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Effects of Performance Pressure on Response Inhibition Performance

Daniel N. Endres
Clemson University, dendres65@gmail.com

EFFECTS OF PERFORMANCE PRESSURE ON RESPONSE INHIBITION PERFORMANCE

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Daniel N. Endres
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Dr. Kaileigh Byrne, Committee Chair
Dr. Leo Gugerty
Dr. Fred Switzer

ABSTRACT

Previous research suggests that psychological pressure tends to exert detrimental effects on action-oriented cognitive tasks. However, the effect of psychological pressure on inhibitory cognitive processes has been relatively overlooked. Consequently, the goal of this study was to examine the effect of psychological pressure on response inhibition performance. Participants (N = 125) were assigned to either a time pressure condition or control condition, and then completed the Stop Signal Task, which tests response inhibition. Outcome variables of interest were stop accuracy, stop signal reaction time, and post error slowing. The results from the study indicated that time pressure significantly impaired stop signal accuracy relative to the control condition. However, time pressure did not affect stop signal reaction time or post error slowing. This study conforms to the distraction theory of performance pressure. From this study, the observed effects detail what can be seen from this type of pressure. With this information, studies can be conducted on other types of performance pressure to expand the knowledge of those effects.

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CHAPTER ONE

INTRODUCTION

Consider a situation in which a person is driving down a road and is approaching a traffic signal. As the person approaches the light, he has a green light, and he thinks he is clear to continue through. However, suddenly at the last second the light changes from green to yellow. To avoid running a red light, the person must quickly slam on the brakes. In the beginning of this scenario, the person has the intent to continue moving or even accelerate, and then under a tight time constraint, must resist his initial action of continuing through the intersection. When in these situations, it can be difficult to restrain oneself from completing that action. This is the premise that underlies response inhibition—the tendency to voluntarily inhibit a prepotent or ongoing motor response (Logan & Cowan, 1984). What if important decisions like these need to be accomplished in just a few seconds? Do people rise to the occasion and flawlessly respond, or do they make hasty decisions as quickly as they can? This study seeks to address these questions by examining the role of time pressure on response inhibition performance.

Response inhibition comes from the idea of two control signals in the brain competing for completion: an action-execution “Go” response and a “NoGo” suppression signal. In particular, if there is an external stop signal or error in performance, then a stopping signal starts in the brain and competes with an already existing action process. If the stop signal wins, then the action is inhibited. In contrast, if the ongoing signal wins, then the action is carried out (Logan & Cowan, 1984). Response inhibition affects two main aspects of performance: response reaction times and response accuracy (Logan

& Cowen, 1984). One measure of response inhibition that can affect these two metrics is a Stop Signal task in which individuals respond with a key press to a Go cue but need to inhibit that response if a Stop cue appears. Thus, this task setup mingles trials that require the participant to respond as directed (Go cues) and trials that ask the participant to not respond as directed (Stop cues), but the signal to not respond is given only after a certain amount of time has passed (Logan & Cowen, 1984). For example, assume the same situation as before while driving a car and approaching a traffic light. The only difference is that this time the person would be having the anticipation that the light will change to yellow as he approaches it. Sometimes, the person will simply continue through the intersection without needing to brake, and sometimes he will need to brake. Each time the person approaches an intersection with the knowledge that the light might change, and all of their responses become affected by the anticipation of this 'stop' response. Response inhibition also affects post-error slowing, or the difference in reaction times between post-error trials and post-correct trials (Li et al., 2008). This measurement is the amount of time that people delay their responses following an error on either a go trial or a stop trial.

In this study, we will specifically be assessing stop signal reaction time and response accuracy. Reaction times in stop signal trials tend to decrease as the response delay increases (Logan, Cowan, & Davis, 1984). In terms of stop signal accuracy, as the stop signal delay increases, inhibitory accuracy decreases (Logan & Cowan, 1984). This trend may be attributed to 'Go' responses coming before the stop signal is displayed, or the Go response motor command is initiated before the Stop Signal is recognized. Either of these could result in an incorrect response. The decrease in reaction times for stop signal trials could lead to inaccuracy given that longer inhibitory delays make it more difficult to overcome an activated, prepotent Go response.

Now imagine having to complete a task like the aforementioned driving scenario with an added time pressure component. Performance pressure instills a strain on an individual in order to generate a sense of urgency and importance (Baumeister, 1984). Performance pressure can take the form of anxiety, competition, self or external evaluation, or even time constraint (Beilock & Carr, 2001; Byrne, Silasi-Mansat, & Worthy, 2015; DeCaro et al., 2011; Gray et al., 2011). Performance pressure that causes people to perform worse on a task than they normally would at their level of skill or expert is known as "choking under pressure" (Beilock & Carr, 2001; DeCaro et al., 2011). One primary account for this phenomenon is distraction theory, which purports that psychological pressure can change something as simple as a single task situation into a dual task situation (Beilock & Carr, 2001; Wine, 1971). The pressure distracts attentional resources away from the task at hand and is allocated to various task-irrelevant information, such as worrying about completing a task within a specified deadline (Wine, 1971). In the context of response inhibition, individuals who are preoccupied by the pressure component of an action-inhibition may be more likely to have reduced cognitive resources available to inhibit their response. Pressure may therefore increase cognitive load and consume task-related focus, leading to decrements in performance, or "choking" relative to pressure-free situations.

Indeed, previous work suggests that performance pressure detrimentally affects such cognitive processes as mathematical problem solving, (Beilock & Carr, 2005), working memory (Beilock & Carr, 2006), long-term memory (Kornell & Metcalfe, 2006), attention (Baumeister, 1984; Gray, 2011), and decision-making (Zur & Breznitz, 1981). Under time pressure, in particular, individuals tend to lock into a strategy and fail to look for an alternative solution (Edland, & Svenson, 1993). If we extend this finding to response inhibition, then it is reasonable to predict that individuals may rush to respond knowing that there is time limit. Even on stop signal trials, individuals may respond before knowing they should stop. In this case, we may expect a decrease in accuracy under time pressure conditions; the time pressure could lead individuals to give a response, rather than wait for an alternative solution to see if inhibiting would be the correct response.

Fast and frugal heuristics exemplify this strategy. These heuristics are simple, task-specific strategies that are easy to execute that involve little information search or thinking (Gigerenzer & Todd, 1999; Reimer & Rieskamp, 2007). Fast and frugal heuristics can support this claim because sticking to a preset strategy, such as "always respond as quickly as possible", requires no additional information seeking or consideration. This heuristic may be particularly relevant when individuals are under high cognitive load. As distraction theory proposes, pressure may lead to a dual-task situation, which may then increase the likelihood of relying on such simple low-load heuristics. In the end, performance may decrease when time pressure is present. If people tend to lock into a strategy or response, they may stick with the first things they see and give a response while seeing the go signal, even though there is a stop signal yet to come.

Despite research on pressure and cognitive performance on tasks such as memory and decision-making, minimal previous work has specifically examined how performance pressure influences response inhibition. Inhibitory cognitive processes are distinct behaviorally and neurally compared to previous cognitive processes that have been examined under performance pressure, and therefore, it is unclear whether prior performance pressure findings can be applied to response inhibition. To our knowledge, only one previous study has investigated this relationship, but focused on comparing performance between a small sample ($N = 9$) of violent, incarcerated male offenders to male non-offenders ($N = 9$; Chen et al., 2008). The primary result from this study was that the violent offenders only showed impaired response inhibition compared to non-offenders under time pressure, but not under standard conditions. This study did not report the statistical differences in performance between the standard and time pressure conditions for the non-offender sample. However, visual inspection of the raw results appears to show a trend in which the non-offenders show reduced stop signal reaction times under pressure, indicating improved inhibitory control. While this study has substantial limitations that curtail strong conclusions to be drawn, this trend seems at-odds with prior work on performance pressure and cognitive performance and highlights the need to empirically investigate the effect of performance pressure on inhibitory control.

Additionally, it is important to note that this study is specifically investigating the effects of performance pressure, rather than stress, on response inhibition. While performance pressure occurs when extraneous variables psychologically create a sense of urgency and anxiety (Baumeister, 1984; Beilock & Carr, 2001), stress is regulated by glucocorticoid hormones that activate multiple receptors in the brain (Schwabe, Höffken, Tegenthoff, & Wolf, 2013). Thus, performance pressure reflects how people react and *perform* in the presence of these extraneous variables, but stress is more focused on the biological changes that occur in the person, rather than the output of that person. Consequently, performance pressure and stress are distinct constructs; one can feel performance pressure and not stress and vice versa. This study aims to determine how performance pressure, in the form of time pressure, affects response inhibition performance.

Based on previous research, there is reason to expect that response inhibition reaction time and accuracy may be affected by time pressure. In terms of reaction time, as the stop signal delay decreases, reaction times increase (Logan, Cowan, & Davis, 1984), and therefore it is expected that time pressure will also cause [or lead to] an increase in stop signal reaction times and post-error slowing, indicating poorer inhibitory control. In terms of response accuracy, prior research shows that people tend to have a decrease in accuracy on cognitive tasks, such as memory, attention, and decision-making, as time pressure is applied (Gigerenzer & Todd, 1999; Edland, & Svenson, 1993; Reimer & Rieskamp, 2007). Thus, it is expected, again, to show a decrease in accuracy under time pressure conditions compared to low-pressure conditions.

CHAPTER TWO

METHOD

Participants

The sample consisted of 148 undergraduate participants (103 females, M_{age} = 18.56, SD_{age} = 1.10), who completed the experiment for partial fulfillment of an introductory psychology course requirement. The study was approved by the Institutional Review Board at Clemson University (IRB Approval Number 2017-297) before procedures were implemented. However, after excluding participants for outliers (described in the Data Analysis section below), the final sample was comprised of 125 participants (86 females, M_{age} = 18.55, SD_{age} = 1.16). Participants were randomly assigned to either the low (N = 58; 37 females) or high (N = 67; 49 females) time pressure condition.

Materials and Design

Design. This study entailed a between-subjects design with a low-pressure group who only complete the stop signal task and a high-pressure group who complete the stop signal task under a time pressure manipulation. This design was chosen over a within-subjects design to eliminate possible confounds from practice effects or fatigue effects between conditions.

Independent Variables. The main independent variable was performance pressure. There were two levels within this condition: low-performance pressure (control) and high-performance pressure. The second independent variable was separating the trials into blocks. The 250 trials were divided into five equal blocks of 50 trials each.

Dependent Variables. The first dependent variable was Stop Signal Reaction Times (SSRT). To compute SSRT, the integration approach will be employed (Verbruggen & Logan, 2009). In this approach, the go trial reaction times are rank ordered from fastest times to slowest times. Then the average of incorrect stop trials, or errors, is taken and multiplied by the number of go trials. This gives a rank in terms of go trial RTs. This number corresponds to a go trial RT and is considered the ranked RT. This number is then subtracted from the average delay of stop trials, i.e. the time it takes for a stop trial's arrow to turn red. This SSRT measure provides an estimated duration of the time that it takes to inhibit this response, such that longer SSRTs are indicative of poorer response inhibition. The next two dependent variables were average go trial accuracy and average stop signal trial accuracy. Accuracy was determined by the average proportion of trials with correct response (i.e., no response in the stop signal trials). For example, if a participant did not respond in 40 out of 50 stop signal trials, the participant's accuracy score would be 80%. Lower stop trial accuracy is indicative of poorer response inhibition.

Finally, the last dependent variable was post-error slowing, calculated as the difference in response time between post-error (both omission and commission errors) trials and post-correct trials. Specifically, the average post-correct RTs) was subtracted from average error RTs. For some participants, there may be missing values for post-error blocks because the participant did not make an error during that block. In order to account for these missing values and not omit these participants from analysis, we imputed a block's missing values with the average reaction time across the participant's other blocks. For example, if a participant had a missing value for Block 2, a value was imputed as the average of their post-error reaction time from Blocks 1, 3, 4, and 5 for a best guess estimate of ability.

Stop Signal Task. This paradigm allows for testing individual differences in the ability to voluntarily inhibit a prepotent or ongoing motor response (Logan & Cowan, 1984). Participants performed a standard stop signal task in which a green left or right arrow was presented (Logan, Schachar, & Tannock, 1997). On go trials, participants were instructed to respond as quickly as possible, while keeping in mind that a red arrow may appear occasionally, by pressing the left arrow key when the arrow was facing leftward and the right arrow key when the arrow faced rightward. If the arrow turned red after the original arrow was presented, then they should have inhibited their response on that trial. The stop trials were set up where the stop signal was first presented at 350 ms after the green arrow and then adjusted using a staircase procedure by ±25 ms corresponding to correct and incorrect inhibitions (Levitt, 1971). In other words, if the participant incorrectly inhibited their response on the first stop trial, the delay stepped from a 350 ms delay to 325 ms. If they then failed to inhibit their response on the next stop trial, the delay stepped from 350 ms to 375 ms. The minimum delay was 50ms, and the maximum delay was 650ms. The goal of this staircase procedure was to have each participant respond correctly to stop trials about 50% of the time. The inter-trial interval (ITI) varied between 1200ms, 1500ms, or 1800ms (randomly varied) after the end of the previous trial and showed a white fixation cross. When participants incorrectly responded on a stop trial, they received feedback stating “incorrect”. Participants completed 200 trials (150 go trials and 50 stop trials).

Time Pressure Manipulation. The pressure that was imposed for individuals in the high pressure condition was in the form of a time pressure. The time pressure that was used was 800 ms per trial, which was calculated by taking the average reaction times from a preexisting data set of reaction times on a similar task and adding that to the average stop signal delay. In order to create a time pressure, there was a progress bar on the screen that showed how much time participants had left. This was used instead of numbers to represent the time as to not distract the participants with fast moving numbers. If participants did not respond within the time limit on a given trial, they received feedback stating, “Time’s Up!”.

Post-Task Questions. Post-Task manipulation check items were (1) “How much pressure did you feel during the task?”, (2) “How difficult did you feel this task was?”, and (3) “How important did you feel it was for you to perform well on the task?”. Participants responded on a 7-point Likert scale from 1 (Not at all) to 7 (Extremely).

Procedure

All participants completed the study on using PsychoPy2 (version 1.83) for Python (Peirce, 2007). There were 20 practice trials to acclimate participants to the task. Once the practice was completed, they began the task, either high or low pressure, for 250 trials. Each trial began with a fixation cross followed by a green arrow that faced either left or right. Participants were instructed that their performance will be based on how quickly and accurately they respond. On go trials, the trial only ended if the participant indicated a direction in the low pressure condition or if time ran out in the high pressure condition. On stop trials, after a designated time had passed based on the staircase procedure, the arrow changed from green to red. Examples of these can be seen below in Figure A-1. The stop trials ended if the participant responded or if the time ran out. After participants completed this inhibitory control task, they answered the three post-task questions. At the end of the session, the participant was debriefed on the study.

Data Analysis

For each of the outcome measures in this study, stop signal reaction time (SSRT), stop trial accuracy, and post-error slowing, separate 2 (Time Pressure Condition: Low vs. High Pressure) X 5 (50-Trial Block) Mixed ANOVAs were performed. Time Pressure Condition was specified as the between-subjects variables, and Trial Block was included as the within-subjects variables. In line with previous work (Congdon et al., 2012), the data were screened for outliers based on two exclusion criteria First, participants were excluded for go trial non-response rates of 20% or greater. Secondly, participants' data that were more than two standard deviations from the mean of reaction time and/or accuracy rates were defined as outliers and were excluded.

Before running the analyses, a Shapiro Wilk test was performed for each of the measures to check for normality of the data. The results showed significance for SSRT ($p < .05$), stop trial accuracy ($p < .001$), post-error slowing ($p<.001$) and go trial accuracy ($p < .001$), which suggests that outcome measures were not normally distributed. Therefore, we conducted a log transformation on the data to normalize it and used these log transformed outcome measures in subsequent statistical analyses. All data are available on the Open Science Framework (https://osf.io/hty9d/).

CHAPTER THREE

RESULTS

Stop Signal Accuracy

A 2 (Time Pressure Condition: Low vs. High) X 5 (50-Trial Block) ANOVA was performed to examine average stop trial accuracy. Mauchly's Test of Sphericity for variance equality was significant ($X^2(9) = 55.32$, $p < .001$), so a Greenhouse-Geisser correction was used. A main effect of Time Pressure Condition was observed, $F(1, 123) = 131.78$, $p < .001$, $\eta_p^2 = .53$, such that those in the Time Pressure Condition ($M = -.36$, $SD = .09$) had significantly lower accuracy scores and thus committed more errors than those in the Control Condition ($M = -.17$, $SD = .14$). Moreover, a main effect of Trial Block emerged, $F(4, 492) = 2.77$, $p < .05$, $\eta_p^2 = .02$. Follow-up post-hoc tests revealed differences between Block 1 and Block 3, Block 1 and Block 4, and Block 1 and Block 5 (ps < .05). Overall, participants showed significant improvements in accuracy in these latter blocks (3, 4, and 5) compared to accuracy scores in the f block of trials. The ANOVA also revealed a significant Condition X Trial Block interaction, $F(4, 492) = 3.61$, $p < .05$, $\eta_p^2 = .03$. Pairwise comparison indicated that performance differed between Block 1 and Block 5 ($p < .05$), such that those in the Time Pressure Condition were less accurate than those in the Control Condition in these particular blocks. The raw data results are shown in Figure B-1.

Stop Signal Reaction Time

Similar to the analysis for stop trial accuracy, a 2 (Time Pressure Condition: Low vs. High) X 5 (50-Trial Block) ANOVA was conducted to examine average SSRT. Because the Mauchly's Test of Sphericity was significant ($X^2(9) = 17.12$, $p < .05$), a Greenhouse-Geisser correction was used. A main effect of Time Pressure Condition was not observed, $F(1, 123) = .00$, $p > .10$, $\eta_p^2 = .00$, such that those in the Time Pressure Condition ($M = 2.32$, $SD = .09$) reported similar stop signal reaction times as those in the Control Condition ($M = 2.32$, $SD = .10$). Additionally, no main effect of Trial Block emerged, $F(4, 492) = 1.30$, $p > .10$, $\eta_p^2 = .01$, and no significant Time Pressure Condition X Trial Block interaction was found, $F(4, 492) = 1.32$, $p > .10$, $\eta_p^2 = .01$. The raw data results are shown in Figure B-2.

Post-Error Slowing

The results of the mixed ANOVA for average post-error slowing was performed. The Mauchly's Test for Sphericity was significant ($X^2(9) = 24.70$, $p < .01$), and thus a Greenhouse-Geisser correction was utilized. While no significant main effect of Time Pressure Condition was observed ($F(1, 123) = 2.61$, $p > .10$, $\eta_p^2 = .02$), a main effect of Trial Block emerged, $F(4, 492) = 3.56$, $p < .01$, $\eta_p^2 = .03$. Follow-up tests indicated a significant difference in post-error slowing between Blocks 1 and 3($p < .001$) and Blocks 1 and 4 ($p < .01$) such that individuals had greater post-error slowing in the latter trial blocks relative to the first block. There was also no significant Time Pressure Condition X Trial Block interaction, $F(4, 492) = 0.88$, $p = .48$, $\eta_p^2 = .01$. The raw data results are shown in Figure B-3.

Manipulation Checks

Go Trial Accuracy. A 2 (Time Pressure Condition: Low vs. High) X 5 (50-Trial Block) ANOVA was conducted to examine go trial accuracy. Mauchly's Test for Sphericity was significant ($X^2(9) = 214.94$, $p < .001$), so a Greenhouse-Geisser correction was used. A main effect of Time Pressure Condition was observed, $F(1, 123) = 12.79$, $p < .001$, $\eta_p^2 = .09$, such that those in the Time Pressure Condition ($M = -.01$, $SD = .00$) committed significantly more go errors than those in the Control Condition ($M = -.01$, $SD = .00$). However, neither a main effect of Trial Block ($F(4, 492) = .26$, $p > .10$, $\eta_p^2 = .00$) nor a Time Pressure Condition X Trial Block interaction was observed, $F(4, 492) = 1.28$, $p > .10$, $\eta_p^2 = .01$. The raw data results are shown in Figure B-4.

Go Trial Reaction Times. Additionally, to determine whether individuals in the high time pressure condition responded faster during the task than the control condition, we conducted a 2 (Time Pressure Condition: Low vs. High) X 5 (50-Trial Block) ANOVA for average go trial reaction times. Mauchly's Test for Sphericity was significant ($X^2(9) = 174.00$, $p < .001$) so a Greenhouse-Geisser correction was used. The results revealed a significant main effect of Time Pressure Condition, $F(1, 123) = 66.30$, $p < .001$, $\eta_p^2 = .35$, such that those in the Time Pressure Condition ($M = 2.70$, $SD = .07$) had significantly faster go reaction times than those in the Control Condition ($M = 2.80$, $SD = .06$). Additionally, a main effect of Trial Block emerged, $F(4, 492) = 27.06$, $p < .001$, $\eta_p^2 = .18$. Pairwise comparison indicated that performance differed between Block 1 and Block 2, Block 1 and Block 3, Block 1 and Block 4, Block 1 and Block 5, and Block 2 and Block 4 ($ps < .001$). There were also differences between Block 2 Block 3 and

Block 2 and Block 5 (*ps* $< .01$). As blocks continued, reaction times became significantly slower for both groups until Block 3 and then there were no significant changes. No significant Condition X Trial Block interaction was found, $F(4, 492) = 1.04$, $p > .10$, $\eta_p^2 = .01$. The raw data results are shown in Figure B-5.

Post Task Questions

In addition to go trial responses, independent samples t-tests were performed for each of the three post task questions. We note that several of the initial participants did not complete these questionnaires due to experimenter error. Question 2 ("How difficult did you feel this task was?") showed a significant difference between groups, ($t(84) = 2.53$, $p < .05$) showing that those in the Time Pressure Condition ($M = 3.89$, $SD = 1.35$) felt the task was significantly more difficult than those in the Control Condition ($M = 3.15$, $SD = 1.37$). However, there were no significant group differences observed for Question 1 ("How much pressure did you feel during the task?"), $t(84) = 2.01$, $p > .10$, or Question 3 ("How important did you feel it was for you to perform well on the task?"), $t(84) = 1.51$, $p > .10$.

CHAPTER FOUR

DISCUSSION

This study sought to investigate the relationship between performance pressure and response inhibition. Consistent with the original hypothesis, the primary results demonstrate that performance pressure impairs response inhibition accuracy. Those in the time pressure condition made more errors of commission than those in the control condition. Moreover, performance pressure led to increased errors of omission on go trials as well. However, in contrast to the original hypothesis, the results did not provide evidence that time pressure decreases stop signal reaction time and post-error slowing. The reason stop signal reaction times and post-error slowing were not affected by time pressure could be due to a possible floor effect. Since response inhibition performance for the time pressure condition is already low, it could have been lowered by the addition of the time pressure. It is not unreasonable to see accuracy affected by time pressure and not stop signal reaction times or post error-slowing. Since the two behaviors are different mechanisms it is possible that the action of correctly responding could be affected but not how fast a response is required. These findings suggest that that time pressure detrimentally impacts accuracy in both action-oriented and inhibitory cognitive tasks.

In addition to inhibitory control, the results revealed that those in the control condition responded slower on go trials than those in the time pressure condition. Furthermore, the control group made significantly more errors in the first block of fifty trials, but error rates declined over time. This finding suggests that, in the absence of time pressure, individuals adaptively adjust their behavior to account for possible upcoming stop signals. Responding slower on go trials may indicate an anticipation period in preparing for a stop signal to appear. This preparation may allow individuals to correctly inhibit their response more often. This behavior may serve to maximize accuracy at the expense of slower responding, which provides evidence of a speed-accuracy tradeoff in the control condition. In contrast, under pressure individuals took significantly less time and consistently made the same percentage of errors throughout the blocks. As a result, this speed-accuracy tradeoff appears to be absent under time pressure. The results also showed an effect in which both groups' performance was characterized by more post-error slowing in the later trial blocks of the task. This effect may be indicative of learning happening over time. Participants seem to be more cautious as time progresses, as indicated by an increase in post-error slowing.

The negative effects of time pressure on action initiation (i.e., go trial) and inhibitory (i.e., stop trial) accuracy are consistent with distraction theory. As previous work has demonstrated (Beilock & Carr, 2001; Byrne, Silasi-Mansat, & Worthy, 2015; DeCaro et al., 2011; Gray et al., 2011), time pressure distracts cognitive resources away from attention-demanding tasks. This work has been limited to tasks that require action-initiation though. The findings from this study show evidence of time pressure impairing action initiation via decreased go trial accuracy. Critically, however, the study results are among the first to demonstrate that performance pressure may distract cognitive away from tasks that require action *inhibition*, resulting in increased error rates. This study collectively supports the hypothesis that time pressure can cause "choking under pressure" effect on inhibitory control.

The pressure condition may be locking into a set strategy and not adapting over time as the control condition did. Mentioned before, a possible strategy to accomplish this task could be to answer as quickly as possible with no regard for how accurate participants need to be. This specific strategy could explain the results that were found in this paper, but without asking participants the strategies employed, it is difficult to say whether this is true.

Consider the study results in the context of the example with an intersection. Knowing that this time pressure as someone approaches an intersection increases the chances of committing an error, how can someone avoid such an impairment? The easiest step would be to avoid the situation of a decision altogether and hovering your foot over the brake while approaching the light. Another way to improve performance in this situation would be to extend the amount of time in which a decision needs to be made. In Gugerty et al. (2014), there is evidence that a decision can be avoided by giving drivers a warning that a green light is ending and soon the driver will need to stop. When a warning was given, deceleration started sooner than when there was no warning. If a design were implemented to prepare someone for the possible conflict of making a time constrained decision, it is reasonable to think that issues will occur by both avoiding the problem as well as reducing the impairment brought on by the effect of a time pressure.

Limitations

One limitation of the study is the smaller sample used in the post-task questionnaire compared to the main analyses. The reason for the lower sample is due to experimenter error during the beginning of the study in which the experimenters neglected to give participants the questionnaire. While this did decrease the sample size considerably, because this was only a manipulation check we believe the questionnaire served its purpose in identifying if our manipulation was strong enough. Additionally, there was a lack of a definition of the term “pressure” for participants in the post-task questions. This could explain why no differences were found for Question 1 (“How much pressure did you feel during the task”?). Another limitation was that our study was strictly limited to time pressure. This effect cannot be generalized to other types of psychological pressure but could inform other types of pressure to examine.

Future Directions

While this study provides support for distraction theory influencing response inhibition accuracy, it is unclear whether other types of pressure, such as explicit monitoring, also influence inhibitory control. The explicit monitoring theory of performance pressure suggests that the reason decrements in performance occur under pressure is because individuals are beginning to self-focus. In these high-pressure situations, attention is heightened to the step by step procedures in one’s skills (Baumeister, 1984; Beilock & Carr, 2001). Future work should be aimed at examining how performance pressure through explicit monitoring manipulations influences inhibitory control.

In addition to explicit monitoring, pressure may increase the physiological arousal. The Yerkes-Dodson Law states that in a difficult task performance levels follow a normal curve as arousal rates increase (Teigen, 1994). This normal curve, or inverted U-shaped relationship between arousal and performance pressure, suggests that at low levels of arousal, such as lethargic or boredom states, performance on a given cognitive task is impaired. In contrast, at very high levels of arousal, which may occur due to performance pressure or acute stress, cognitive performance declines. However, at the peak of the curve when arousal levels are mild or moderate, cognitive performance is optimized (Teigen, 1994). Future work should be aimed at examining arousal while participants are performing a response inhibition task under pressure to determine how arousal influences the relationship between performance pressure and inhibitory control.

Conclusion

The results of this study support the phenomenon in which individuals "choke under pressure" on both cognitive tasks that entail action initiation and action inhibition. The experimental evidence demonstrates that time pressure leads to an increase in errors of both omission and commission. To avoid performance detriments induced by time pressure, it is important to design around the possibility of performing or inhibiting an action under a time constraint. It is possible that impairments can arise from other pressures and once they are explored, designs may address what types of pressures need to be minimized in order to optimize performance. This exploratory study breaks new ground into the effects that time pressure has on response inhibition. Considering no other study has looked at this effect, this study has importance by paving the way for furthering the literature on the topic. As mentioned before, next steps should include exploring other types of psychological pressures, as well as the other theory of performance pressure. Hopefully this study guides the way in doing so.

APPENDICES

Appendix A

Images of Study Materials

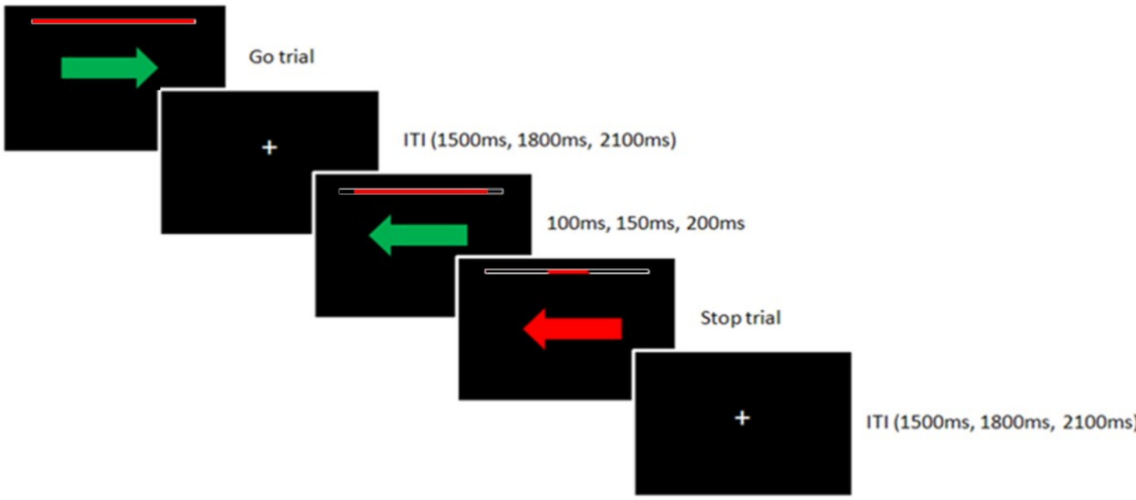

Figure A-1: Sample of a stop trial in the time pressure condition of the Stop Signal Task.

Appendix B

Collection of Results' Graphs

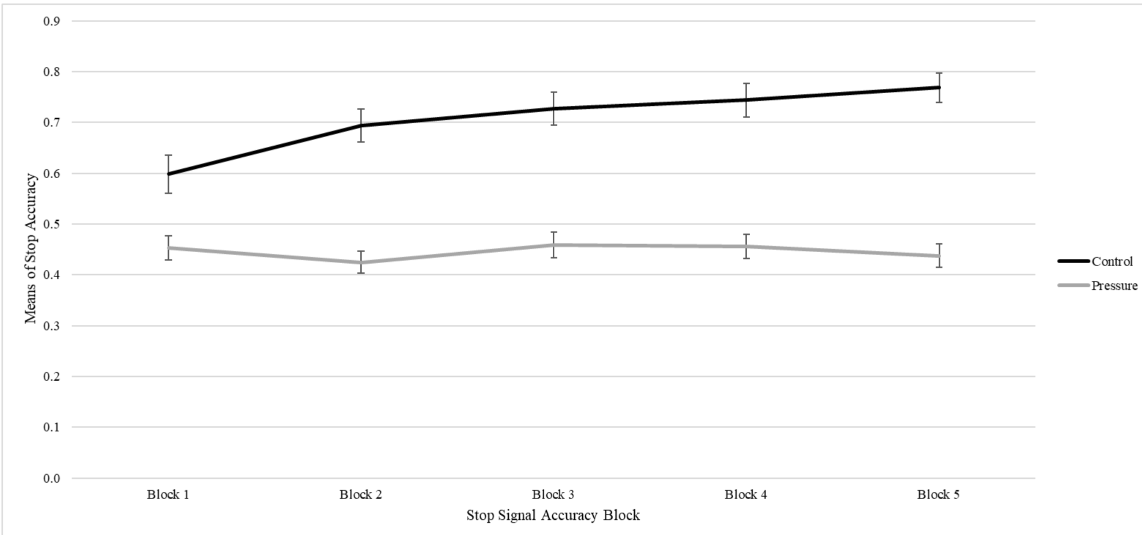

Figure B-1: Estimated marginal means for the effect of Time Pressure on Stop Signal Accuracy by Block.

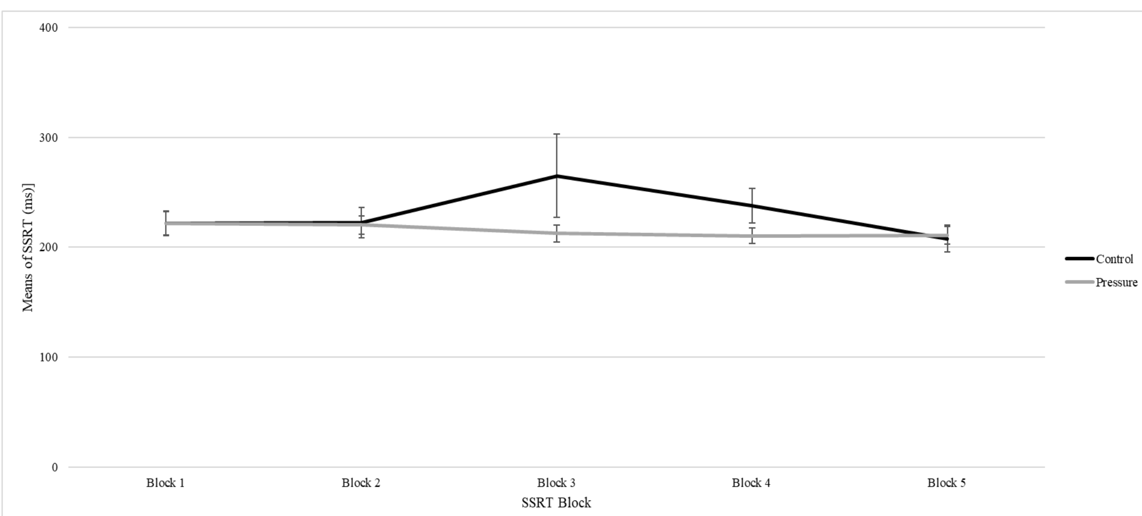

Figure B-2: Estimated marginal means for the effect of Time Pressure on Stop Signal Reaction Time by Block.

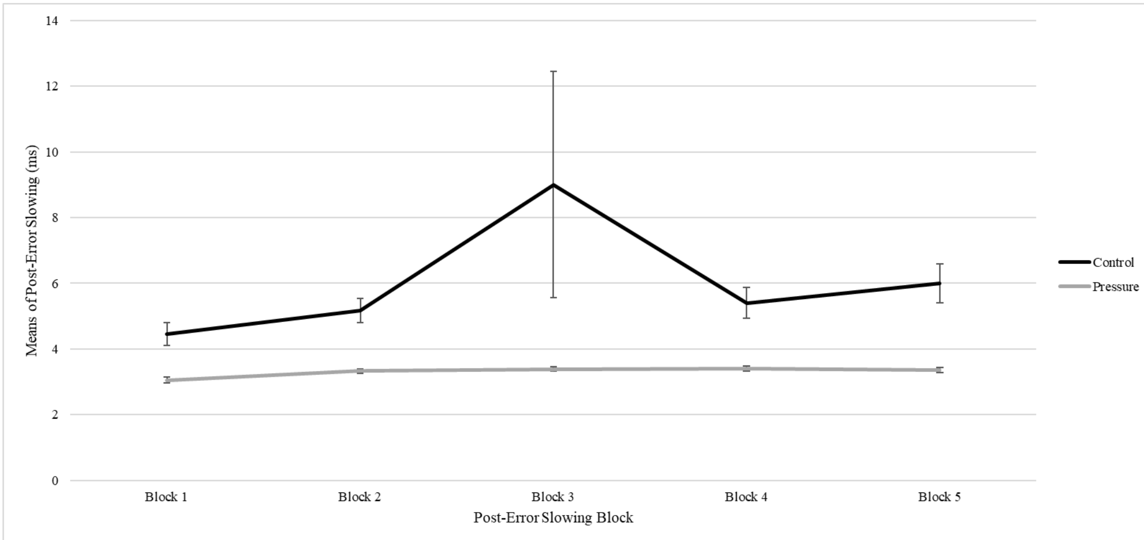

Figure B-3: Estimated marginal means for the effect of Time Pressure on Post-Error Slowing by Block.

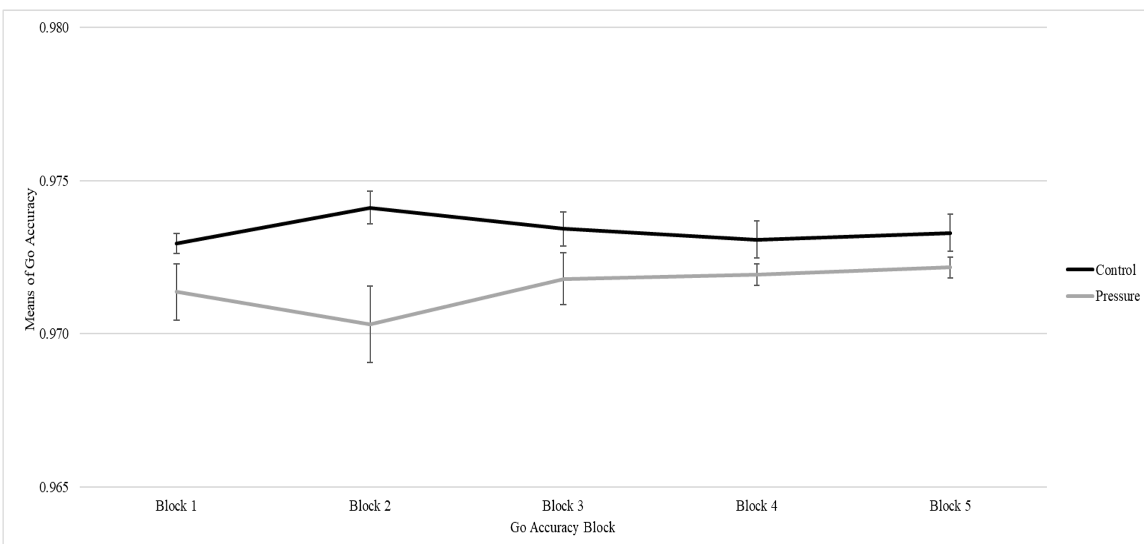

Figure B-4: Estimated marginal means for the effect of Time Pressure on Go Accuracy by Block.

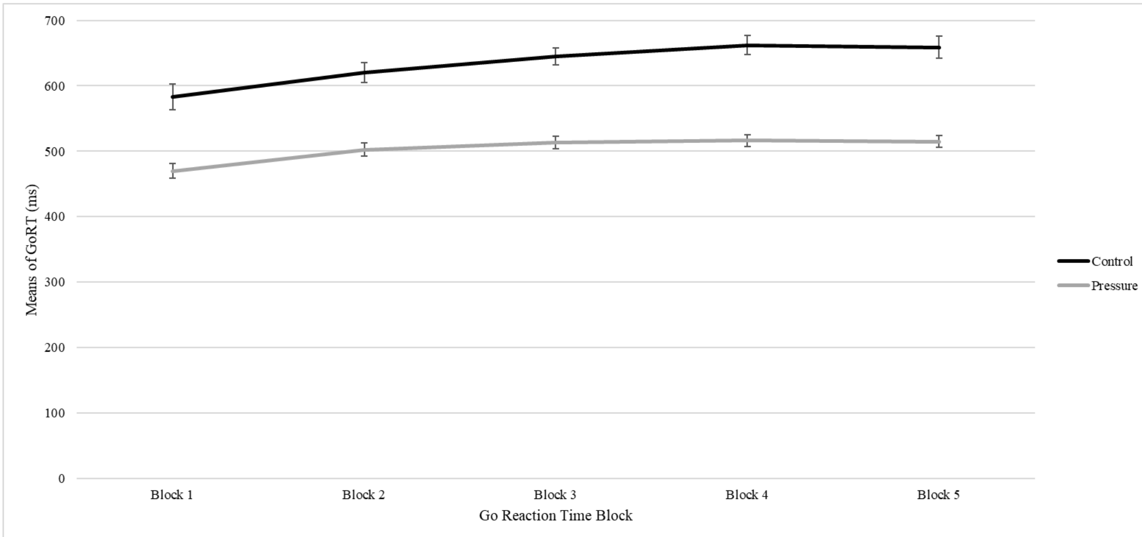

Figure B-5: Estimated marginal means for the effect of Time Pressure on Go Reaction Time by Block.

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