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Do I Have Enough Time? The Effects of Perceived Test Difficulty and Perceived Time Pressure on Cognitive Performance

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Do I Have Enough Time? The Effects of Perceived Test Difficulty and Perceived Time Pressure on Cognitive Performance

by

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Dedication

I would like to dedicate this thesis to my lovely parents Marjorie and Peter Stein. Your unconditional love, compassion, patience, and willingness to provide for me has made me a successful and compassionate person. I cannot thank you enough for your continued support though out my life. I love you both to the moon and back.

I also dedicate this thesis to my partner-in-crime, Rocky Raccoon. You’re the best little buddy who is always excited to see me no matter what.

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Abstract

Do I Have Enough Time? The Effects of Perceived Test Difficulty and Perceived Time Pressure on Cognitive Performance

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ABSTRACT

Previous research on time pressure has shown that time pressure has paradoxical effects on task performance. Findings from previous studies show that time pressure can either help or hurt performance. Thus, it was hypothesized that an inverted U-shape relationship between time pressure and cognitive performance might explain the inconsistent results. In the current study, we used a 2 (Practice set difficulty: easy vs. hard) x 2 (Perceived time pressure: low vs. high) between-subjects design to investigate the effects of perceived test difficulty and perceived time pressure on cognitive performance. Participants either received an easy or hard practice set of Remote Associate Task problems. After, participants were told that 10 mins was either a sufficient (i.e., low perceived time pressure) or insuffient (i.e., high perceived time pressure) amount of time to complete a 30-item test. Upon completion of the test, participants then answered a battery of questionnaires regarding their personality, behavior, and beliefs. Results showed that there was no effect of perceived test difficulty or perceived time pressure on creative task performance or time spent on items. Exploratory analyses using the self-report surveys showed that ADHD behaviors, impulsivity, procrastination, need for cognition, and regulatory focus interacts with perceived test difficulty and perceived time pressure. Findings from this study provides insight into the influence of individual differences on perceived test difficulty and perceived time pressure. Understanding how people with different personalities, behaviors, and beliefs perceive time will help elucidate the different contexts under which time pressure can impair or improve performance.

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INTRODUCTION

The purpose of this study is to explore the influences of time pressure on cognitive performance. From students to businesspeople to doctors, people experience the pressure of time: waking up on time, getting to work on time, and finishing tasks on time. In order to better understand the influences of time pressure on performance, I first review literature on the effects of high-pressure situations and cognitive performance and motivation. I then discuss the effects of time pressure and how it relates to previous research on pressure and performance. Next, I discuss how individual differences might play a role in how a person is affected by time pressure. After, I discuss the theoretical framework and practical implications of cognitive performance under pressure and investigate its relevance to the present research. Finally, I present the purpose of the current experiment and how this research advances our understanding of time pressure on performance. At the end, I discuss the study limitations and potential directions for future research.

Effects of High-Pressure Situations on Cognitive Performance

Throughout life we often encounter high-pressure situations in which we desire to perform our best; however, different aspects of pressure (i.e., social, peer, monetary, and time) affect us and often lead to disappointing performance. Research on the influences of pressure on cognitive performance demonstrates that high-pressure situations induce performance decrements. Researchers previously investigated the effects of performance-induced high-pressure situations by manipulating aspects of peer, social, monetary, and time pressure (Grimm, Markman, Maddox, & Baldwin, 2009; Beilock & Carr, 2005; Beilock, Kulp, Holt, & Carr, 2004; Beilock & Carr, 2001; Roskes, Elliot, Nijstad, De Dreu, 2013; Kerstholt, 1993; Ordonez & Benson, 1997; Dror, Busemeyer, Basola, 1999).

“Choking under pressure” is a phenomenon in which people perform worse in high-pressure situations than in low-pressure situations. For example, Beilock & Carr (2005) studied the relationship between working memory capacity and “choking under pressure” in math. In this experiment, participants solved novel math problems with a high or low working memory demand under high or low amounts of pressure. In the low-pressure condition, participants were told to solve math problems as practice. Thus, participants solved math problems in a low stress environment without any pressure manipulations. Following the low-pressure condition, high-pressure situations were induced by presenting the participants with 3 different pressure manipulations: (1) monetary performance incentive (i.e., if you improve your scores over the course of the experiment, you will receive a $5 bonus), (2) peer pressure situation (i.e., you will be randomly paired with another participant who has already improved their score, if you also improve your score, you will both receive a $5 bonus.), (3) social evaluation pressure (i.e., your performance will be video recorded and will be assessed by local math teachers and professors). Beilock and Carr (2005) found that participants who have a higher working memory capacity perform worse on math questions than those with a low working memory capacity while under high amounts of monetary, peer, and social evaluation pressure. These results suggest that people who are equipped to perform well (i.e., high working memory capacity) are more negatively affected by high-pressure situations than those who have a low working memory capacity. The researchers further suggested high-pressure situations consumes mental resources (i.e., working memory) that compromises the ability to perform well.

Another way to induce a high-pressure situation is to activate a negative stereotype about a social group before task performance. *Stereotype threat* is defined as a situation in which a person feels or is at risk of confirming a stereotype about their social group (Steele & Aronson, 1995). Previous research has shown that activating a stereotype threat induces performance decrements, similar to research on high-pressure situations (Steele & Aronson, 1995; Aronson, Lustina, Good, Keough, Steele, & Brown, 1999).

Research on stereotype threat has also found that activating a stereotype threat influences a person's regulatory focus, which also influences performance (Seibt & Forster, 2004). Regulatory focus is a motivational mechanism that affects one's sensitivity to potential gains and losses in their environment (Higgins, 1987, 1997). The motivation literature makes a clear distinction between being sensitive to the absence and presence of gains (i.e., promotion-focused) and being sensitive to the absence and presence of losses (i.e., prevention-focused; Markman & Brendl, 2000). Furthermore, there is an interaction between a person's regulatory focus and the type of task (Grimm et al., 2009; Higgins, 2000, Shah et al., 1998). That is, the fit (or mismatch) between a person's regulatory focus and the reward structure of a task influences performance. For example, a promotion-focus increases a person's sensitivity to gains, so there is a regulatory fit between people with a promotion-focus and a task that requires them to gain rewards (i.e., maximize points); however, there is a regulatory mismatch for promotion-focused individuals on a task that requires them to avoid punishment (i.e., minimize losses). Conversely, a prevention-focus increases a person's sensitivity to losses, thus there is a regulatory fit between prevention-focused individuals and tasks in which people avoid losses and a regulatory mismatch between tasks that require people to maximize gains.

To study the effect of stereotype threat on motivation and performance, Grimm et al. (2009) activated a stereotype threat in participants that men are better than women at math by telling participants that they will take a test that is designed to be diagnostic of math ability.

After activating a stereotype threat for women, participants took a math test in which the reward structure of the test was manipulated. Participants were randomly assigned to a gains condition in which participants had to either (1) maximize the number of points they earned (i.e., +2 points for correct answers, +0 for incorrect answers) or (2) minimize the amount of points they lost (i.e., -1 points for correct answers, -3 for incorrect answers). In this 2 (gender: male, female) x 2 (reward structure: gains, losses) between-subjects design, Grimm et al. (2009) found that under the gains reward structure, women performed worse than men (i.e., mismatch). However, under the losses reward structure, women performed as well as the men (i.e., regulatory fit). This research demonstrates that the pressure to avoid confirming a negative stereotype induces a performance decrement for participants who are affected by the negative stereotype. Similar to "choking under pressure" activating a stereotype might induce the heightened sense to monitor one's performance, which consumes mental resources necessary to perform well.

Beilock and Carr's (2005) and Grimm et al.'s (2009) studies on the effects of social, peer, and monetary pressure on cognitive performance provide insight into how time pressure might influence performance. Both researchers suggest that performance decrements under high-pressure situations are related to monitoring one's progress and performance on cognitive tasks. Research on time pressure suggests a similar mechanism for why people perform poorly under high vs. low amounts of time pressure.

The Influence of Time Pressure on Cognitive Performance

Studies also demonstrate that time pressure has a profound effect on how people approach different tasks and how they perform on those tasks (Roskes, Elliot, Nijstad, & De Drue; Ganushchak & Schiller, 2009). High time pressure has been found to impair performance on variety of tasks such as math tasks, the Stroop task, chess games, and decision-making tasks (Kellogg, Hopko, & Ashcraft, 1999; Keinan, Friedland, Kahneman, & Roth, 1999; van Harrevaeld, Wagenmakers, & van de Maas, 2006; Kerstholt, 1994; Ordonez & Benson, 1997).

In 1999, Kellogg et al. tested the effects of time pressure on math performance. More specifically, the authors wanted to investigate if highly math-anxious people are less efficient at completing math problems compared to non-math-anxious individuals, especially under a time pressure. Kellogg et al. (1999) hypothesized that anxiety elicited during testing (i.e., "worry") consumes working memory resources necessary to perform well. Furthermore, the authors wanted to test the hypothesis that time pressure might be a component that contributes to the consumption of mental resources during testing, thus leading to poor math performance especially among high math anxious individuals. In their study, participants were first divided into three anxiety groups (i.e., low, medium, and high math anxiety) based on their scores from the Math Anxiety Rating Scale (Alexander & Martray, 1989). The participants then took an untimed and timed version of the math test (ordering was counterbalanced). Both forms contained 10-pages of math problems that increased in difficulty and complexity. Results showed that participants performed better in the untimed vs. the timed math test; however, there was no interaction between the timing condition and the anxiety groups. The authors concluded that time pressure does not contribute to the mentally consuming "worry" process because the high anxiety group did not perform worse than the low or medium anxiety group performance. However, Kellogg et al. (1999) noted that their sample size (n = 10 per anxiety group) was problematic and can potentially influence their results. Despite their conclusion, the results demonstrate that time pressure induces an effect that negatively influences performance regardless of math anxiety levels.

In 2008, Orfus studied the effects of test anxiety and time pressure on performance by using a 2 (Time Pressure: No vs. Yes) x 2 (Test Anxiety: Low vs. High) design. Participants took a test anxiety scale and were classified as having high or low test anxiety. Participants then took a math test and were told that they either had a limited (high time pressure) or unlimited (low time pressure) amount of time to complete the test. Results showed a significant interaction between test anxiety and time pressure. Participants with high test anxiety did worse under time pressure when compared to high test anxiety participants under the no time pressure. This suggests, that test anxiety and time pressure elicits arousal which ultimately impairs performance. Together, the findings from both studies suggest that analytical tasks like math are affected by time pressure; however, are creative tasks that require cognitive flexibility affected the same as analytical tasks?

Roskes et al. (2013) sought to study the effects of time pressure on approach- vs. avoidance-motivated individuals using a creative task known as the Remote Associates Task (RAT; Mednick, 1962). The researchers hypothesized that time pressure undermines performance in avoidance-, but not approach-motivated individuals. In the motivation literature, approach motivated individuals aim to success or achieve, whereas avoidance motivated individuals strive to avoid failures (Elliot, 1999). Research on the approach-avoidance distinction shows that avoidance motivation elicits a focused, cognitively expensive, top-down way of thinking and processing that consumes mental resources. Conversely, approach motivation induces a more heuristic and flexible way of thinking and processing that relies less on the cognitively expensive, top-down processing (for reviews see Elliot & Covington, 2001). Findings suggest that avoidance motivation enhances performance on tasks that require vigilance and careful attention to detail (Forster, Friedman, & Liberman, 2004; Friedman & Elliot, 2008), but impairs performance on creative and insight tasks that require cognitive flexibility (Cretenet & Dru, 2009; Sligte, De Dreu, & Nijstad, 2011). Because avoidance-motivated people already engage in the mentally consuming process of top-down cognitive control, the researchers predicted that time pressure taxes cognitive resources, which ultimate leads to the impairment of performance.

In this experiment, participants first took a questionnaire that assessed their avoidance temperament. After, participants performed in the RAT and were randomly assigned to either the high time pressure condition (8s per item) or low time pressure condition (18s per item). That is, participants had more time to answer a question under low vs. high time pressure. The researchers found that high time pressure impairs the performance of participants with high levels of avoidance temperament, whereas the performance is spared in participants with low levels of avoidance temperament. Similarly, performance was spared when participants with high levels of avoidance temperament performed in the low time pressure condition. The results suggest that time pressure and motivation interact and affect performance differently, where time pressure undermines performance more in avoidance- compared to approach-motivated individuals.

The findings from Kellogg et al. (1999) and Roskes et al. (2013) demonstrate that high time pressure negatively affects performance on both analytic and creative tasks; however, it is relatively unknown how the perception of time pressure influences performance on cognitive tasks.

The Influence of Perceived Time Pressure on Cognitive Performance

The influence of time pressure has been shown to be detrimental to performance; however, is poor performance due to a lack of time to finish the task or a perceived lack of time. To test this hypothesis, an alternative to using absolute time pressure as a manipulation, high amounts of perceived time pressure might also induce a high-pressure situation that leads to a decrement in performance. Instead of giving people more or less time to complete a task (e.g., 5 vs. 15 mins to complete a task), DeDonno and Demaree (2008) manipulated whether or not participants thought they had enough time to complete a task. DeDonno and Demaree (2008) was motivated by the idea that perception of time can influence cognitive performance (Maule & Maillet-Hausswirth, 1995) and the Variable State Activation Theory (Maule & Hockey, 1993) that links perceived time pressure to cognitive performance. The Variable State Activation Theory (Maule & Hockey, 1993) posits that poor performance can occur when a person feels like they have an insufficient amount of time to complete a task. This theory hypothesizes that poor performance can arise from a change in strategy when they feel the effects of time pressure or perceived time pressure. Thus as time runs out (or is thought to run out), people tend to consider less variables when making a decision in order to speed up the decision making process and save time.

To test the effects of perceived time pressure on decision making performance, DeDonno and Demaree (2008) used the Iowa Gambling Task (IGT). The IGT tests risk-taking behavior by simulating real-life decision-making processes using ambiguity, rewards, and penalties. In this task, the goal is to maximize the amount of money participants receive by drawing cards from 1 of 4 decks. The four decks of cards are composed of both reward and penalty values. Two of the decks have higher reward values, but also higher penalty values (i.e., "the bad decks"). The other two decks have smaller reward values, but they also have smaller penalty values (i.e., "the good decks"). The optimal strategy is to avoid large losses by selecting the cards from the decks that have the smaller reward and penalty values.

In this experiment, participants were randomly assigned to either the high or low perceived time pressure group. The researchers experimentally manipulated perceived time pressure by telling participants that they had 2 seconds to select a card, and that it was either a sufficient (control/low perceived time pressure) or an insufficient (experimental/high perceived time pressure) amount of time to learn and complete the task successfully. Participants in the low perceived time pressure group made the optimal choice than the high perceived time pressure group. Evidence from DeDonno and Demaree (2008) supports the predictions from the Variable State Activation Theory (Maule & Hockey, 1993) and suggests that participants underperform when they feel like the time allotted is insufficient to successfully complete a task. Similar to the studies of time pressure on cognitive performance, perceived time pressure might also consume mental resources that are important for completing a task successfully.

Time Pressure, Time Perception, and Individual Differences

Together, these studies suggest that time pressure and perceived time pressure impairs performance on creative and decision-making tasks. Furthermore, results from Roskes et al. (2013) suggest that individual differences in motivational approach interacts with time pressure. Research on individual differences, such as ADHD, impulsivity, emotion, etc., suggest that people experience time differently. Further, an altered experience of time can influence performance under time pressure, as suggested by the studies of perceived time pressure on cognitive performance (DeDonno & Demaree, 2008).

Evidence from ADHD research on children and adolescents suggest that ADHD alters and disrupts the perception of time. People with ADHD have been found to overestimate how much time they have on time estimation tasks and became less accurate at longer time scales (Barkley, Murphy, & Bush, 2001; Meaux & Chelonis, 2003). Because people with ADHD perceive time differently than normal controls (Smith, Taylor, Rogers, Newman, & Rubia, 2002; Meaux & Chelonis, 2003; Gilden & Hancock, 2007; Marusich & Gilden, 2014), perceived time pressure can have a differential effect depending on the type of task they're engaging in. For instance, because people with ADHD overestimate how much time they have, ADHD individuals might think they have enough time to complete a task, when they actually don't. Thus, people with high levels of ADHD might perform worse when they're told that they have enough time to complete the task because they might overestimate how much time they have. In contrast, individuals with ADHD might perform even worse under high- vs. low perceived time pressure (enough time vs. not enough time, respectively) because they're more susceptible to distracting thoughts that are not task-relevant. Regardless of time perception, the Distraction and Monitoring hypotheses predicts that individuals with attention deficits might be undermined by time pressure more than normal controls since time pressure distracts one from the task and consumes resources necessary to complete the task at hand.

Similarly, people who exhibit impulsive behaviors show deficits in time perception. Wittmann and Paulus (2007) suggest that impulsive individuals overestimate time durations which can lead to them to opt for more immediate rewards compared to a delayed but larger reward. Thus, similar to ADHD individuals, impulsive people might perform worse under low amounts of perceived time pressure compared to healthy controls. Impulsive people might also perform worse than controls under a time pressure since they are focused on smaller, immediate rewards, not larger, delayed rewards. Thus, in a decision-making task, impulsive individuals make more sub-optimal choices under time pressure compared to no time pressure, sacrificing overall performance. Similar to participants with ADHD, impulsive individuals have an impaired sense of time which can negatively affect their performance on any given task under a time pressure. Wittman and Paulus (2007) also mentioned that emotional states can have a profound influence on time perception.

In 2007, Droit-Volet and Meck reviewed research on the effect of emotions on time perception. Droit-Volet and Meck (2007) found that interactions between emotional arousal and valence can lead to either increases or decreases in attention to time. This idea can be better captured by the statement, “time flies when you’re having fun.” Together, there is evidence that shows that the influence of time pressure can interact with individual differences, and might lead to increases or decreases in performance. Similar to emotions, individual differences of personality type has been shown to influence how people perform under time pressure.

Need for closure (Lay Epistemic Theory; Kurglanski, 1989) is described as an individual’s desire to seek answers to questions while also avoiding ambiguity. Thus, individuals with high need for closure are characterized by cognitive impatience which leads to a decision based on incomplete or inclusive evidence and rigidity. In contrast, individuals with low need for closure tend to take their time in order to gain more information to make a more informed decision. By investigating the effects of time pressure on need for closure during negations, De Dreu (2003) found that perceived time pressure increases a need for closure. Under high amounts of time pressure, participants with high need for closure were more likely to rely on cognitive heuristics which resulted in making faster and lower demands and less persuasive arguments during negotiations. These results indicate that time pressure increases one’s need for closure, and a heighted need for closure results in poor performance.

Conversely, need for cognition is described as an individual’s desire to engage in and enjoy thinking (Cacioppo & Petty, 1982). In a study investigating the relationship between need for cognition and time pressure, Verplanken (1993) found that under time pressure, participants with low need for cognition expended less effort compared to those with high need for cognition. Interestingly, under a high time pressure, participants with low need for cognition showed that they varied more in the amount of information obtained compared to low need for cognition participants under no pressure. Similar to the finding from De Dreu (2003), this result suggests that participants with low need for cognition under high amounts of time pressure rely more on heuristic strategies to complete a task on time.

Another behavior that might interact with time pressure is procrastination. Procrastination is "the delay of a relevant and timely activity" (Ferarri, 2001; Knaus, 1973). Because procrastination involves the delaying of an important timely activity, chronic procrastinators might be negatively affected by a time pressure. In 2001, Ferarri studied the influence of procrastination on self-regulation of performance (speed vs. accuracy), cognitive load, and working under a time limit. Ferarri (2001) found that chronic procrastinators, compared to non-procrastinators, completed fewer items and made more errors on a shape-matching task. Ferarri (2001) also found that chronic procrastinators performed slower on a shape-matching task compared to non-procrastinators when there was a 2-second time limit to make a judgement. Thus, when under a time pressure, chronic procrastinators' self-regulation of performance is compromised. These results suggest that chronic procrastinators are inefficient when working under a time pressure, which might lead to a decrease in performance.

Together, these studies on individual differences and time pressure show that perceived time pressure can negatively influence performance. These studies provide evidence that there are individual differences in time perception, and this difference in time perception can influence performance. As an exploratory analysis for this study, we participants completed the Regulatory Fit Questionnaire (Higgins et al., 2001), the Adult ADHD Scale (Schweitzer et al., 2001), the Barrett Impulsivity Scale (Patton et al., 1995), the Need for Closure Scale (Roets & Van Hiel, 2011), the Need for Cognition Scale

(Cacioppo, Petty, & Kao, 1984), as well as the Procrastination Scale (Lay, 1986). This data allows us to explore the various ways in which these individual differences in personality and behavior are affected by perceived time pressure.

Theoretical and Practical Implications

A common finding from the studies outlined above is that high amounts of time pressure or perceived time pressure negatively affects performance. Currently there are two theories that might explain why performance is negatively affected under high amounts of pressure (e.g., time, social, peer, etc.). The Distraction Hypothesis (Wine, 1971) posits that pressure elicits anxiety and stress that distracts an individual and consumes working memory resources necessary to successfully complete any given task. For example, time pressure might elicit stress and anxiety that makes individuals worry about their current performance, other people's performance, and how they might be perceived by others. The intrusive thoughts might divide one's attention between how they are feeling and the task demands. Thus, poor performance can be explained by the idea that these self-relevant thoughts divert attention away from task-relevant demands. In the studies mentioned above, the detrimental effects of time pressure might be caused by the distracting nature of stress and arousal elicited by time pressure or perceived time pressure (Kellogg et al., 2000; Beilock & Carr, 2005; DeDonno & Demaree, 2008; Roskes et al., 2013).

Similar to the Distraction Hypothesis (Wine, 1971), detrimental effects of time pressure might arise because time pressure increases a need to monitor how much time is left and one's task progress. The Explicit Monitoring Hypothesis (Baumeister, 1984) predicts that this heightened need to monitor task progress and time remaining consumes mental resources necessary to complete the task successfully. For example, as time runs out, a person might explicitly track how much time is left while also tracking how they're performing. Similar to the Distraction Hypothesis (Winer, 1971), the Explicit Monitoring Hypothesis (Baumeister, 1984) predicts that poor task performance is due to the idea that the attention to the task at hand is disrupted by thoughts of task progress and time left.

Together, these two theories of attention predict that disruptive thoughts (e.g., stress, arousal, task progress, and time left) shifts the attention needed to complete a task successfully. The Distraction and Explicit Monitoring theories of pressure theorizes that time pressure elicits: 1) stress and arousal that distracts individuals from completing the task (Bargh, 1992; Keinan et al., 1999), and 2) monitoring task progress and time remaining consumes mental resources necessary to complete the task (Karau & Kelly, 1992; Kelley, Jackson, & Hutson-Comeaux, 1997). In essence, poor performance can be due to distracting thoughts that diverts attention from the task at hand, and/or due to the consumption of mental resources via the monitoring of task progress and time remaining.

Findings from Roskes et al. (2013) provide crucial support for the Distraction and Explicit Monitoring Hypothesis. Roskes et al. (2013) showed that avoidance motivated individuals who engage in a cognitively taxing top-down control are more negatively affected by time pressure than approach motivated individuals. These results illustrate that time pressure also consumes cognitive resources that might aid in creative task performance. Similarly, DeDonno and Demaree (2008) found that perceived time pressure negatively affects performance on a decision task, not a creative cognitive task. Furthermore, the authors did not discuss or explicitly test the Distraction and Monitoring theories.

To summarize, people show impaired performance on a number of cognitive tasks because time pressure might (1) elicit arousal that distracts one from a task and (2) lead to an increase in monitoring one's progress and amount of time left that taxes cognitive resources. However, other studies demonstrated that time pressure can increase focus and can improve performance under certain conditions (Chajut & Algom, 2003; Gardner, 1990).

Because the influence of time pressure is unclear, researchers have hypothesized that there is an inverted U-shape relationship between levels of time pressure and performance, where low levels and high levels of pressure are detrimental to performance (Baer & Oldham, 2006; Byron, Khazanhi, & Nazarian, 2010). Taken together, findings on the effects of time pressure depends on the context. Thus, there is little known about how time pressure changes the way in which people regulate their behaviors while achieving their goals, and subsequently, how time pressure affects performance. In addition, the influences of perceived time pressure on creative performance is still relatively unknown.

It is important to investigate the effects of perceived time pressure on cognitive performance in high-stakes situations because we experience time pressure and perceived time pressure every day. For example, doctors experience time pressure constantly throughout their careers. In a study on the adherence of doctors to medical guidelines under time pressure, Tsiga et al. (2013) found that doctors under time pressure did not adhere to national guidelines by asking fewer questions about current symptoms, conducting a less thorough exam, relying more on heuristics, and giving less advice on lifestyle choices (e.g., addressing alcohol and drug-related use). Doctors were less confident in their diagnosis during the study. Tsiga et al. (2013) suggested that time pressure negatively influences decisions made by doctors which ultimately puts the patient's health and safety at risk.

Another important issue is that students with disabilities, such as ADHD, are often given extra time to complete exams, assignments, etc. However, does giving extra time to a student with disabilities reduce the effects of their disabilities? To test this question, Lewandowski et al. (2007) investigated whether extended time on a math test effects performance in both children with and without ADHD. Results showed that extra time did not boost math test performance in students with ADHD compared to students without ADHD. Further, results showed that students with ADHD processed information more slowly and inefficiently than normal controls on a speed-based math test. This finding suggests that extra time is not an effective way to reduce the influences of a disability. It further suggests that we need to study and develop ways in which people with learning disabilities can use their time more efficiently.

People often encounter situations in which they think they have enough time, but don't. By understanding how we perceive and act under a time pressure, we can make more informed decisions under time pressure and maybe alleviate any adverse effects of time pressure. However, as mentioned above, people are affected differently by time pressure. Thus, it is also important to study and understand how individual differences in personality and behavior influences how different people perform under time pressure.

Study Overview

As this review demonstrates, the influence of perceived time pressure on creative performance is poorly understood. The aim of this study is to clarify the effect of perceived test difficulty and perceived time pressure on creative performance and to explore the influences of individual differences. We used perceived test difficulty as our other between-subjects factor since it has been found to significantly induce arousal (Hong, 1999).

The current study was a 2 (Perceived test difficulty: Easy vs. Hard) x 2 (Perceived time pressure: Low vs. High) between-subjects design. Participants were randomly assigned to 1 of the four conditions of interest (Figure 1). Participants first either took an easy or hard practice test. After, participants were told that 10-minutes was either a sufficient or insufficient amount of time to complete the creative task. Following the test, participants then answered a battery of questionnaires that probed the participant's personality, behaviors, and beliefs.

According to the U-shaped theory of pressure and performance (Baer & Oldham, 2006; Byron, Khazanhi, & Nazarian, 2010), we hypothesized that the easy practice/low time pressure groups would lead to little arousal, thus there would be no enhancement of performance. Similarly, we hypothesized that the hard practice/high time pressure might elicit high levels of arousal that would lead to an impairment of performance. We further predicted that the easy practice/high time pressure and the hard practice/low time pressure group would lead to an optimal level of arousal that enhances test performance (Figure 2). In addition to our main hypotheses, we predicted that participants who score high on the self-reported scales of ADHD, impulsivity, and procrastination will perform slower and worse than healthy controls. We also predicted that participants who score high on need for closure and/or low on need for cognition will perform faster, but worse than healthy controls. We did make any specific predictions for regulatory focus.

METHODS

Participants

Ninety-five undergraduates were recruited from the Introduction to Psychology participant pool at The University of Texas at Austin. The age range of the participants were 18-23 years old (*M* = 19.17, *SD* = 1.12). The sample consisted of 72.6% female and 27.4% male. The reported races of sample were as follows: Caucasian: 63.04%, Asian: 17.39%, African American/Black: 3.26%, American Indian/Alaskan: 2.17%, Multiracial: 6.52%, and No Response: 7.61%. Within the sample, 35.87% reported that they were of Hispanic/Latino origin. All participants were compensated with course credit upon completion of the experiment. Data from 3 participants were excluded from the analyses due to incomplete data. All recruitment and testing procedures were approved by IRB at The University of Texas at Austin.

Materials

Remote Associates Task

Forty Remote Associates Task (RAT; Mednick, 1962) items were selected from a pool of 50 RAT items based on average performance, average time spent, and the average reported difficulty of each item from a separate pilot study. These metrics allowed us to divide the 40 RAT items into 3 different difficulty levels: 14 easy, 12 moderate, and 14 hard items. Two different difficulty practice sets (i.e., easy and hard) of 6 RAT items each were created. The easy practice set (see Appendix A) consisted of the 4 easiest items in addition to 2 moderate items, whereas the hard practice (see Appendix B) set consisted of the 4 hardest items in addition to the same 2 moderate items in the easy practice set. The order of the practice questions was randomly shuffled for each participant. The remaining 30 RAT items were used to create the test set (see Appendix C). Within the test set, there were 10 easy, 10 moderate, and 10 hard items. All test items were randomly presented to the participants via Qualtrics. Each question included a 5-point difficulty rating scale ranging from 1 (*Very Easy*) to 5 (*Very Hard*). For each question, we recorded the participant's response, the average time spent on each question, and the participant's perceived difficulty of each question. We also calculated the number of times a participant skipped a question.

Self-Reports & Questionnaires

Pre-test Questionnaire

Before taking the timed RAT test, participants were asked questions such as "Do you think you will have enough time to complete the task?" and "How difficult do you think the test will be?" in order to check our experimental manipulation of perceived time pressure and expectation of test difficulty. Participants used a 5-point scale to rate the 5 questions about the test. Scores were summed and analyzed for each question separately.

Post-test Questionnaire

After taking the timed RAT test, participants were given the opportunity to elaborate on their strategies and thoughts about the timed test. Similar to the pre-test questionnaire, the post-test questionnaire asked questions about the participant's perceived difficulty and if they felt like they had enough time to complete the task. Participants used a 5-point scale to rate the 6 questions about the test and their perception of the test difficulty and time pressure. Scores were summed and analyzed for each question separately.

Adult Attention Deficit Hyperactivity Disorder (ADHD) Scale

The Adult ADHD Scale (Schweitzer et al., 2001) is a two-part symptom checklist that consists of the 18 DSM-IV-TR criteria for ADHD in adults. Part A contains 6 questions that evaluates if a participant has symptoms consistent with ADHD. Part B consists of 12 questions that provide additional insight into the participants' symptoms. Participants were asked questions, for instance, "How often do you feel overly active and compelled to do things, like you were driven by a motor?" (Part A) and "How often are you distracted by activity or noise around you?" (Part B). Participants rated items on a 5-point scale ranging from 1 (*Never*) to 5 (*Very Often*). Scale scores were summed within each part and summed across the 2 parts. High summed scores indicate that participants' symptoms are highly consistent with ADHD in adults.

Barrett Impulsivity Scale (BIS-11)

The Barrett Impulsiveness Scale (BIS-11; Patton et al., 1995) assesses the personality and behavioral traits associated with impulsivity. The BIS-11 consists of 30 statements that describe common impulsive and non-impulsive preferences and behaviors, for example, "I act on the spur of the moment" and "I plan tasks carefully". Participants rated their level of agreement on a 4-point scale ranging from 1 (*Rarely/Never*) to 4 (*Almost Always/Always*). Scores were summed across the 30 items. Higher summed scores indicate higher levels of impulsivity.

Regulatory Focus Questionnaire

The Regulatory Focus Questionnaire (Higgins et al., 2001) is an 11-item scale that measures a participants' motivational orientation. The scale includes of 6 promotion-focused scale items (e.g., "How often have you accomplished things you got you 'psyched' to work even harder?") and 5 prevention-focused scale items (e.g., "Did you get on your parents' nerves often when you were growing up?"). Participants rated how frequently these events occur have occurred in their life on a 5-point scale ranging from 1 (*Never or Seldom*) to 5 (*Very Often*). The scale scores were computed using the method described by Higgins et al. (2001) in order to assess whether a participant is promotion- or prevention-focused.

Procrastination Scale

The Procrastination Scale (Lay, 1986) is a 20-item scale that assesses the degree to which a participant engages in procrastinating behavior, for example, "I generally delay before starting on work I have to do". Participants decided whether each statement is characteristic of themselves on a 5-point scale ranging from 1 (*Extremely Uncharacteristic*) to 5 *(Extremely Characteristic*). Scores were summed across all items, where higher scores indicate higher levels of procrastination tendencies.

Need for Closure

The abridged version of the Need for Closure Scale (Roets & Van Hiel, 2011) measures the participants desire for cognitive closure. Participants rated how much they agreed with 15 statements such as, "I do not like situations that are uncertain" and "I find that a well ordered life with regular hours suits my temperament" on a 6-point scale ranging from 1 (*Strongly Disagree*) to 6 (*Strongly Agree*). Scores were calculated according to procedure outlined by Roets & Van Hiel (2011).

Need for Cognition

The shortened Need for Cognition Scale (Cacioppo, Petty, & Kao, 1984) is an 18-item questionnaire that quantitatively measures a participant's tendency to engage in thinking. Participants rated how characteristic statements such as, "I prefer complex to simple problems" and "I like to have the responsibility of handling a situation that requires a lot of thinking" on a 5-point scale ranging from 1 (*Extremely Uncharacteristic*) to 5 (*Extremely Characteristic*). Scale scores were summed and computed based on methods from Cacioppo et al. (1984).

DESIGN & PROCEDURE

In this experiment, we used a 2 (Practice set difficulty: Easy vs. Hard) x 2 (Perceived time pressure: Low vs. High) between-subjects design. We experimentally manipulated whether or not a participant received the easy or hard practice set and whether or not they were instructed that there was low or high time pressure.

At the start of the experiment, participants were informed that they were going to take a short creative task (i.e., the RAT) followed by a survey that asks them questions about their personality, behaviors, and beliefs. After obtaining informed consent, participants were randomly assigned to 1 of 4 independent experimental conditions of interest: (1) Easy practice/Low perceived time pressure (n = 24), (2) Easy practice/High perceived time pressure (n = 23), (3) Hard practice/Low perceived time pressure (n = 25), and (4) Hard practice/High perceived time pressure (n = 20).

After, participants were placed at a testing computer and were instructed on how to complete the RAT. In the RAT, participants were presented with 3 remotely associated cues (e.g., swiss, cottage, & cake) and are asked to generate a 4^{th} word that connects all three cues (e.g., cheese – swiss cheese, cottage cheese, cheese cake). Participants were instructed to guess if they could not generate an answer. Furthermore, participants were also instructed to skip any questions if they found the question to be too difficult or if they felt like they were spending too much time on any given question. The experimenters encouraged participants to ask questions in order to better understand the task.

Following the instructions, participants were then given the opportunity to practice the task before the actual test using the easy or hard practice set. After completing the practice set, the participants then answered the questions in the pre-test questionnaire (described above). Once the participants were finished, the experimenter then informed the participants about the timed test. For the low perceived time pressure condition, the experimenter said, "Previous research in this lab has shown that 10 minutes is a sufficient amount of time to complete the following test. Past participants finished this test on or before the time limit". For the high perceived time pressure condition, the experimenter said, "Previous research in this lab has shown that 10 minutes is not enough time to complete the following test. Past participants found it difficult to finish this test on or before the time limit". The experimenter then set a 10-minute timer and instructed the participants that they will be given a 5-minute and a 1-minute warning. The questions test and the amount of time to complete the test (10 mins) was the same for all experimental conditions. The order of the questions was randomly presented by Qualtrics and each question was presented individually. Participants also had access to a progress bar that allowed them to track where they are in the test at any given time.

After 10 minutes, the participants were instructed to stop and exit out of the test if they didn't complete the test. Following the timed test, the participants then answered a battery of questionnaires regarding the timed test, their personality, behavioral tendencies, and beliefs. Participants were instructed to answer each question as honestly as possible. Following the self-report surveys, the participants were then debriefed about experimental manipulation. Since we used deception in this study (i.e., the framing of low vs. high perceived time pressure), participants were given the opportunity to either allow us or not allow us to use their data. Once the participants were debriefed about the real purpose of the study, the participants were thanked and compensated with course credit.

RESULTS

In the current experiment, we used a 2 (Practice set difficulty: Easy vs. Hard) x 2 (Perceived Time Pressure: Low vs. High) between-subjects design to investigate the effects of practice set difficulty and perceived time pressure on mean proportion correct, mean time spent (s) on RAT items, and the mean difficulty rating of RAT items. We were also interested in studying the influence of personality, behavioral tendencies, and beliefs on cognitive performance. Since we had an unbalanced design, all ANOVAs were computer using Type III Sums of Squares. All post-hoc t-tests were corrected using Bonferroni correction.

MANIPULATION CHECK

Pre-test Perceived Difficulty Manipulation Check

Confirming that we manipulated the perceived difficulty of the timed test, a 2 (Practice set difficulty: Easy vs. Hard) x 2 (Perceived Time Pressure: Low vs. High) between-subjects ANOVA showed a main effect of practice set difficulty (Figure 3; $F(1, 88) = 24.56$, $p < 0.001$, $\eta^2 = 0.22$). An independent sample t-test revealed that the participants in hard practice set rated that the test would be harder ($M = 3.82$, $SE = 0.09$) compared to the participants in the easy practice set ($M = 3.21$, $SE = 0.09$; $t(89.31) = 4.86$, $p < 0.001$, $d = 1.01$).

Pre-test Perceived Time Pressure Manipulation Check

Confirming that we manipulated the perceived time pressure of the timed test, a 2 (Practice set difficulty: Easy vs. Hard) x 2 (Perceived Time Pressure: Low vs. High) between-subjects ANOVA showed a main effect of perceived time pressure (Figure 4; $F(1, 88) = 77.68$, $p < 0.001$, $\eta^2 = 0.45$). An independent sample t-test revealed that the participants in high perceived time pressure condition rated that they did not have enough time (M = 1.77, SE = 0.11) compared to the participants in the low time pressure condition ($M = 3.22$, $SE = 0.13$; $t(89.82) = -8.48$, $p < 0.001$, $d = 1.75$).

Practice Performance

As a manipulation check, we compared the performance between the two practice set groups. A t-test revealed that participants in the easy practice set ($M = 0.64$, $SE = 0.04$) performance better on the practice test than those in the hard practice set ($M = 0.16$, $SE = 0.02$; $t(75.98) = 10.645$, $p < 0.001$).

PERFORMANCE ANALYSES

The mean proportion correct data was analyzed using a 2 (Practice set difficulty: easy vs. hard) x 2 (Perceived time pressure: high vs. low) x 3 (Question difficulty: easy, moderate, and hard) mixed model ANOVA with practice set difficulty and perceived time pressure as between-subjects factors and question difficulty as a within-subjects factor. Results revealed that there was a main effect of question difficulty (Figure 5; $F(2, 176) = 166.76$, $p < 0.001$, $\eta^2 = 0.36$). Pairwise post-hoc t-tests revealed that participants performed better on the easy questions ($M = 0.52$, $SE = 0.03$) compared to the moderate questions ($M = 0.38$, $SE = 0.02$; Easy > Moderate: $t(91) = 6.93$, $p < 0.001$) and the hard questions ($M = 0.14$, $SE = 0.01$; Easy > Hard: $t(91) = 17.21$, $p < 0.001$). Participants also performed better on the moderate questions compared to the hard questions (Moderate > Hard: $t(91) = 11.93$, $p < 0.001$). Results also showed that there was no significant 3-way or 2-way interactions ($p > 0.1$). In addition, there was no main effect of perceived time pressure ($F(1, 88) = 2.06$, $p = 0.15$) or practice set difficulty ($F(1, 88) = 0.18$, $p = 0.67$).

We further analyzed the mean proportion correct separately for each question difficulty. Only the moderately difficult questions showed a significant main effect of perceived time pressure ($F(1, 88) = 4.02$, $p < 0.05$, $\eta^2 = 0.04$). Participants in the low perceived time pressure condition outperformed (*M* = 0.42, *SE* = 0.03) those in the high time pressure condition on the moderately difficult questions (*M* = 0.33, *SE* = 0.03; $t(89.92) = 1.99$, $p < 0.05$).

TIME SPENT ANALYSES

The mean time spent on RAT items data was analyzed using a 2 (Practice set difficulty: easy vs. hard) x 2 (Perceived time pressure: high vs. low) x 3 (Question difficulty: easy, moderate, and hard) mixed model ANOVA with practice set difficulty and perceived time pressure as between-subjects factors and question difficulty as a within-subjects factor. Results revealed that there was a main effect of question difficulty (Figure 6; ($F(2, 176) = 52.42$, $p < 0.001$, $\eta^2 = 0.15$). Pairwise post-hoc t-tests revealed that participants spent more time (in seconds) on the hard questions (*M* = 30.38s, *SE* = 1.64s) compared to the moderate questions (*M* = 22.77, *SE* = 0.93; Hard > Moderate: $t(91) = 5.84$, $p < 0.001$) and the easy questions (*M* = 18.76, *SE* = 1.03; Hard > Easy: $t(91) = 9.02$, $p < 0.001$). Participants also spent more time on the moderate questions compared to the easy questions (Moderate > Easy: $t(91) = 4.91$, $p < 0.001$). There was no significant 3-way or 2-way interactions ($p > 0.16$). There was also no main effect of perceived time pressure ($F(1, 88) = 1.23$, $p = 0.27$) or practice set difficulty ($F(1, 88) = 1.64$, $p = 0.20$).

DIFFICULTY RATING ANALYSES

On each RAT item, participants rated how difficult the question was on a scale from 1 (*Very Easy*) to 5 (*Very Hard*). Mean difficulty ratings were analyzed using a 2 (Practice set difficulty: easy vs. hard) x 2 (Perceived time pressure: high vs. low) x 3 (Question difficulty: easy, moderate, and hard) mixed model ANOVA with practice set difficulty and perceived time pressure as between-subjects factors and question difficulty as a within-subjects factor. Results revealed that there was a main effect of question difficulty (Figure 7; $F(2, 176) = 133.72$, $p < 0.001$, $\eta^2 = 0.33$). Thus participants rated the hard questions ($M = 4.01$, $SE = 0.06$) higher than the moderate questions ($M = 3.48$, $SE = 0.06$; Hard > Moderate: $t(91) = 8.50$, $p < 0.001$) and the easy questions ($M = 2.92$, $SE = 0.08$; Hard > Easy: $t(91) = 13.96$, $p < 0.001$). Participants also rated the moderately questions as being more difficult than the easy questions (Moderate > Easy: $t(91) = 10.16$, $p < 0.001$). There was no significant 3-way or 2-way interactions ($p > 0.30$). There was also no main effect of perceived time pressure ($F(1, 88) = 2.57$, $p = 0.112$) or practice set difficulty ($F(1, 88) = 0.05$, $p = 0.82$).

EXPLORATORY ANALYSES

The effect of ADHD and perceived time pressure on RAT performance

In order to determine if there is an effect of ADHD symptoms on RAT performance, we used multiple linear regression in combination with a stepwise model selection procedure that uses Akaike information criterion (AIC) to find the best fit model. This procedure employed both forward and backward steps, adding and subtracting predictors in order to find the best fit model. The original full model included both the main effects and interactions between practice set difficulty, perceived time pressure, and the summed ADHD scale scores. By using a stepwise model selection procedure, we found that the best fit model of the data included the main effect of perceived time pressure, the main effect of summed ADHD scores, and the interaction between the two. Using this reduced model, we found that there was a significant main effect of perceived time pressure (Figure 8; $F(1, 88) = 4.72$, $p < 0.05$). There was also a marginally significant interaction between perceived time pressure and ADHD scores ($F(1, 88) = 3.83$, $p = 0.05$). The slope of the high perceived time pressure condition was significantly different from zero ($\beta = 1.23$, $p < 0.05$), meaning that ADHD significantly predicted performance for the high perceived time pressure group.

The effect of impulsivity and perceived time pressure on RAT performance

In order to determine if there is an effect of impulsivity on RAT performance, we used multiple linear regression in combination with a stepwise model selection procedure as described above. The original full model included both the main effects and interactions between practice set difficulty, perceived time pressure, and the summed impulsivity scale scores. By using a stepwise model selection procedure, we found that the best fit model of the data included the main effects of perceived time pressure, practice difficulty set, the summed impulsivity scores, and the 2-way and 3-way interactions between these three predictor variables. We found that this model did not significantly predict mean proportion correct ($F(7, 84) = 0.52$, $p = 0.82$).

The effect of procrastination and perceived time pressure on RAT performance

In order to determine if there is an effect of procrastination on RAT performance, we used multiple linear regression in combination with a stepwise model selection procedure as described above. The original full model included both the main effects and interactions between practice set difficulty, perceived time pressure, and the summed impulsivity scale scores. By using a stepwise model selection procedure, we found that the best fit model of the data included the main effects of perceived time pressure, practice difficulty set, the summed procrastination scores, and the 2-way and 3-way interactions between these three predictor variables. Using this model, we found that there were no significant predictors of RAT performance ($F(7, 84) = 0.47$, $p = 0.86$).

The effect of need for cognition, practice set difficulty, and perceived time pressure on RAT performance

To test the effect of need for cognition on RAT performance, we first created the full model which included the main effects of and the interactions between practice set difficulty, perceived time pressure, and need for cognition scores. Using the same model selection procedure described above, we settled for a model that included the main effects of practice set difficulty, perceived time pressure, and need for cognition scores, as well as the interaction between perceived time pressure and need for cognition scores and the interaction between practice difficulty set and need for cognition scores. Results revealed a marginal interaction effect between practice difficulty and need for cognition scores (Figure 9; $F(1, 86) = 3.51$, $p = 0.06$).

The effect of ADHD, practice set difficulty, and perceived time pressure on mean time spent on RAT items

We investigated the effect of ADHD, practice set difficulty, and perceived time pressure on mean time spent on RAT items using multiple linear regression. Our model included the main effects and interactions between the three predictors of interest. Results showed that this model was not statistically significant ($F(7, 84) = 0.94$, $p = 0.48$).

The effect of impulsivity, practice set difficulty, and perceived time pressure on mean time spent on RAT items

We investigated the effect of impulsivity, practice set difficulty, and perceived time pressure on mean time spent on RAT items using multiple linear regression. Our model included the main effects and interactions between the three predictors of interest. Results showed that this model was not statistically significant ($F(7, 84) = 1.53$, $p = 0.17$).

The effect of procrastination, practice set difficulty, and perceived time pressure on mean time spent on RAT items

We investigated the effect of procrastination, practice set difficulty, and perceived time pressure on mean time spent on RAT items using multiple linear regression. Our model included the main effects and interactions between the three predictors of interest. Results showed that this model was not statistically significant ($F(7, 84) = 1.18$, $p = 0.32$).

The effect of regulatory focus, practice set difficulty, and perceived time pressure on mean time spent on RAT items

We investigated the effect of regulatory focus, practice set difficulty, and perceived time pressure on mean time spent on RAT items using multiple linear regression. Our model included the main effects and interactions between the three predictors of interest. Results showed a three-way interaction between regulatory focus, practice set difficulty, and perceived time pressure (Figure 10; $F(1, 84) = 6.84$, $p < 0.05$).

The effect of need for cognition, practice set difficulty, and perceived time pressure on mean time spent on RAT items

To investigate the effect of need for cognition on mean time spent on RAT items, we first created the full model which included the main effects of and the interactions between practice set difficulty, perceived time pressure, and need for cognition scores. Since the 3-way interactions was not significant, we excluded that term in order to better fit our data. Results revealed a significant interaction between practice difficulty and need for cognition scores (Figure 11; $F(1, 86) = 6.59$, $p < 0.05$) and a significant interaction between perceived time pressure and need for cognition scores ($F(1, 86) = 4.51$, $p < 0.05$). We also found significant main effects of perceived time pressure ($F(1, 86) = 4.88$, $p < 0.05$) and practice set difficulty ($F(1, 86) = 7.43$, $p < 0.01$).

STRATEGY ANALYSES

The strategy analyses described below are relatively exploratory. The analyses were underpowered due to the fact that the majority of the participants did not complete the test on time.

Do participants spend more time on questions in the beginning, middle, or end of the test?

For the current analysis, 24 participants were removed from this analysis due to missing data. To investigate how a participant spends their time on the test, we divided the 30-item test into 3 test segments: (1) Early (Questions 1-10), (2) Middle (Questions 11-20), and (3) Late (Questions 21-30). Results from the 2 (Practice set difficulty: easy vs. hard) x 2 (Perceived time pressure: low vs. high) x 3 (Test segment: early vs. middle vs. late) mixed model ANOVA using mean time spent on each question. The between-subjects factors were the practice set (i.e., easy vs. hard) and the perceived time pressure (i.e., low vs. high). The within-subjects factor was the test segment (i.e., early, middle, and late). Results revealed a significant 3-way interaction between practice set difficulty, perceived time pressure, and test segment (Figure 12; $F(2, 128) = 4.27$, $p < 0.05$, $\eta^2 = 0.05$).

Do participants skip more items as they progress through the test?

For this analysis, 57 participants were excluded from this analysis due to missing data. To test how a participant spends their time on the test, we ran a 2 (Practice set difficulty: easy vs. hard) x 2 (Perceived time pressure: low vs. high) x 3 (Test segment: early vs. middle vs. late) mixed model ANOVA using mean number of items skipped. The between-subjects factors were the practice set (i.e., easy vs. hard) and the perceived time pressure (i.e., low vs. high). The within-subjects factor was the test segment (i.e., early, middle, and late). Results revealed a significant interaction between perceived time pressure and test segment (Figure 13; $F(2, 62) = 7.64$, $p < 0.05$, $\eta^2 = 0.05$). We further investigated this interaction and found that within the late test segment, there is a significant difference in mean items skipped between the low and high perceived time pressure group (Low > High: $t(23.11) = 2.79$, $p < 0.016$). Thus this result suggests that participants in the low perceived time pressure group skipped more items towards the end of the test compared the participants in the high perceived time pressure group.

DISCUSSION

The purpose of the study was to examine the effects of perceived test difficulty and perceived time pressure on performance in a creative task. More specifically, we wanted to test the U-shaped theory of pressure and performance (Baer & Oldham, 2006; Byron, Khazanhi, & Nazarian, 2010). As shown in figure 2, we predicted that the easy practice/low time pressure groups would lead to little arousal, therefore there would be no enhancement of performance. Similarly, we predicted that the hard practice/high time pressure might elicit high levels of arousal that would lead to an impairment of performance. We further predicted that the easy practice/high time pressure and the hard practice/low time pressure group would lead to an optimal level of arousal that enhances test performance. Results showed that we did not find evidence that the framing of the perceived time pressure and the practice difficulty set was enough to effect cognitive performance or the strategy one employs under time pressure. Thus, these results do not support our original hypotheses.

We were also interested in investigating how individual differences might affect test performance and mean time spent on each question. We found that performance and mean time spent on questions were not affected by perceived time pressure, difficulty practice set, impulsivity, and procrastination scores. Our results do not support our hypothesis that participants who score high on the self-reported scales of impulsivity and procrastination will perform slower and worse than healthy controls.

When investigating the effect of ADHD and perceived time pressure, we found that there was a main effect of perceived time pressure and a marginally significant interaction between perceived time pressure and ADHD scores (Figure 8). However, the results are the opposite of what we expected. We predicted that participants with ADHD would perform worse than healthy controls under a high vs. low perceived time pressure. We found that participants with ADHD performed better than controls under a high perceived time pressure. There was no difference in performance between participants with ADHD and healthy controls under low perceived time pressure.

We also predicted that participants who score high on need for closure and/or low on need for cognition will perform faster, but worse than healthy controls. Our results showed that there was a marginal interaction between practice set difficulty and need for cognition scores for performance. Thus, our results did not support our hypothesis that participants with low need for closure did not perform worse than those with high need for closure. However, when we investigated the effects of need for cognition, perceived time pressure, and practice difficulty set on mean time spent on each question, we found that there was a significant interaction between perceived time pressure and need for cognition and a significant interaction between practice difficulty set and need for cognition (Figure 11). Under a hard practice difficulty set and high perceived time pressure, participants who scored low on need for cognition scores spent more time on questions compared to participants who scored low on need for closure under a low perceived time pressure.

Even though we did make any specific predictions for regulatory fit, we found that they had a significant influence on average time spent on each question. When investigating the effects of regulatory focus, perceived time pressure, and practice set difficulty, we found that there was a significant 3-way interaction. Under a hard practice difficulty set, we found that participants who scored high on regulatory focus scores (i.e., promotion-focus) spent more time on questions under a high vs. low perceived time pressure. Under an easy practice set and a high perceived time pressure, participants who scored low on regulatory focus (i.e., prevention-focus) spent more time on questions compared to those under a low perceived time pressure. In addition, participants who are promotion-focused are spend more time under low vs. high perceived time pressure.

Results from the performance and time analyses, in addition to the exploratory individual differences analyses, suggest that individual differences might play a critical role in how a person performs when they think they have enough or not enough time to complete a task.

Every day, people often experience the effects of time pressure at home, work, or school. From waking up on time to arriving to work on time to finishing assignments on time, understanding how time pressure affects how we behave is both theoretically and practically important. Previous research shows that time pressure disrupts performance on a number of tasks, such as chess and the Stroop Task (van Harreveld, Wagenmakers, & van der Maas, 2006; Keinan, Friedlan, Kahneman, & Roth, 1999). Findings from these studies suggest that time pressure impairs performance because: (1) time pressure evokes arousal and stress, which can be distracting (Keinan et al., 1999), and (2) time pressure leads to an increased attention to task progress and the amount of time left, which consumes and taxes cognitive resources necessary for task performance (Karau & Kelly, 1992).

Research on time pressure and motivation showed that participants who are more avoidance-motivated were undermined more than those who are approach-motivated (Roskes et al., 2013). This suggests that individual differences play a crucial role how a person performs under time pressure. Roskes et al. (2013) used the RAT in order to study the effects of time pressure for people who are more avoidance-motivated. Instead of perceived time pressure, Roskes et al. (2013) manipulated time pressure on each individual question. In the low time pressure condition, participants were given 18 seconds per item, whereas in the high time pressure condition, participants were given 8 seconds per item. Subsequently, Roskes et al. (2013) found that participants answered more questions when given more time per item. This suggest that there is a confound between performance and the time given to perform a task. That is, performance is related to the time spent on a given task. The current study sought to avoid this confound by using perceived time pressure, not absolute time pressure. In all, this finding suggests that individual differences might account for differences in behavior under time pressure (Roskes et al., 2013).

Research on individual differences, such as ADHD, impulsivity, emotions, etc., suggest that it is the perception of time pressure that might influence performance on a wide range of cognitive tasks (Droit-Volet & Meck, 2007; Wittman & Paulus, 2007; Barkley, Murphy, & Bush, 2001). Results from our study suggest that personality traits, such as ADHD, need for cognition, regulatory focus (or motivational orientation), and theory of intelligence, might also lead to differences in perceived time pressure. Thus, participants who exhibit these individual differences could perceive time differently while performing on a cognitive test, and differences in perception can lead to differences in performance.

One interesting finding is that participants with symptoms consistent with ADHD performed better than controls under a high perceived time pressure. Previous research suggests that participants with ADHD tend to overestimate how much time they have (Barkley, Murphy, & Bush, 2001; Meaux & Chelonis, 2003). Therefore, participants under the high perceived time pressure group ("Previous research in this lab has shown that 10 minutes is not enough time to complete the following test. Past participants found it difficult to finish on or before the time limit") might have changed their perception of time, thus leading to better performance compared to controls under high perceived time pressure. Thus, participants with ADHD might have benefited from the high perceived time pressure framing. This suggests that framing can possibly help participants with ADHD focus their attention during this high-pressure situation, which might result in better performance.

We also found that need for cognition plays a role in how people perform under high vs. low perceived time pressure. We found that participants who scored low in need for cognition spend more time on questions under a high perceived time pressure compared to those who scored high on the need for cognition score. This result suggests that participants with low need for cognition might process information slower under a high perceived time pressure than participants with high need for cognition. This finding is contrary to what we expected. We predicted that participants with low need for cognition will spend less time on each question because these participants rely on cognitive heuristics and tend to expend less effort than participants who have high need for cognition (Verplanken, 1993; De Dreu, 2003).

The current study used perceived test difficulty and perceived time pressure as our main manipulation. Given that participants were unfamiliar with the RAT, participants might have been profoundly affected by the practice set manipulation. That is, poor performance on the practice set could have made participants less persistent on harder items during the timed test. We also manipulated perceived time pressure via verbal instructions, "Previous research in this lab has shown that 10 minutes is a sufficient/insufficient amount of time to complete the following test. Past participants finished/didn't finish this test on or before the time limit". These instructions seemed to alter the participants' expectation of whether or not they had enough time to complete the task. However, these instructions also include an aspect of social pressure that might motivate participants differently depending on how confident they are in their ability to complete the test. That is, we specifically tell participants that past participants either finished or didn't finish before the time limit. If a participant has low confidence in RAT performance and heard that other people didn't finish on time, then they might not try as hard as someone who has high confidence in their RAT performance.

Additionally, if participants who have low confidence in their ability and heard that other people finished on time, then they might rush and complete the task in order to fit the social norm of finishing on time. Thus, influence of perceived time pressure on performance depends on certain individual differences. Our exploratory analyses revealed that individual difference might play a role in how people perform when they think they either have enough or not enough time to complete a task.

Future studies should incorporate other ways to manipulate perceived time pressure and test the Distraction hypothesis (Wine, 1971) and the Explicit Monitoring hypothesis (Baumeister, 1984). For instance, experimenters could show participants a timer (or not) during a timed task. This manipulation would allow us to test the Monitoring hypothesis by seeing whether or not having an explicit timer helps reduce cognitive load in participants. Thus, we predict that if a participant has access to a timer, then they will perform better than those who do not have access to a time.

We can also manipulate perceived time pressure by showing a timer that changes colors (i.e, from green to red) at different times to compare performance at times when a participant thinks they are running out of time. This manipulation would allow us to test the difference in performance at different perceived levels of perceived time pressure while holding absolute time constant.

Future research should also use other tasks such as decision-making, problem-solving, and analytical tasks. In addition to using different tasks, future studies should also look at how cognitive load might affect how a person performs under a perceived time pressure. Additionally, studies that specifically investigate the relationship between individual difference and time perception could provide additional insight into how people strategize and perform under time pressure.

Traditionally, students with learning disabilities are often given extra time to complete the task; however, what if giving more time is not enough? That is, studies on how students with disabilities use their time under time pressure might be beneficial to creating a more comprehensive learning experience. If one knows how to cope with their symptoms under time pressure, then it could have a profound positive influence on how students with disabilities perform and learn. Similarly, future studies should investigate the role of test anxiety on time perception. Test anxiety has been found to elicit physiological responses that includes increased galvanic skin response, heart rate, dizziness, nausea, or feelings of panic (Deffenbacher, 1980; Hembree, 1988; Morris, David, & Hutchings, 1981). In line with the hypothesis that time pressure elicits arousal that distracts a person from the task, physiological responses elicited by test anxiety and time pressure can lead to severe impairment of performance (Cassady & Johnson, 2002). Thus, research on interoceptive awareness, or awareness of one's internal bodily senses (e.g. heart rate) could be incorporated to help those who suffer from debilitating physiological responses elicited by time pressure or test anxiety (Pollatos, Traut-Mattausch, Schroeder, & Schandry, 2007).

Together, the preliminary findings from the current study provides a framework for understanding how perceived time pressure, perceived test difficulty, and individual differences interact. By understanding this interaction, we can apply our knowledge to both the academic and industrial level and create new strategies and programs to help those who are affected by time pressure.

APPENDIX A

EASY PRACTICE SET

Difficulty	Remote Associate 1	Remote Associate 2	Remote Associate 3	Answer
Easy	Cottage	Swiss	Cake	Cheese
Easy	Cream	Skate	Water	Ice
Easy	Fountain	Baking	Pop	Soda
Easy	Aid	Rubber	Wagon	Band
Moderate	Show	Life	Row	Boat
Moderate	Preserve	Ranger	Tropical	Forest

APPENDIX B

HARD PRACTICE SET

Difficulty	Remote Associate 1	Remote Associate 2	Remote Associate 3	Answer
Hard	Piece	Mind	Dating	Game
Hard	Stick	Maker	Point	Match
Hard	Illness	Bus	Computer	Terminal
Hard	Child	Scan	Wash	Brain
Moderate	Show	Life	Row	Boat
Moderate	Preserve	Ranger	Tropical	Forest

APPENDIX C

TEST SET

Difficulty	Remote Associate 1	Remote Associate 2	Remote Associate 3	Answer
Easy	Loser	Throat	Spot	Sore
Easy	Night	Wrist	Stop	Watch
Easy	Duck	Fold	Dollar	Bill
Easy	Rocking	Wheel	High	Chair
Easy	Dew	Comb	Bee	Honey
Easy	Flake	Mobile	Cone	Snow
Easy	Dream	Break	Light	Day
Easy	Fish	Mine	Rush	Gold
Easy	High	District	House	School
Easy	River	Note	Account	Bank
Moderate	Cadet	Capsule	Ship	Space
Moderate	Sense	Courtesy	Place	Common
Moderate	Flower	Friend	Scout	Girl
Moderate	Pie	Luck	Belly	Pot
Moderate	Fox	Man	Peep	Hole
Moderate	Light	Birthday	Stick	Candle
Moderate	Palm	Shoe	House	Tree
Moderate	Wheel	Hand	Shopping	Cart
Moderate	Dust	Cereal	Fish	Bowl
Moderate	Right	Cat	Carbon	Copy
Hard	Office	Mail	Hat	Box
Hard	Catcher	Food	Hot	Dog
Hard	Tank	Hill	Secret	Top
Hard	Home	Sea	Bed	Sick
Hard	Trip	House	Goal	Field
Hard	Fence	Card	Master	Post
Hard	Mail	Board	Lung	Black
Hard	Wise	Work	Tower	Clock
Hard	Cry	Front	Ship	Battle
Hard	Line	Fruit	Drunk	Punch

Figure 1. The Experimental Design of the Current Study

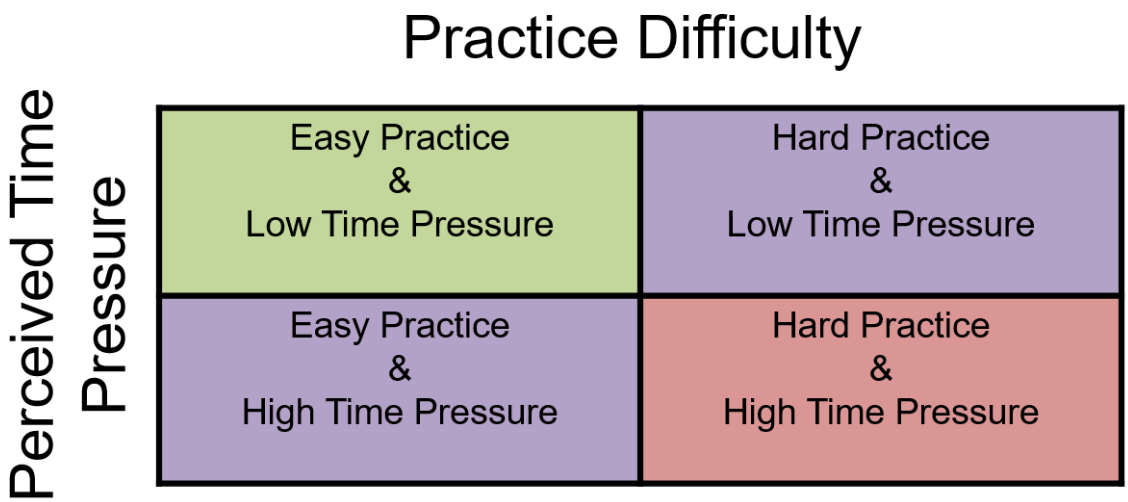


Figure 2. The Predictions for the Current Study

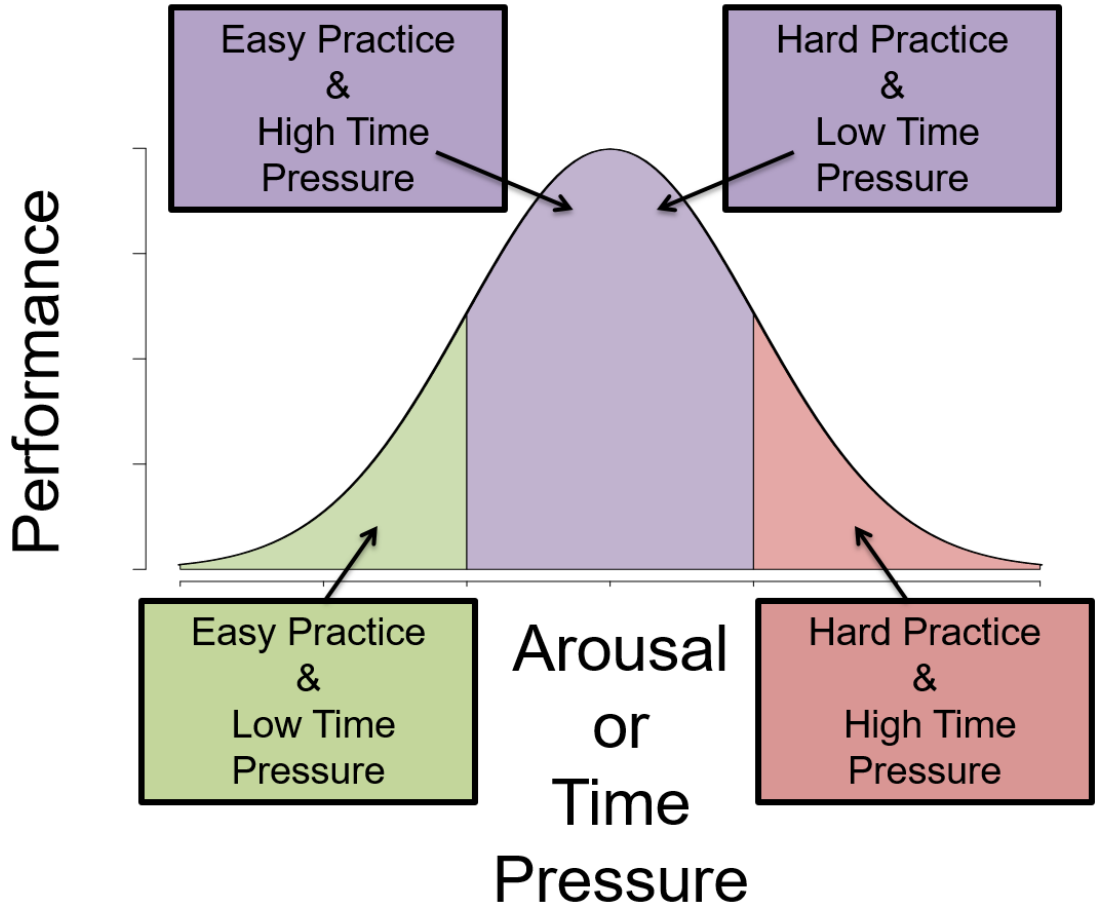
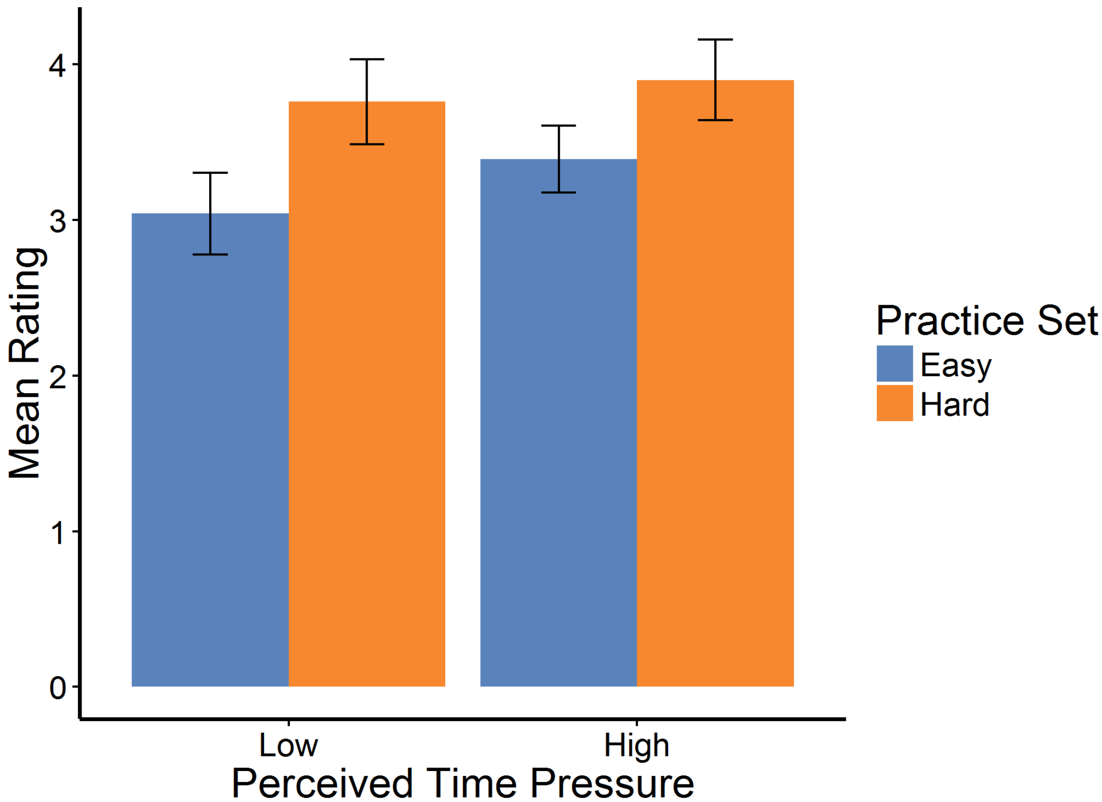
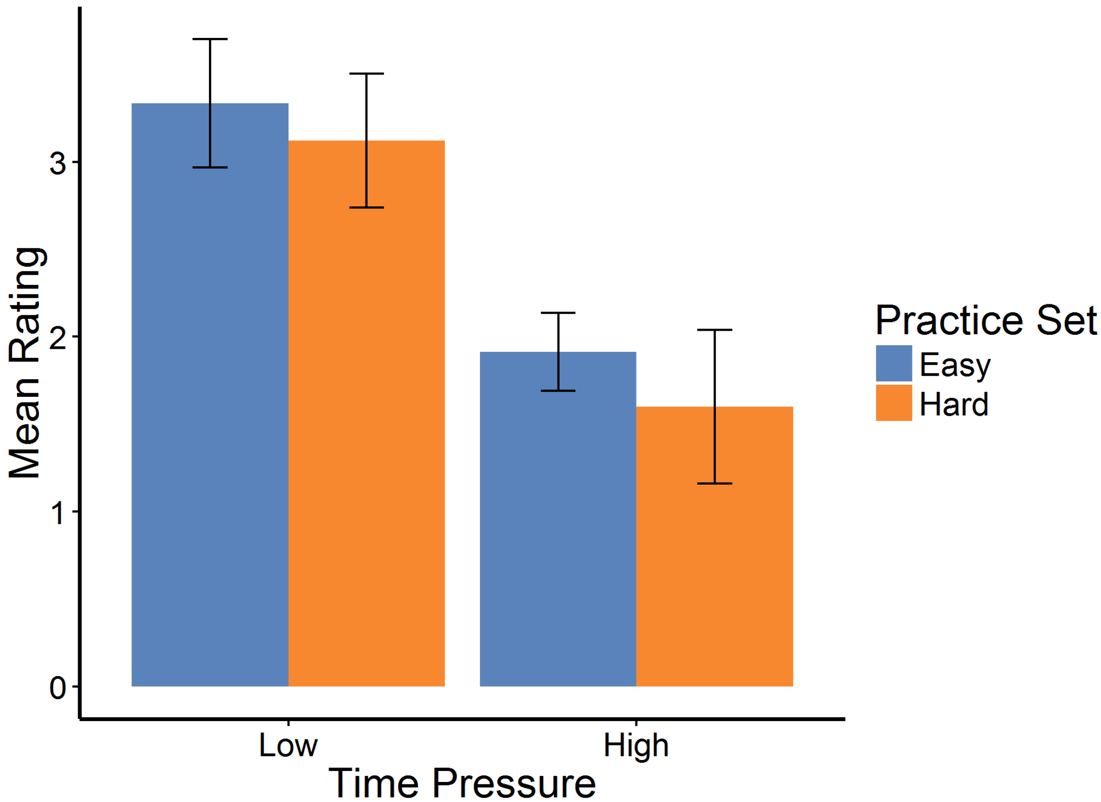


Figure 3. The Pre-test Experimental Manipulation Check of Perceived Difficulty



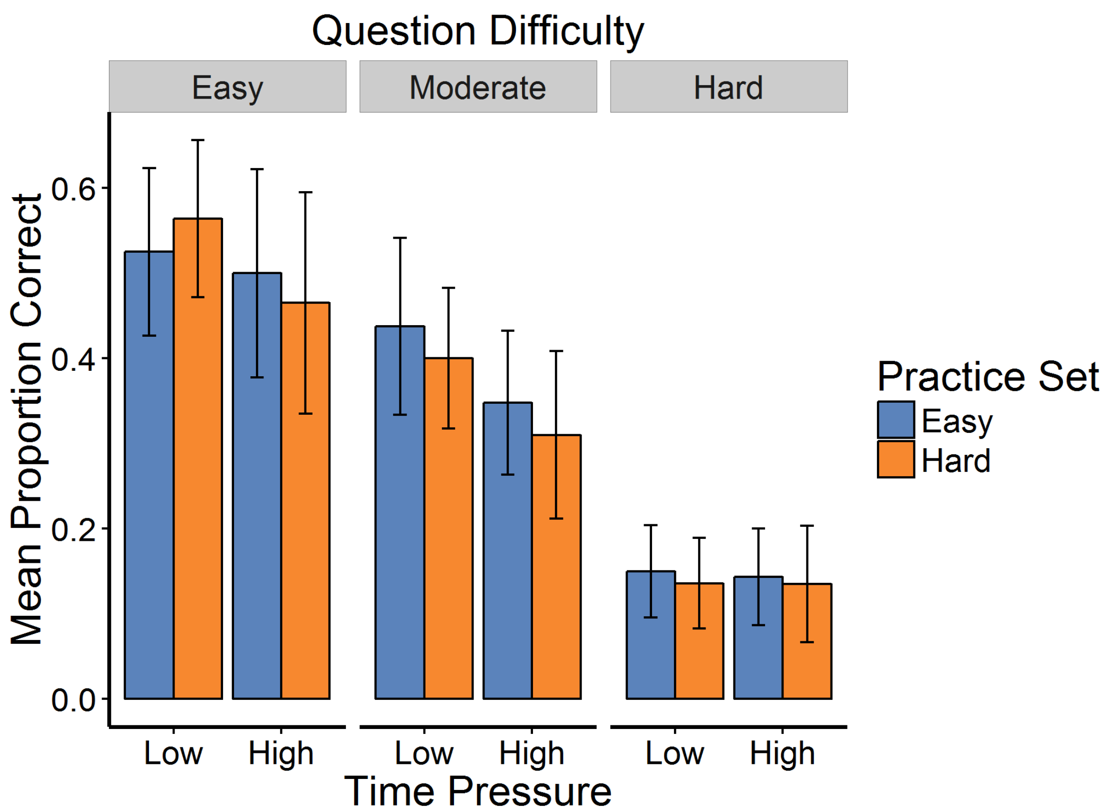
Note. Participants were asked to rate "How difficult do you think the timed test will be?" on a scale ranging from 1 (*Very Easy*) to 5 (*Very Hard*). The mean rating was plotted for each condition of interest. There was a main effect of practice difficulty ($F(1, 88) = 24.56$, $p < 0.001$, $\eta^2 = 0.22$). Error bars represent 95% confidence intervals.

Figure 4. The Pre-test Experimental Manipulation Check of Perceived Time Pressure



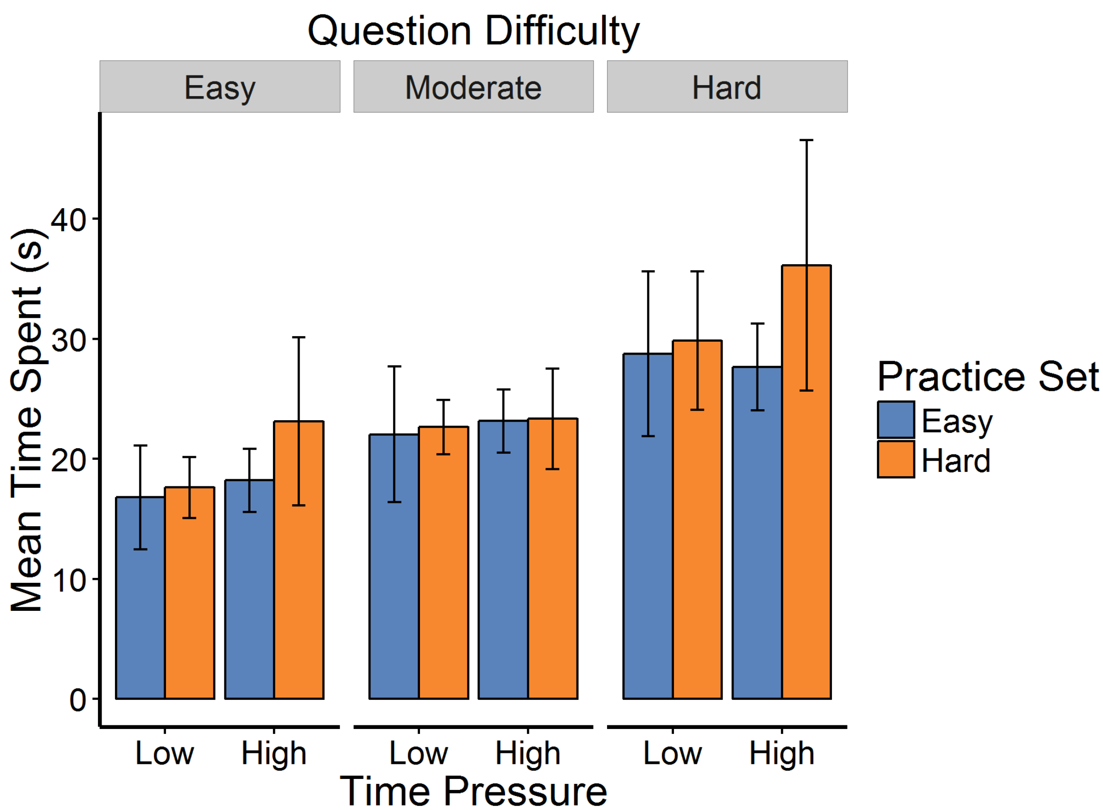
Note. Participants were asked to rate "Do you think you will have enough time to complete the task?" on a scale ranging from 1 (*Definitely Not Enough Time*) to 5 (*Definitely Enough Time*). The mean rating was plotted for each condition of interest. There was a main effect of perceived time pressure ($F(1, 88) = 71.68$, $p < 0.001$, $\eta^2 = 0.45$). Error bars represent 95% confidence intervals.

Figure 5. Mean Proportion Correct of the RAT Test Items



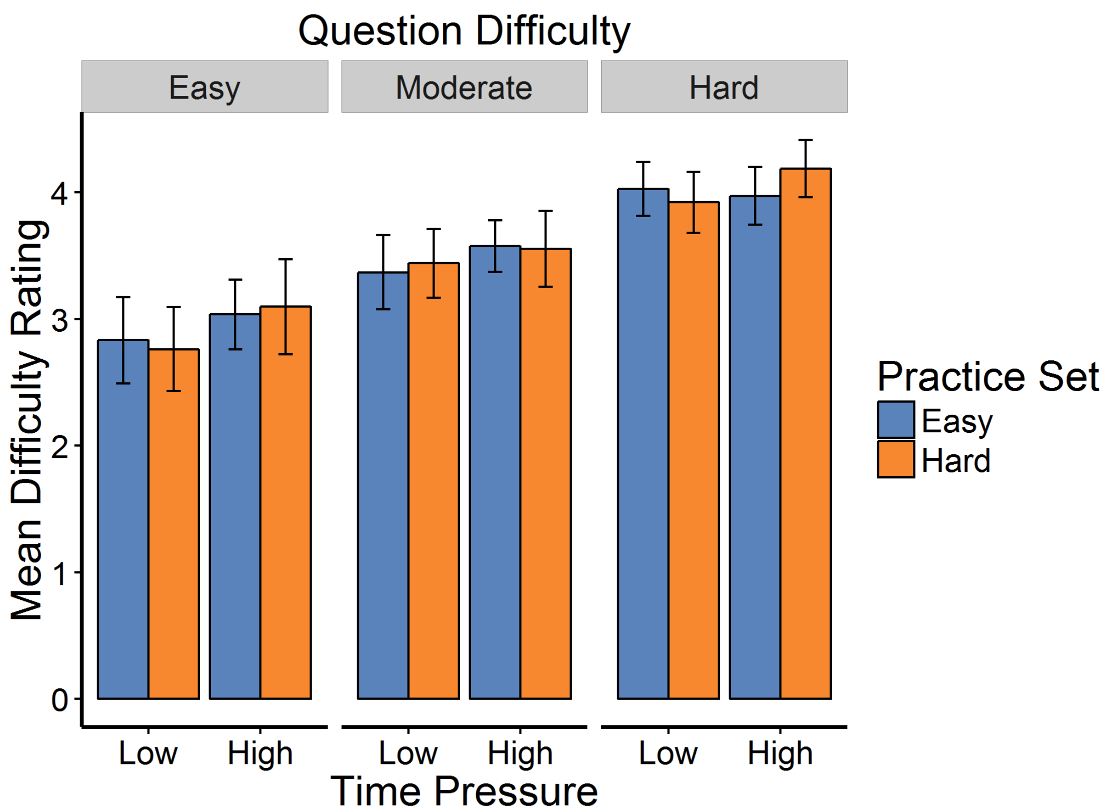
Note. Results from the 2x2x3 mixed model ANOVA using mean proportion correct. The between-subjects factors were the perceived time pressure (i.e., low vs. high) and the practice set (i.e., easy vs. hard). The within-subjects factor was question difficulty (i.e., easy, moderate, and hard). There was a main effect of question difficulty ($F(2, 176) = 166.76$, $p < 0.001$, $\eta^2 = 0.36$). Error bars represent 95% confidence intervals.

Figure 6. Mean Time Spent (in seconds) on the RAT Test Items



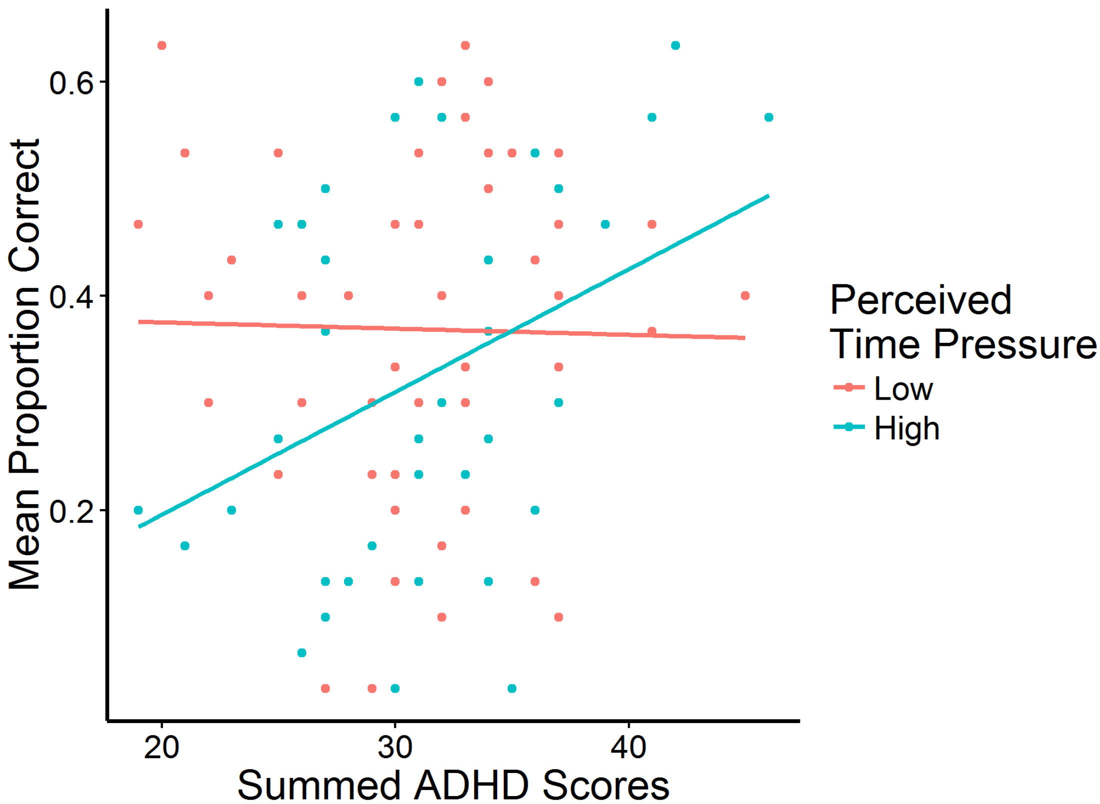
Note. Results from the 2x2x3 mixed model ANOVA using mean time spent (s) on each question. The between-subjects factors were the perceived time pressure (i.e., low vs. high) and the practice set (i.e., easy vs. hard). The within-subjects factor was question difficulty (i.e., easy, moderate, and hard). There was a main effect of question difficulty ($F(2, 176) = 52.42$, $p < 0.001$, $\eta^2 = 0.15$). Error bars represent 95% confidence intervals.

Figure 7. Mean Difficulty Rating of the RAT Test Items



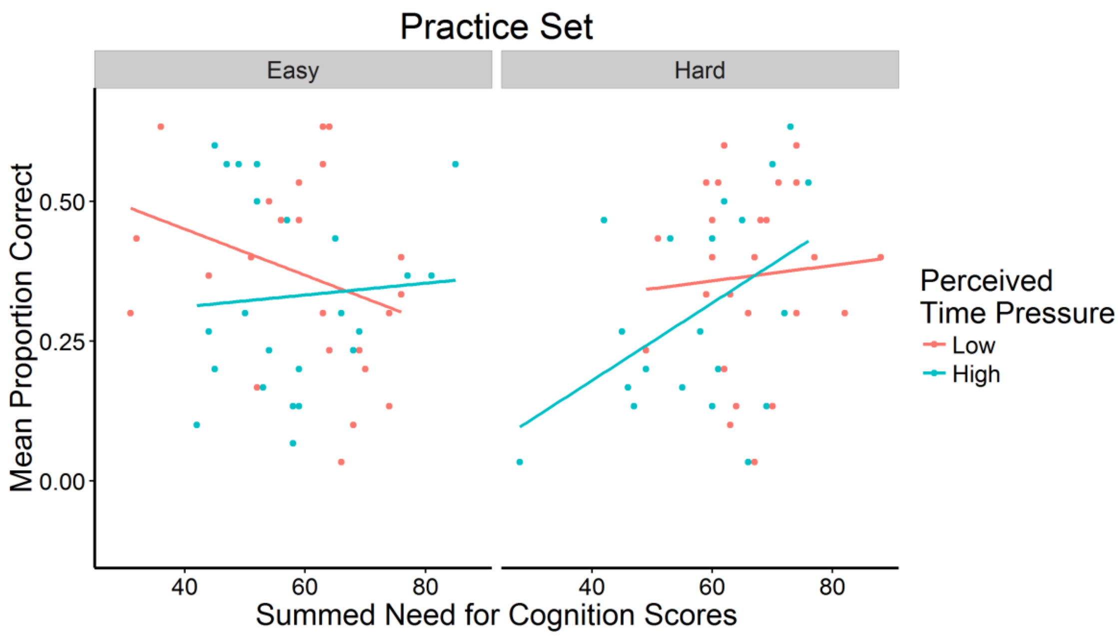
Note. Results from the 2x2x3 mixed model ANOVA using mean difficulty rating of each question. The between-subjects factors were the perceived time pressure (i.e., low vs. high) and the practice set (i.e., easy vs. hard). The within-subjects factor was question difficulty (i.e., easy, moderate, and hard). There was a main effect of question difficulty ($F(2, 176) = 133.72$, $p < 0.001$, $\eta^2 = 0.33$). Error bars represent 95% confidence intervals.

Figure 8. Mean Proportion Correct as a Function of Summed ADHD Scores



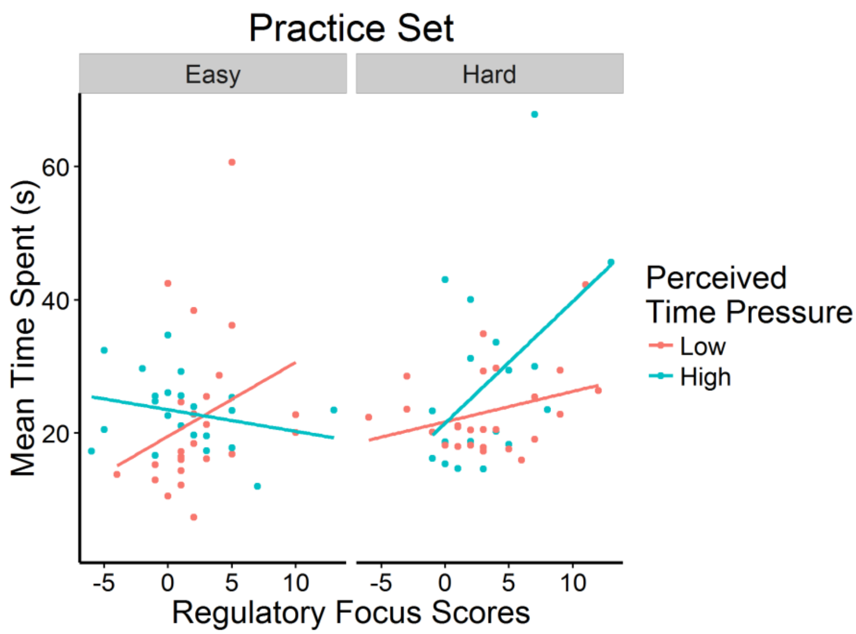
***Note*.** Results from the multiple linear regression analysis of mean proportion correct using perceived time pressure and summed ADHD scores as predictors. There was a main effect of perceived time pressure ($F(1, 88) = 4.72$, $p < 0.05$). Lines represent best fit lines for each perceived time pressure conditions.

Figure 9. Mean Proportion Correct as a Function of Summed Need for Cognition Scores



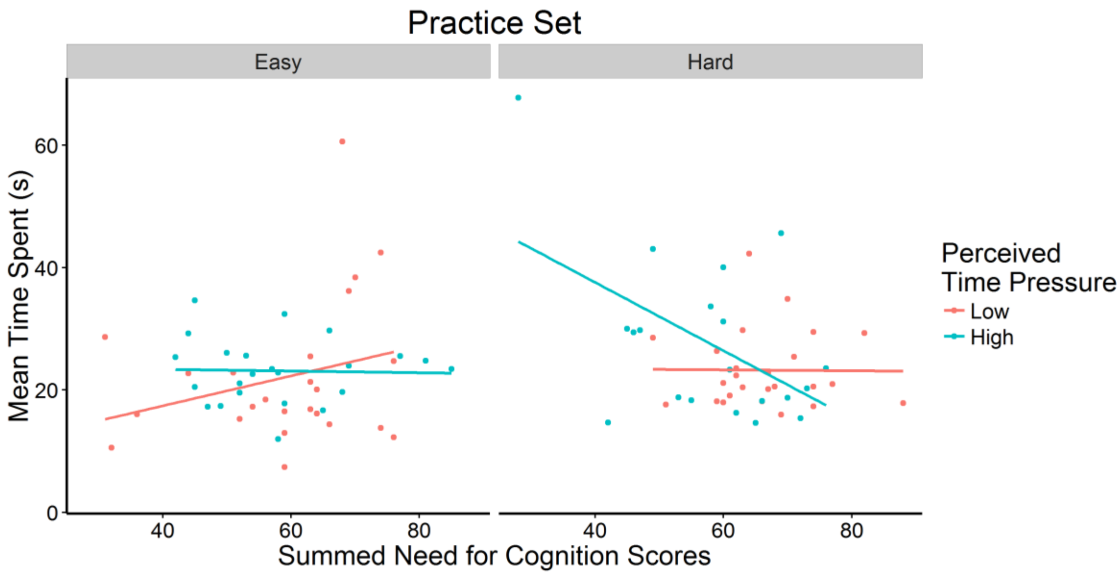
***Note*.** Results from the multiple linear regression analysis of mean proportion correct using perceived time pressure and summed Need for Cognition scores as predictors. Lines represent best fit lines for each perceived time pressure conditions.

Figure 10. Mean Time Spent (s) on RAT Items as a Function of Perceived Time Pressure, Practice Set, and Regulatory Focus Scores



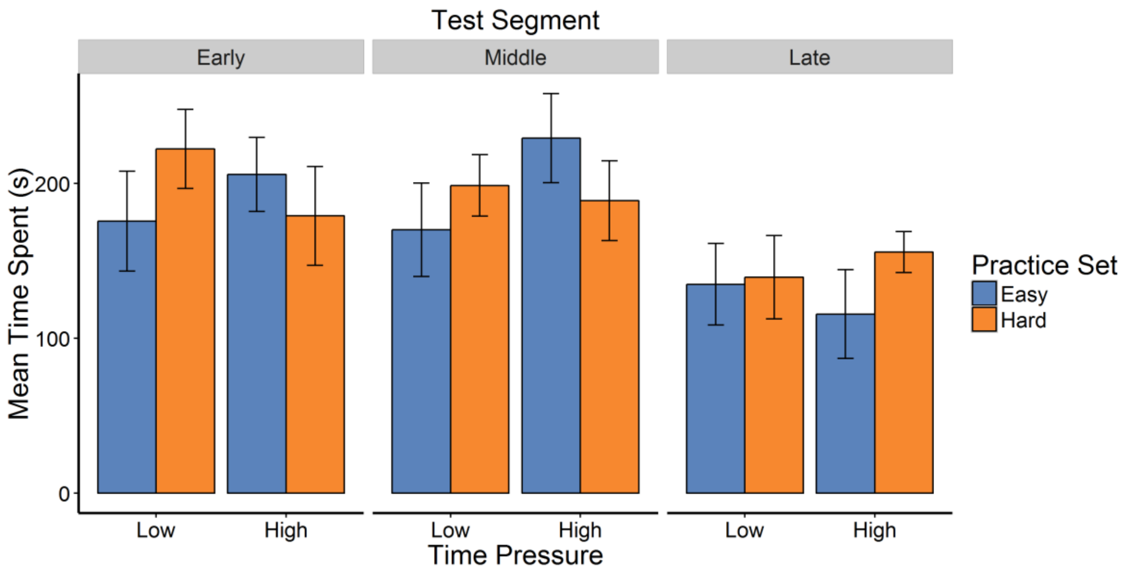
***Note*.** Results from the multiple linear regression analysis of mean time spent on RAT items using perceived time pressure, practice set, and Regulatory Focus scores as predictors. There was a significant three-way interaction between perceived time pressure, practice set, and regulatory focus scores ($F(1, 84) = 6.84$, $p < 0.05$). Lines represent best fit lines for each perceived time pressure and practice set conditions.

Figure 11. Mean Time Spent (s) on RAT Items as a Function of Summed Need for Cognition Scores



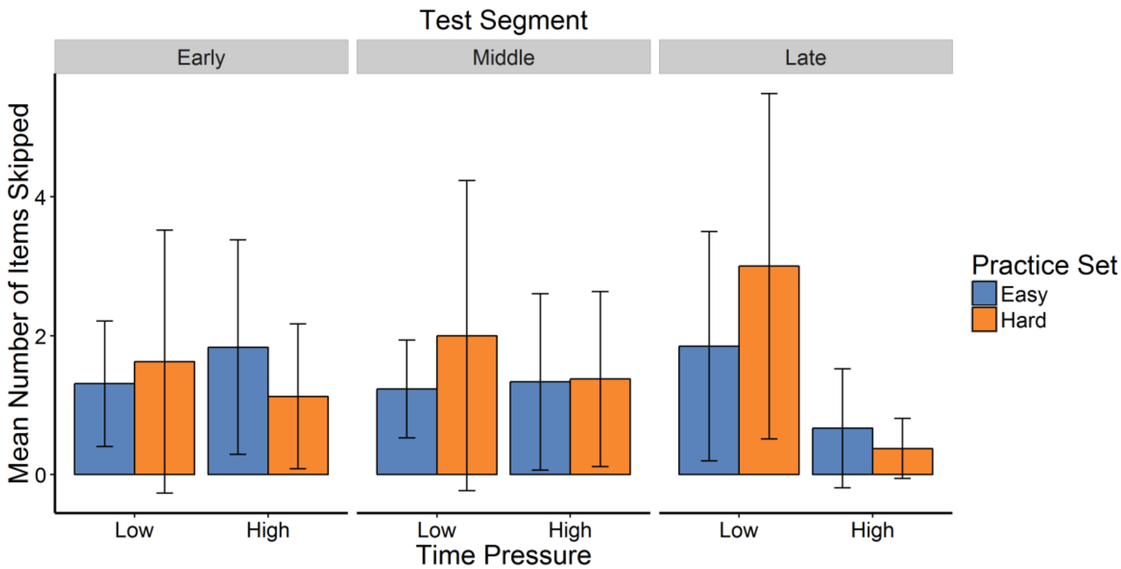
Note. Results from the multiple linear regression analysis of mean time spent on RAT items using perceived time pressure, practice set, and summed Need for Cognition scores as predictors. Lines represent best fit lines for each perceived time pressure condition. There was a significant interaction between perceived time pressure and Need for Cognition ($F(1, 86) = 4.52$, $p < 0.05$) and a significant interaction between practice set and Need for Cognition ($F(1, 84) = 6.59$, $p < 0.05$).

Figure 12. Mean Time Spent (s) on RAT Items as a Function of Perceived Time Pressure, Practice Set, and Test Segment



Note. Results from the 2x2x3 mixed model ANOVA using mean time spent on each question. The between-subjects factors were the perceived time pressure (i.e., low vs. high) and the practice set (i.e., easy vs. hard). The within-subjects factor was test segment (i.e., early, middle, and late). Results showed a significant three-way interaction between perceived time pressure, practice set, and test segment ($F(2, 128) = 4.27$, $p < 0.05$, $\eta^2 = 0.05$). Error bars represent 95% confidence intervals.

Figure 13. Mean Number of Items Skipped as a Function of Perceived Time Pressure, Practice Set, and Test Segment



Note. Results from the 2x2x3 mixed model ANOVA using mean number of items skipped. The between-subjects factors were the perceived time pressure (i.e., low vs. high) and the practice set (i.e., easy vs. hard). The within-subjects factor was test segment (i.e., early, middle, and late). There was a significant interaction between perceived time pressure and test segment ($F(2, 62) = 7.64$, $p < 0.05$, $\eta^2 = 0.05$). Error bars represent 95% confidence intervals.

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