the participant instructions on the mathematic task, which was no more than 2-3 minutes. As a result, there might have not been enough time for the effects of power posing to manifest and for the hormone levels to change. In the future, it may be fruitful to look at performance on a high pressure task after allowing more time between the power pose and the task.

Past research has focused on the effect stress has on performance on high and low difficulty tasks, suggesting that high pressure overloads the executive cognitive functions, leading to worse performance (Beilock, Kulp, Holt & Carr, 2004). However, there are few, if any, studies looking directly at ways to mitigate the effects of stress on working memory and consequently improve performance under pressure. This study aimed to shed light on how we can reduce the negative effects stress has on performance in high-pressure situations. Even though the results were not statistically significant, they demonstrate a trend that suggests that high power posing can help improve performance.

Moreover, looking at the performance of the high power and low power conditions on the high and low difficulty tasks, the trend suggested by past research was noticeable (Beilock, Kulp, Holt & Carr, 2004). The difference between the means of the two conditions was greater for the high difficulty than for the low difficulty questions indicating that performance may have suffered more in the low power condition with the high difficulty questions when the problems were more working memory intensive. However, since there was no control condition, we cannot be certain of the direction of this difference. In future research, it could be helpful to modify this study design by adding a control condition to allow for a more accurate understanding of the direction of the effect power posing has in these situations.

Since past research has found that anxiety and stress caused by pressure significantly affects performance on tasks that require the use of working memory (Beilock, 2008), it was important to look at the changes in participant stress-levels in the two conditions right after the task, in comparison to their normal level. A state-trait anxiety inventory (STAI) was used to measure difference in stress level. The results of the STAI did not show any statistically significant results, showing no significant difference between the high power and the low power condition. Despite the lack of statistical significance, the difference in anxiety levels between the two conditions was larger in the state portion compared to that of the trait portion. This suggests that power posing may have affected the level of stress participants experienced during the high pressure task. Again, we cannot be certain of the direction of this effect, and it could thus be useful to include a control condition in future studies to better understand the effect power posing has on stress. Moreover, the lack of significant results may be due to the lack of enough time between the power posing and the high pressure task. It is possible that the effects power posing has on cortisol were not yet fully exhibited at the time thus leading to an insignificant effect on the participants' stress level. Repeating this study with a longer interval between the power posing and the high pressure task may lead to more significant results.

Due to findings of past studies that demonstrate the effect gender stereotype threat has on performance on mathematical tasks (Schmader & Johns, 2003), it was important to ensure that gender had no significant effect on performance. Even though the participants were not primed about their gender before the task, it was necessary to ensure that gender was not affecting their performance on the task as this could affect the overall results of the study. The difference between the mean performance levels of each gender was not statistically significant even though males performed slightly better than females overall.

None of the results of this study were statistically significant, and thus we cannot accept the hypothesis that high power posing reduced the effect of choking in high pressure situations, the hypothesis is still interesting to explore in the future. Being able to better understand how we can mitigate the effects that pressure has on performance on working memory intensive tasks can be beneficial both for individuals, as well as businesses. On the one hand, on an individual level, knowing and understanding how one can relieve stress and how that can affect performance can help in multiple situations. There are numerous standardized tests that determine the future of many students in the US and around the world. These high pressure tests are meant to accurately represent the abilities of the students, and demonstrate their knowledge and critical thinking. However, more often than not students rely on their working memory to solve these problems since a lot of times it is hard to practice enough in order to make the process of solving them automated. Thus, understanding the effect pressure has on performance and how one can mitigate these negative effects can be very beneficial for these students. Being able to overcome or reduce the negative effects that pressure creates in these situations can help make their performance more representative of their actual abilities. Especially since, according to Beilock, people who are expected to perform best (and would perform best in a no-pressure situation) have been found to suffer the most from the negative effects of pressure (2008).

Moreover, businesses can benefit from a better understanding of how to mitigate the effects of pressure and its effects on working memory intensive tasks. A lot of jobs that require high mathematical skills require that their applicants take the hard mathematical tests in order to better comprehend their abilities. However, these tests are taken under a lot of pressure as they could determine the applicant's future. Since they require the use of the central executive system, pressure may lead to misleading results that do not accurately represent the abilities of the applicants. Since, in this case, it is difficult to eliminate stress from a situation, it is important to find a way to mitigate its effects. Understanding how to reduce these negative effects can lead to more reliable results making the selection process more fair and effective. This is beneficial to both businesses and job-applicants since they will be able to more accurately select the participants that have higher executive cognitive functions. Moreover, understanding what leads to skill success and failure, and how out nonverbal behavior affects our performance can make businesses better equipped to interpret the applicants' and employees' performance as well as assist them in overcoming the negative effects pressure might have on it.

Understanding how power posing can help mitigate the effects of pressure and stress as well as improve performance can help expand to other, non-mathematical tasks. Pressure highly affects our cognitive abilities, which are necessary for a range of different tasks. Thus, investigating the effect power posing has on other high pressure, working memory intensive tasks could shed more light on ways we can improve performance.

This study can also help guide future studies. The lack of statistically significant results might be the results of flaws in the design of the study, further investigating these flaws and avoiding them in the future can lead to statistically significant findings that can contribute to our understanding of the effect that power posing has on performance on high pressure tasks.

Even though the design of the study was meant to control variables that might affect the results, there were several limitations that could have interfered with the findings. The video, the power posing part of the study, was approximately a minute long and even though the participants were actively engaged in the power pose it might have been too short for them to experience the full effects of power posing. Since this was the first time that participants were actively engaged in the power pose with both their bodies and minds, it was hard to determine the optimal length. This can be further investigated in future studies to determine what the optimal range of time is for the pose to be most effective., and if active power poses are more effective than static ones. Moreover, even though participants were following the instructions of another person, the power posing environment was not particularly social, which might have also affected the effect the power pose had on participants. In previous studies, when asked to hold a power pose the participants looked at a slideshow of faces placing them in a more social situation and thus making them feel powerful or powerless in relation to other people, possibly enhancing the effects of the pose The absence of a more social setting for the power pose may have mitigated the effects power posing had on participants. Better understanding the social component of power posing and recognizing what affects the effect it has on an individual can lead to a more accurate way of testing the effects of the power poses. Furthermore, the gender and appearance of the lady in the video may have affected the effect the power posing had on the participants. Even though she was carefully selected to avoid external factors affecting the results, we cannot be sure that her gender or her appearance did not affect the participants. It could thus be useful to experiment with the person in the video in future studies to determine whether the gender affects the way participants feel and respond to the video.

Moreover, pressure was an important aspect of the study, and it was thus necessary to ensure that the participants felt pressured while completing the mathematical task. The same experimenter ran all sessions, in order to ensure consistency in the way the high pressure situation was presented. However, the gender and appearance of the experimenter (young female), may have affected the way participants responded to the description of the high pressure situation. The pressure was meant to be both social and personal. On the one hand, the fact that their responses were being evaluated by one or more experimenters was meant to inflict social pressure. On the other hand, the monetary compensation for better performance created more personal pressure to perform well. The time constraint and setup of the task was meant to more closely emulate the real world situations that we are trying to address. Standardized test and other stressful-test taking situations in which there is a time limit and the test-takers are able to scroll or flip through the whole exam. In this way, I aimed to make this task a high pressure one and ensure that most participants, if not all, would feel sufficiently pressured to perform well. The high pressure situation, however, might have caused a stress overload causing participants to feel too intimidated by the task and the time limit leading them to not try at all. Despite trying to make the task a high pressure one, there might have been participants that were not engaged and did not care about their performance randomly selecting their responses. Even though the real life situations, such as standardized tests, that this task aimed to simulate have all the same components of pressure (social, personal, time), there is also more personal drive and incentive to perform well making people more engaged and dedicated to the test. The methods used to create a high pressure situation had been used in past studies indicating that they are effective in inducing stress; however, they were not used simultaneously. Thus, the effects of too much stress in this context is unknown.

The task used was meant to be foreign and unfamiliar to the participants to ensure that the process of solving the problems is not automated and outside the working memory functions. Modular mathematics has been used in previous studies looking at the causes of choking in a high pressure situation. Using the same task that Beilock used in her studies ensured that it would address the cognitive functions that were being investigated (2008). However, even though it was an unfamiliar task to most participants, the fact that it involved mathematics may have resulted in some participants experiencing the effects of stereotype threat. Using a working memory intensive task that is not mathematical could lead to interesting findings, and even though the effect of gender on performance was not statistically significant varying the type of task could produce interesting and enlightening results.

The lack of a control condition for this study was also a limitation in analyzing and understanding the results since even though a difference (even though it was insignificant) was detected, often it was hard to determine the direction of the effect since there was no baseline to compare it to. Recruiting more participants and including a control condition may help shed more light on the direction of the effect power posing has on performance under pressure.

There are many things to learn from this study. Even though it did not provide any statistically significant results, future researchers can learn from the possible flaws of the study. Understanding how to mitigate the effects pressure has on our performance can benefit everyone.

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Appendix

Power Posing Script

High Power Pose:

First, stand with your feet apart.

Now make sure that your shoulders are pulled back and down.

Lift your chin so that it's parallel to the ground

Then stretch your arms out to your sides and raise them up. You want your arms to be by your head but not straight up. Imagine that you are trying to spread further and further out and becoming bigger and bigger.

Your chest should be open and spreading out

Your legs are energized and set apart.

While keeping your shoulders down, imagine that you are continually rising upward and expanding.

Make your spine and neck as long as possible. Imagine that there is a string pulling you up toward the ceiling, making you longer.

While you are spreading out imagine that you are trying to fill the room, that you are trying to get noticed and seen.

Now resume your natural position

Low Power Pose:
First, stand with one leg crossed tightly over the other.

Raise your shoulders and curl them, pulling them to your chest

Lower your chin so that it is pointing toward the ground.

With one hand clutch your neck pressing your fingertips against the sides of your neck, wrap your other arm around your body with your hand reaching and clenching your side. Imagine you are squeezing your side tighter and tighter becoming smaller and smaller.

You should be tightening and collapsing inward

Your legs are tightly crossed together

While keeping your shoulders curled toward your chest, imagine that you are continually coiling in, and contracting

Make your back as hunched as possible. Imagine that there is a string wrapped around your body tightening and compressing you.

While you are curling inward, imagine that you are trying to take up as little space as possible, that you are trying to avoid being noticed or seen

Now you can resume your natural position