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The Effects of Stress on Delay Discounting Performance for Higher and Lower Intelligence Individuals

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Maintaining self-control can be a draining and arduous task, which may be affected by several external factors, such as stress or IQ level. An experiment was conducted on the effects of induced stress on Delay Discounting (DD) performance, or a measure of self-control, and the extent to which IQ level moderated this effect. Participants recorded their SAT or ACT scores (which were later converted to IQ scores), were exposed to a stress-inducing or control task requiring them to place their arms in ice-cold or luke-warm water, respectively, and then completed a DD task where they made a number of hypothetical decisions asking them to choose between smaller, immediate rewards, or larger, more delayed rewards. Although it was predicted that high IQ individuals, regardless of whether or not they were in the stress or no-stress condition, would be better at delaying gratification than low IQ individuals, this was not found. It was also hypothesized that stress would generally increase delay discounting; however, this relationship was not seen. Finally, the prediction that the negative effects of stress on delay discounting would be minimized for more intelligent individuals was obtained as those in the higher IQ group chose the delayed rewards more often than those in the lower IQ group when they were exposed to stress.

The Effects of Stress on Delay Discounting Performance for High and Low Intelligence Individuals

A little boy sits at the kitchen table waiting for his mother to finish preparing dinner. The boy's mother has tried countless times to get him to sit still without repeatedly asking her when dinner will be ready. Only after he realizes that dinner will not be served until he acts like a "good boy," does he attempt to ignore his desire to devour his food instantly. As the boy waits in his chair, he begins to develop some unusual behaviors in attempts to make his waiting period less difficult. He sits on his hands, averts his attention away from his mother, hums a song to himself and incessantly pets his dog. It would appear that, for this boy, simply waiting for his food is a great challenge.

Exhibiting self-control, as demonstrated by the little boy, is a difficult but rather important process. Although we all attempt to maintain self-control, various factors can impede on this ability, and cause individuals to act on their impulses. Two specific variables are studied in depth in this paper: stress and intelligence (IQ) in attempts to determine if and how they impact individuals' abilities to self-control. These variables were selected for the study on the basis of prior research suggesting they each plays a role in self-regulatory behavior. Although the impact of stress and IQ on self-control measures have been studied in the past, no study has yet looked at their combined influence on self-control. In the current study, Delay Discounting (DD), a commonly used type of self-control measure was used to determine if stress and IQ have an impact on people's abilities to self-control.

To help explain the origin of this research, this introduction is divided into five different sections. In the first section, *Defining Self-Control*, the importance of self-control for people's overall wellbeing is explained. DD, or the specific type of self-control measure used in this research is defined, and I also explain why DD was chosen for the study.

In the next section, *Stress as a Confound of Self-Control*, previous research is discussed, suggesting that individuals experiencing stress have difficulties maintaining self-control. In this section it will become apparent that stress, in many forms, can debilitate and drain individuals from exerting self-control efforts.

To explain how cognition, or more specifically working memory (WM) and self-control ability are related, previous research on WM's influence on decision making is discussed in the third section, *Cognitive Functioning and Self-Control Ability*. While some researchers believe WM influences people's DD abilities, more convincing evidence suggests that IQ, not WM per se, contributes to people's self-regulatory capabilities. In the next section, *The Negative Correlation between Intelligence and Delay Discounting*, this specific link between IQ and DD is further discussed, supporting the idea that individuals with higher IQs have a better chance at resisting temptation, and choosing rewards in DD tasks that require more self-control.

Lastly, in the *Having a High IQ Helps with Coping* section, I show that individuals with high IQs have increased abilities to resist the debilitating effects of stress. In this section, it will be suggested that if individuals with high IQs are subjected to stress, they will do a better job at maintaining their abilities to self-control even though evidence has shown that stress hurts self-control ability.

Defining Self-Control

Self-regulation, or self-control, can enable people to manage their desires, impulses, emotions, and behaviors in attempts to strengthen their long-term best interests (Muraven & Baumeister, 2000; Oaten & Cheng, 2005). The ability to effortfully regulate impulsive thoughts or behaviors can help individuals succeed in their daily lives by resisting less desirable outcomes. Having self-control might, for example, benefit those who are determined to uphold a demanding diet, focus on finishing a difficult paper, or avoid the cravings of smoking a cigarette. It can be difficult to choose between pleasures available now and rewards available in the distant future; however, individuals with considerable self-control will be able to ignore temptation and instead delay gratification.

Individuals with little self-control are faced with difficult obstacles, and have trouble resisting their impulses and avoiding temptation. Those with self-control problems are more likely to have poor academic achievement, increased behavioral problems, and addictions to alcohol, marijuana and other drugs (Bobova, Finn, Rickert, & Lucas, 2009). To avoid these negative consequences, individuals must learn how to ignore their impulsive thoughts, and instead focus on pursuing more distant, long-term goals in hopes of experiencing positive outcomes.

Delay Discounting (DD) is a significant indicator of self-control, because it captures people's abilities to delay gratification for hypothetical rewards. The most commonly used DD task requires individuals to chose between smaller, immediate monetary rewards or larger, more delayed rewards (eg., Shamosh & Gray, 2007). An example DD question is, "Which would you prefer, $100 now or $400 in one year." Reduced preference for the delayed reward, although it has a larger value, exists because of the undesirable outcome of having to wait. A person's decision's to choose the delayed reward over the immediate reward is considered a measure of self-control. Those who prefer smaller, more proximate rewards demonstrate greater DD, and therefore can be considered to have a lower ability to self-control.

Stress as a Confound of Self-Control

Experiencing a stressful situation, especially one in which individuals have little control, can negatively impact decision-making (Keinan, 1987; Klein & Barnes, 1994). It has been suggested that stressed individuals may fail to consider every option in a decision making process, scan the options in a disorganized fashion, and fail to devote adequate time to consider each option (Keinan, 1987; Klein & Barnes, 1994). Klein and Barnes demonstrated that experiencing general life stress, high private body consciousness and high state anxiety can infringe on one's abilities to thoroughly confront complex problems and can consume one's cognitive resources. These individuals who experienced increased life stress made more errors during problem solving tasks, making decisions using non-optimal strategies. Keinan (1987) found similar results: experiencing stress and inadequate decision-making were related. In Keinan's study, participants in the stress condition were threatened with fake electric shocks during an analogy task, and were told that if they answered a question wrong, they would experience a painful, but harmless shock. Individuals in the stress condition often made inadequate and unorganized decisions during an analogy task, and were more likely than the unstressed participants to answer questions before all options were presented. Given these findings, it seems possible that individuals experiencing stress might inadequately consider all the options in a DD task, and for this reason, may chose the more immediate reward, rather than the delayed one.

Experiencing stress has been found to impede self-control, which is one specific type of decision-making process. Dealing with stress is an arduous and emotionally draining task; therefore, when faced with the pressure to cope with stress, individuals may not have enough additional resources to resist temptation, causing their subsequent self-control performance to suffer (Glass, Singer & Friedman, 1969; Muraven & Baumeister, 2000). Muraven and Baumeister provide extensive evidence explaining that individuals have limited strength needed to continuously self-control, and self-control well. Glass et al.'s study demonstrates this finding, and showed that participants in their stress-induced group exhibited poor self-control. After being forced to listen to unpredictable loud noises, participants found it difficult to tolerate their frustrations and to successfully participate in the rest of a proofreading task. Although other participants had the choice of pressing a button to stop the unwanted noise, consequently ending their unwanted stress, those who had no choice but to withstand the music experienced additional stress, and in response, were worse at inhibiting their desires to stop proofreading.

Being exposed to stress, either acute or general, has been linked with a desire to seek out pleasure invoking rewards (Oaten & Cheng, 2005; Muraven & Baumeister, 2000). Not only did the participants in the exam-stress group of Oaten and Cheng's study report a greater feeling of perceived stress and display greater impairments on the Stroop Test, they also experienced difficulties avoiding impulsive behaviors during their daily lives. Their tendencies to smoke and consume caffeine increased, and their healthy eating, physical activity, self-care habits, monitoring of spending, maintaining of sleep patterns and study habits all decreased. While the Oaten and Cheng study demonstrates that acute stress is linked to poor self-control, Muraven and Baumeister suggest that long-lasting stress might also reduce individuals' capabilities to exert the self-control needed to avoid detrimental habits like smoking, drinking or stopping a diet.

A study conducted by Tice, Bratslavsky and Baumeister (2001) on emotional distress and impulse control helps further demonstrate the negative correlation between stress and self-control. Their study found that individuals hoping to reduce their experienced emotional distress are more likely to eat large quantities of food and are unable to delay gratification in a problem-solving task with monetary rewards. Tice et al. found these results by manipulating the participants' emotions, to either feel emotional distress or happiness by making them read a story where a driver either kills or saves a child during a car accident, respectively. Next, participants' moods were either frozen, the experimenter told them their current mood would not change for the duration of the study, or their moods were left to change, and the experimenter told the participant nothing. The participants whose moods were frozen, did in fact, continue to experience that mood for the duration of the study. In their first study, participants tasted three kinds of junk food, demonstrating that those in the distress group ate significantly more than those in the happy group. In their second study, participants completed a problem-solving task where they "fished" for fish in a computer game, playing for money. As the participants caught fish, the amount of available fish to catch depleted, causing the participants to estimate how many fish they should catch before the fish supply ran out. Waiting for the fish to replenish was labeled as an ability to delay gratification.

Individuals in the distress condition consequently delayed gratification less effectively than those in the happy condition. Seeing that emotional distress may be considered a form of stress, stressed individuals may react similarly, and search for immediate pleasurable rewards to escape their unwanted feelings of discomfort.

Children exposed to stress also have trouble resisting temptation (Wang, Karns & Meredith, 2003). To induce stress, Wang, Karns and Meredith provided different amounts of toys to the children participating in their study, creating a high and a low stress condition. In the high stress condition, children were offered two "hardly playable" blocks and in the low stress condition children were offered four blocks and an additional different block with wheels on it, that could be played with in many different ways. There were also two conditions that were included in an attempt to motivate or dissuade children from displaying self-control: the high motivation groups were told not to play with an attention attractor (a toy parrot, which was deemed highly attractive in two pilot studies) and the low motivation groups were not given any instruction on whether on not they could play with an attention attractor. Children in the high stress group displayed increased non-compliant behaviors, and played with the forbidden toy more than those in the low stress group. Children in the high motivation group displayed significantly less noncompliant behavior than those in the low motivation group. Given these results, it can be noted that individuals of all ages can be affected by stress, and can struggle to control their impulses as a result of this stress.

People can experience stress in many ways, and simply not receiving an adequate night of sleep can even have detrimental effects on individuals' abilities to perform successfully in many situations (e.g., Hagger, 2010; Harrison & Horne, 2000). One night of insufficient sleep can temporarily decrease someone's wellbeing; however, when deprived of sleep over a long period of time, individuals gradually lose their abilities to self-control (Barber et al., 2010). Harrison and Horne (2000) explain that sleep deprivation can seriously complicate people's decision-making abilities, causing them to spend more time attending to irrelevant information in certain decision-making tasks.

The aforementioned studies support the notion that stress, in many forms, can negatively impact people's abilities to make smart, less impulsive decisions. Maintaining a high level of self-control is a difficult task; however, when experiencing a heightened level of stress, resisting temptation may seem unfathomable. Whether an experimenter exposes you to a stressful situation or you seem to be having an unusually stressful week at work, this additional burden can have the power to impede your ability to self-control and resist the temptations you might have been able to ignore prior to your stressed state-of-mind. The next section explores a variable that, unlike stress, helps to enhance one's abilities to self-control.

Cognitive Functioning and Self-Control Ability

While stress negatively impacts an individuals' ability to make decisions that help to avoid temptation, individuals with high IQs tend to be good at problem solving and considering every choice's implication. Intelligent individuals, possibly due, at least in part, to their large working memory (WM) capacities, make decisions using considerable self-control. They, unlike individuals with smaller WM capacities have been found to exhibit high levels of self-control, specifically during DD tasks (Shamosh & Gray, 2008).

Evans (2003) highlighted the relationship between intelligence and decision-making and believes that WM plays a large role in peoples' capacities to think and make coherent decisions. Evans discussed the two cognitive systems of cognitive reasoning. System one is comprised of a subset of systems that act autonomously and innately, and system two can be seen as WM, specifically involved in hypothetical thinking and deductive reasoning (which occurs in the DD task). The explicit characteristics of system two help to reduce impulsive tendencies of system one, or the cognitive mechanism that is innate and responsible for general learning. This cooperation between the systems helps keep system one in check, and prevents individuals from making entirely impulsive decisions (Evans, 2003). Increasing evidence has acknowledged system two and its' hard task of controlling inhibitory responses and making logical decisions. People rely on their WM abilities to prevent themselves from becoming distracted by impulsive thoughts or actions; therefore, those with highly functioning WMs may have an easier time considering the most distant solutions in hypothetical situations, like DD tasks (Evans, 2003).

Metcalfe and Mischel's (1999) hypothesized two-system theory of executive processing helps further Evans' idea that cognition and self-control ability are related. Metcalfe and Mischel (1999) believe that there are two types of executive processing driven by a hot and a cool system. The researchers describe the hot system as one's impulsive tendency to act based on emotion, and the cool system as using cognition and strategy to make more contemplative decisions. An interaction between the two systems—one that favors the cool system over the hot system—helps individuals stop from discounting rewards. The cool system's cognitive functioning leads individuals to resist immediate rewards, more so than the hot system. However, if individuals are mostly driven by the hot system, they will act impulsively, making decisions that please their emotions. In addition, high levels of stress affect the two systems. According to Metcalfe and Mischel (1999), as stress increases, the cool system loses control, and the hot system begins to take over, resulting in less self-control and a greater likelihood of making decisions based solely on emotion. The willpower to resist temptation may derive from one's cognitive abilities, or the cool system's potential to suppress the hot system's authority. From this perspective, a powerful cool system helps to avoid temptation and make decisions using self-control.

A link was found between executive functioning, specifically WM capacity, and the ability to make beneficial choices in decision-making tasks in a study by Rakow, Newell and Zougkou's (2010). They found that participants with larger WM capacities commonly chose the maximizing options in binary prediction tasks, or tasks that require participants to make decisions based on the probability that certain outcomes will arise. In some conditions, their results further demonstrated an interaction between IQ and decision-making ability; participants with greater WM capacities and greater IQs made the most beneficial decisions during the study. Not only do these participants tend to choose the option that maximizes their rewards, they also make decisions more quickly than those with lesser WM capacities.

It has also been found that taxing one's WM, or in other words, increasing one's WM load, causes individuals to struggle to delay gratification of monetary rewards during DD tasks (e.g., Hinson, Jameson, & Whitney, 2003; Rakow, Newell & Zougkou, 2010). As participants' WMs were taxed, both with an extrinsic load of digits and with an intrinsic load of increasing the number of evaluated options, participants experienced deficits in their decision-making (Hinson, Jameson, & Whitney, 2003). WM load manipulations also caused participants to increase their reaction times as compared to those who did not receive any WM load manipulations. Although these researchers intentionally induced WM deficiencies, their results strengthen the notion that individuals with inadequate WM abilities are more likely to struggle to self-control.

Although these findings demonstrate a relationship between WM and self-control; stronger evidence exists supporting the idea that IQ is more strongly linked to one's self-control abilities than is WM. However, considering the wide range of evidence showing a significant correlation between individuals' WM capacities and IQ levels, the findings that support the relationship between WM and DD also help to support the larger idea that IQ and DD are related (e.g., Engle, 2002; Kane, Hambrick & Conway, 2005; Suß, Oberauer, Wittmann, Wilhelm, & Schulze, 2002). Individuals with highly functioning WMs may be better able to fully consider both options during a DD task and may therefore better understand the benefits of resisting temptation and choosing the delayed option. However, as seen in the study by Shamosh et al. (2008), WM did not correlate with DD independently of IQ, highlighting IQ's larger role in contributing to DD performance (Shamosh et al., 2008). Apparently, individuals with high IQs, or those with the abilities to reason abstractly in decision-making processes, prefer larger, delayed rewards over smaller, immediate rewards during DD tasks (Shamosh et al., 2008). Although a relationship between cognition and self-control has been addressed, the next section will further address the connection between IQ and DD specifically.

The Negative Correlation between Intelligence and Delay Discounting

It is believed that intelligent individuals are more capable of considering all possible outcomes in decision-making tasks, making it easier for them to determine which decisions are most beneficial. Those with higher IQs constructively approach difficult problems and frequently are capable of providing cohesive explanations for their choices in decision-making tasks (Frederick, 2005). When individuals are requested to give reasons for choosing either the proximate or delayed rewards in DD tasks, DD has been found to decrease, supporting the idea that using cognitive resources will help increase self-control (Benjamin, Brown & Shapiro, 2006). Frederick observed that individuals with high IQs thoroughly contemplated the pros and cons of each presented reward in a DD task and tended to resist temptation and choose the delayed rewards. These participants supported their decisions by explaining, for example, that it would be more beneficial to invest the larger amount of money, rather than the smaller, more proximate amount (Frederick, 2005). In DD tasks, intelligent participants, given their abilities to reason constructively, are at an advantage, with regards to displaying self-control.

To better understand the relationship between IQ and DD, age and its' connection to DD performance should be explored. It has been observed that children's DD performance follows, to some degree, their intellectual progression, and as individuals mature, their IQ improves as well (e.g., Green, Fry & Myerson, 1994; Krietler & Zigler, 1990). As individuals get older, their likelihood to delay discount monetary values decreases**;** sixth graders choose immediate rewards faster than young adults, and young adults choose immediate rewards faster than older adults (Green, Fry & Myerson, 1994). This connection between age and DD, helps to indirectly support the notion that intelligence may be a determining factor in one's ability to self-control.

Although children usually have a difficult time delaying gratification during DD tasks, children with high IQs have a better chance at displaying self-control (Mischel & Metzner, 1962; Rodriguez, Mischel & Shoda, 1989). For children, the use of cognition and the way they focus their attention has been found to have a large effect on whether or not they will choose the immediate or delayed reward during DD tasks (Rodriguez, Mischel & Shoda, 1989). Rodriguez et al. observed children as they sat alone in a room with both potential immediate and delayed edible rewards. The children who waited until the allotted time had passed received the delayed reward: a larger pile of candy. They observed that children with high verbal-intellectual abilities spent a large portion of the delay time ignoring the rewards, and attending elsewhere. Their abilities to focus their attention away from the tempting reward helped as the children with higher verbal-intellectual abilities were more likely to resist giving into their temptations and eventually received the larger reward. Mischel and Metzner's (1962) seminal study on DD provided similar concrete evidence showing a large significant correlation between IQ and DD; the mean IQ of children who chose the delayed reward was 105.7, while the mean IQ of children who chose the immediate reward was 99.0.

Having the ability to delay gratification in childhood has even been found to predict intellectual competence later on in life. Children who portrayed self-regulation in a delay of gratification task, by ignoring the reward available to them during the study and waiting until the study was completed to get the larger reward, did in fact score better on their SATs during adolescence (Shoda, Mischel & Peake, 1990). The children with larger delay times displayed methods needed to distract them from thinking about the reward in front of them. This finding further demonstrates the noteworthy connection between intelligence and self-control ability.

Being more intellectually competent, as demonstrated by college performance, has also been associated with people's abilities to delay gratification. In Kirby, Winston and Santiesteban's (2002) study on DD, participants partook in auctions, bidding on large and small monetary reward options available at 43 different delayed time periods. The participant with the highest bid was required to pay the smaller amount offered, but would receive the delayed amount of money in the number of days specified. A negative correlation was found, showing that participants with higher college GPAs and SAT scores were less likely to delay discount. Individuals who succeed in school are already familiar with having to wait a long period of time to experience the rewards of academic success; one might have to wait a number of days, weeks or even months to receive a paper or test grade. Kirby, Winston and Santiesteban's hypothesis that these individuals, because of their abilities to understand the benefits of delaying gratification, were capable of doing so in their study, and therefore resisted succumbing to their impulses.

Many of the studies conducted on intelligence and DD support the existence of a negative correlation between IQ and DD. Shamosh and Gray's (2008) 24-study meta-analysis found that intelligent individuals chose delayed rewards during DD tasks, more often than less intelligent individuals. Nearly all studies included in the meta-analysis found that participants who preferred the immediate option in a DD task, displayed lower fluid IQs. The results of this meta-analysis can be generalized to many DD situations because studies using a wide range of DD tasks and IQ measures were included: some DD tasks provided real rewards, some provided hypothetical rewards; some DD procedures were commitment-choice paradigms, meaning that participants were unable to change their decisions once they were made, and some were sustained-choice paradigms, meaning that participants could give up receiving larger rewards promised at the end of the study for a reward provided immediately; and some measured verbal IQ only whereas others measured verbal and nonverbal IQ. Considering that many different types of studies were included, their results provide convincing evidence that intelligence and DD decisions are highly correlated.

Having a High IQ Helps with Coping

Not only does having a high IQ improve one's ability to self-control, it also has been shown to help individuals cope with stress. Hisli Sahin, Guler and Basim (2009) showed that individuals with higher cognitive intelligence developed more effective coping strategies for dealing with stress than those with lower cognitive intelligence. Among other variables tested, participants completed the Ways of Coping Inventory (WOCI) and the Raven Standard Progressive Matrices (RSPM), as a measure of cognitive ability. A significant positive correlation existed between ways of coping and cognition. Their results suggest that having high cognitive intelligence might help individuals successfully choose the most effective coping mechanisms, like seeking out social support and remaining optimistic.

Although Gale, Hatch, Batty and Deary's (2009) main interest was the link between cognitive ability and development of psychological distress, they suggested that the ability to cope with threats might be the mediating factor between the two variables. They defended their conclusions reasoning that perhaps higher IQ individuals are better apt at finding "a cognitive 'way out' of potentially stressful stimuli" (Gale et al., p. 597, 2009). Correlational evidence supporting their view comes from Fergusson and Lynskey's (1996) study showing that children and adolescents with higher intelligence are more resilient to stress.

A relationship has also been found between intelligence and risk of developing PTSD. It has been found that children with an IQ of one or more standard deviations above the mean are less likely to develop Post Traumatic Stress Disorder (PTSD), when compared to lower IQ children exposed to the same level of stress (Breslau, Lucia & Alvarado, 2006). The study also found that six-year-old children with IQ scores above the population mean of 100 had a lower risk of being affected by numerous different types of trauma. McNally and Shin (1995) also found a significant relationship between intelligence and PTSD symptoms in adults. The participants were Vietnam combat veterans and their level of intelligence predicted the differences in PTSD. Specifically, the lower a veteran's intelligence, the more severe were his PTSD symptoms.

A Combined Examination of Stress, Delay Discounting and Intelligence

As described above, there is a clearly established link between stress and self-control. Both acute and general stress decrease self-regulation abilities. Moreover, there is considerable evidence that IQ is related to self-control, with higher IQ individuals showing a greater ability to delay gratification. The purpose of the current study was to investigate the extent to which IQ interacts with stress to influence Delay Discounting (DD) performance. To study the interactive effects of stress and intelligence on DD performance, participants were placed into different groups; some received high levels of stress while others received low levels of stress. Before the stress manipulation, participants rated their general level of stress using the first version of the Stait Trait

Anxiety Inventory-Trait Subscale (STAI-T) (Spielberger et al. 1983). Immediately after the stress manipulation, participants rated their current level of stress using the second version of the STAI-T, which allowed me to determine the effectiveness of the stress manipulation. The participants were then asked to complete a DD task that required them to choose between two hypothetical monetary rewards: one smaller, immediate reward or one constant, delayed reward in two conditions. In attempts to distinguish which participants had lower or higher intelligence, their SAT and ACT scores were collected, converted to IQ scores and then used to place participants into either a higher or lower IQ group. Based on past research linking IQ with DD, it was predicted that high IQ individuals, regardless of whether or not they were in the stress or no-stress condition, would be better at delaying gratification than low IQ individuals. It was also hypothesized that stress would generally increase DD, seeing that other researchers have found stress to be an impeding factor on self-control ability. Finally, the critical prediction was that the negative effects of stress on DD would be minimized for more intelligent individuals, given their enhanced abilities to cope with stress. Although having to cope with stress can decrease individuals' abilities to self-control, having a higher IQ may help individuals handle the negative aspects of stress, and enable them to continue making decisions using self-control.

Method

Participants and Design

Eighty-three Union College students, served in exchange for course credit toward their psychology class or for $6.00. Twenty-four of the participants were male and 59 of the participants were female. Participants of all grades completed the study: 22 were freshmen, 13 were sophomores, 19 were juniors and 29 were seniors. Participants were selected only if they agreed to report their SAT or ACT scores. They were randomly assigned to the CPS (stress) or control groups; half of the participants were assigned to the CPS group and the other half were assigned to the control group. To transform SAT and ACT scores into IQ scores, first the ACT scores were converted to SAT scores. Then each participant's SAT verbal and math scores were converted into equivalent IQ scores using a conversion chart (de la Jara). Once IQ scores were determined, participants were divided into those with higher and lower IQs. A median split was performed on IQ scores, and those with an IQ of 126 or lower were placed in the lower IQ group, and those with an IQ of 126 or higher were placed in the higher IQ group. The study was a 2 (High IQ or Low IQ) X 2 (CPS or Control) between subjects design, where the dependent variables were the participants performance on the DD task for both a small and large set of monetary rewards.

Materials

To acquire participants' basic information a sheet with demographic questions was distributed. The demographic sheet can be seen in appendix A. The sheet included sections where participants were able to report their SAT or ACT scores, could report the accuracy of their reported scores and included five demographic questions.

Two versions of the State-Trait Anxiety Inventory Trait Subscale (STAI-T) (Spielberger et al. 1983) were used to measure trait anxiety. Both versions included the same 20 statements; however, the first STAI-T asked the participants to answer each statement based on how they generally feel on a day-to-day basis and the second STAI-T asked the participants to answer based on how they felt while they completed the questionnaire. The first STAI-T is shown in appendix B and the second STAI-T is shown in appendix C. To indicate their feelings, a Likert scale ranging from one to seven was presented at the top of the questionnaire; one meaning strongly disagree, two meaning disagree, three meaning disagree slightly, four meaning neutral/mixed, five meaning agree slightly, six meaning agree and seven meaning agree strongly. Example statements on the subscale were, "I am calm," "I am jittery," and "I am rested".

To implement the Cold Pressor Stress (CPS) two medium-sized plastic buckets, one filled with ice-cold water (32° F to 37° F) and one filled with warm water (99° F to 104° F) were used. After the participants removed their hands from the water, a towel was used to cover and dry their hands.

A computerized DD task program was used to present the DD combinations to the participants. At the start of the task, directions appeared on the computer monitor explaining that the participants would be asked to choose one of two hypothetical monetary reward options in a number of combinations. The computer program presented the various combinations of hypothetical monetary rewards in two conditions. In the smaller reward condition, 20 hypothetical monetary rewards were presented; the delayed reward always remained $200, and the immediate reward varied from $10 to $200 in increments of $10. Table 1 displays the largest and the smallest differentials between the immediate and the delayed monetary rewards presented to the subjects at each of the different delay periods in the smaller reward condition. The 20 hypothetical reward options in the larger reward condition were higher values; the delayed reward always remained $20,000, and the immediate reward varied from $1,000 to $20,000 in increments of $1,000. Table 2 displays the largest and the smallest differentials between the immediate and the delayed monetary rewards presented to the subjects at each of the different delay periods. The delay rewards were delayed across seven time periods: 1 month, 6 months, 1 year, 2 years, 3 years, 5 years and 8 years, and each of these time periods was presented twice with every DD combination, once in ascending order and once in descending order.

Procedure

Prior to the start of the study the researcher distributed consent forms to the participants explaining the general purpose of the study (to learn more about how individuals make decisions), the general procedure, and that all information used in the study would remain anonymous and confidential. The participants were again reminded that they were permitted to withdraw from the study at any moment without penalty. The subjects were then asked to report their verbal, quantitative, writing and total SAT scores or their total ACT score as best as they could remember on a blank sheet of paper. Prior to the study, participants were informed they should come prepared to report these scores accurately, as they would be imperative for the accuracy of the study. They were also asked to report how accurate they believed their reported scores were on a scale of one to ten, one being completely unsure and ten being completely sure that their scores were correct. The participants were again reassured that this information would remain anonymous and confidential. Next, the researcher distributed the STAI-1, which asked the participants to indicate how they generally feel on a day-to-day basis (Spielberger, Gorsuch, Lushene, Vagg & Jacobs 1983).

After the participants finished the first STAT-T, they either completed the CPS or participated in the warm water control condition. The CPS is a commonly used, low-risk technique to induce stress (Cahill, Gorski & Le, 2003; Schoofs, Wolf & Smeets, 2009). The subjects in the CPS group were instructed to submerge their left arms, up to the elbow in ice-cold (32° F to 37° F) water. The researcher told the participants to try their hardest to keep their arms immersed in the water for as long as possible or until three minutes had passed. They were explicitly informed that the procedure might be particularly uncomfortable, and they could remove their arms from the ice-cold water whenever they pleased, without any repercussions. They were also informed that while the task might be uncomfortable, it would not cause permanent damage. Participants who kept their arms in the water for three minutes were told to remove their arm at that time. The participants in the warm (99° F to 104° F) water condition were instructed to keep their arms submerged for either one, two or three minutes in an attempt to roughly match the amount of time subjects in the cold water condition kept their arm submerged. Following the CPS or the control task, the participants rested for three minutes, with a towel wrapped around their left arms. The participants were then asked to rate the level of discomfort they experienced during the water task on a scale of 1 to 100 based on the worst physical pain they ever experienced. Then they were asked to complete the second STAI-T, asking them to indicate how they were feeling at the moment.

Directly following the second STAI-T, the DD task was administered using a computer software program called Inquisit (Draine). The participants read the directions presented on the computer monitor and began the task whenever they were comfortable with the procedure. They were informed to consult the researcher with any questions they had about the computer program. The task required participants to choose between two hypothetical monetary rewards: one smaller, immediate reward or one constant, delayed reward multiple times in two conditions. The participants indicated which monetary value they preferred by clicking on one of the two monetary values presented on the screen with the mouse.

Table 1 and Table 2 display all the presented reward options for both the small reward and large reward condition, respectively. The order that the two reward conditions were given was counterbalanced; half of the participants were first presented the smaller monetary rewards followed by the larger monetary rewards, and the other half of the participants were first presented the larger monetary rewards followed by the smaller monetary rewards**.** For each delayed time period, the presented monetary values either ascended from the lowest possible value to the highest possible value and then descended back down to the lowest possible value or descended from the highest possible value to the lowest possible value and then ascended back to the highest possible value. Half of the participants were given the descending order first followed by the ascending order, with the other half receiving the opposite order. Immediately following the DD task the researcher debriefed the participants.

The Area Under the Curve (AUC) empirical discounting function was used to measure delay discounting. The X-axis represents the extent to which the delayed reward is delayed and the Y-axis represents the proportional value of the delayed reward relative to the immediate reward. If a participant values the delayed reward equally to the immediate reward, he or she is likely to choose the delayed rewards often, and refrain from delay discounting. The more a person delay discounts, the lower the AUC is, because the curve drops quickly, leaving little area under the curve.

Small Reward Condition		
Range of Immediate Monetary Rewards Presented	**Delayed Monetary Reward Presented**	**Delay Periods**
10-200	200	1 month
10-200	200	6 months
10-200	200	1 year
10-200	200	2 years
10-200	200	3 years
10-200	200	5 years
10-200	200	8 years
10-200	200	8 years
10-200	200	5 years
10-200	200	3 years
10-200	200	2 year
10-200	200	1 year
10-200	200	6 month
10-200	200	1 month

Table 1. The immediate monetary reward presented varied from $10 to $200 in increments of $10 and was presented with the $200 delayed monetary reward at each of the 14 delay periods.

Large Reward Condition		
Range of Immediate Monetary Reward Presented	**Delayed Monetary Reward Presented**	**Delay Periods**
1,000-20,000	20,000	1 month
1,000-20,000	20,000	6 months
1,000-20,000	20,000	1 year
1,000-20,000	20,000	2 years
1,000-20,000	20,000	3 years
1,000-20,000	20,000	5 years
1,000-20,000	20,000	8 years
1,000-20,000	20,000	8 years
1,000-20,000	20,000	5 years
1,000-20,000	20,000	3 years
1,000-20,000	20,000	2 years
1,000-20,000	20,000	1 year
1,000-20,000	20,000	6 month
1,000-20,000	20,000	1 month

Table 2. The immediate monetary reward presented varied from $1,000 to $20,000 in increments of $1,000 and was presented with the $20,000 delayed monetary reward at each of the 14 delay periods.

Results

Participants recorded how accurate they believed their reported SAT or ACT scores were on a scale of 1 to 10, with 1 meaning their reported scores were completely inaccurate and 10 meaning their reported scores were completely accurate. The mean level of accuracy for the reported SAT and ACT scores was 8.30, with a standard deviation of 1.64.

The CPS test proved to be a painful and difficult task to complete. While participants in the stress-condition could leave their arm in the cold water for up to 180 seconds, the mean length of time participants kept their hand in the cold water was only 105.45 seconds. On a scale from one to 100, participants were asked to rate the level of discomfort they experienced during the cold water task, one being no pain at all and 100 being the worst physical pain they had ever experienced. Participants subjected to the CPS reported a mean level of discomfort of 50.71, while participants in the warm water condition reported a mean level of discomfort of only 2.63.

The first STAI-T questionnaire was used to measure participants' general anxiety levels, whereas the second STAI-T questionnaire was used to measure participants' anxiety levels immediately following the stress manipulation. For both STAI-T versions, the lowest possible score was a 20 and the highest possible score was a 140. Participants in both the stress and no-stress condition demonstrated similar anxiety levels for the first STAI-T; the mean score for the stress condition was 59.1 and the mean score for the no-stress condition was 62.9. The mean scores for the second STAI-T demonstrated the differences in anxiety for participants in either the cold or warm water condition. Lower IQ individuals in the stress condition had a mean score of 61.9 and higher IQ individuals in the stress condition had a mean score of 65.8. Whereas, those in the no-stress condition demonstrated lower anxiety scores. Lower IQ individuals had a mean score of 52.6 and higher IQ individuals had a mean score of 46.2. An independent groups t-test revealed that lower IQ individuals did not score significantly higher than higher IQ individuals on the first (trait) STAI-T subscale, $t(81) = -.37$, $p = .71$. However, after the participants completed either the CPS or the warm water task, their scores on the second STAI-T differed, such that the participants in the high stress group demonstrated higher anxiety levels. This difference was demonstrated by a 2 (IQ group: lower or higher) x 2 (Stress group: CPS or control) between subjects analysis of variance (ANOVA) performed on the second STAI-T scores, and showed that the main effect of stress group was significant, $F(1, 79) = 19.94$, $p = .000$. However, the main effect of IQ group and the interaction effect were not significant, F(1, 79) = .151, p = .686 and F(1, 79) = 2.54, p = .115, respectively.

To help verify that it was the CPS manipulation that caused the increase in anxiety levels, a Pearson's r was performed to test the relationship between the time participants left their hands in the ice water and their scores on the STAI-S, and revealed a significant correlation, r (N = 83) = -.252, p = .021. Individuals who scored higher on the second STAI-T were more likely to remove their arm from the ice-cold water after a shorter amount of time, which can be seen in Figure 1. This demonstrates that individuals who found it most difficult to maintain their hand in the ice water tended to report the highest anxiety.

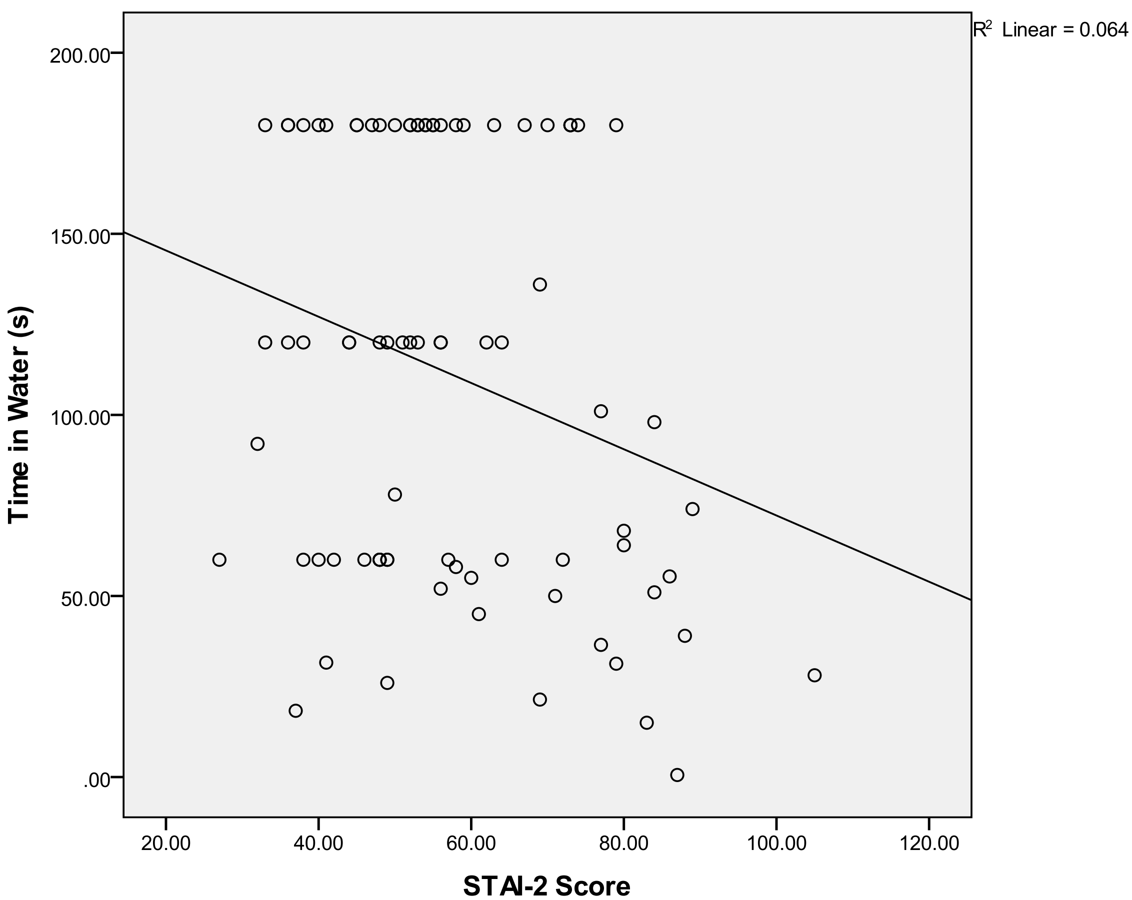

Figure 1. The relationship between the second STAI-T scores and the amount of time participants left their arm in the ice-cold water.

Considering there were two reward conditions in the DD task, the large reward condition and the small reward condition, the results for each condition will be presented separately. Figure 2 shows the difference in DD performance in the small reward condition for the four different groups. A 2 (Stress group: CPS or control) x 2 (IQ Group: lower or higher) between subjects analysis of variance (ANOVA) was conducted on the AUC for the DD reward condition. It revealed that the stress group x IQ group interaction was significant, $F(1, 79) = 7.07$, $p = .009$. However, neither the main effect of the condition group or the main effect of the IQ group were significant, $F(1, 79) = .224$, $p > .05$, and $F(1,79) = .394$, $p > .05$, respectively. Considering the interaction was significant, follow-up t-tests were performed on the AUC for the small reward condition, and showed that under conditions of no stress, lower IQ participants performed marginally better than higher IQ participants, $t(36) = 2.01$, $p = .052$, whereas under conditions of high stress, higher IQ participants did marginally better than lower IQ participants, $t(43) = -1.67$, $p = .102$.

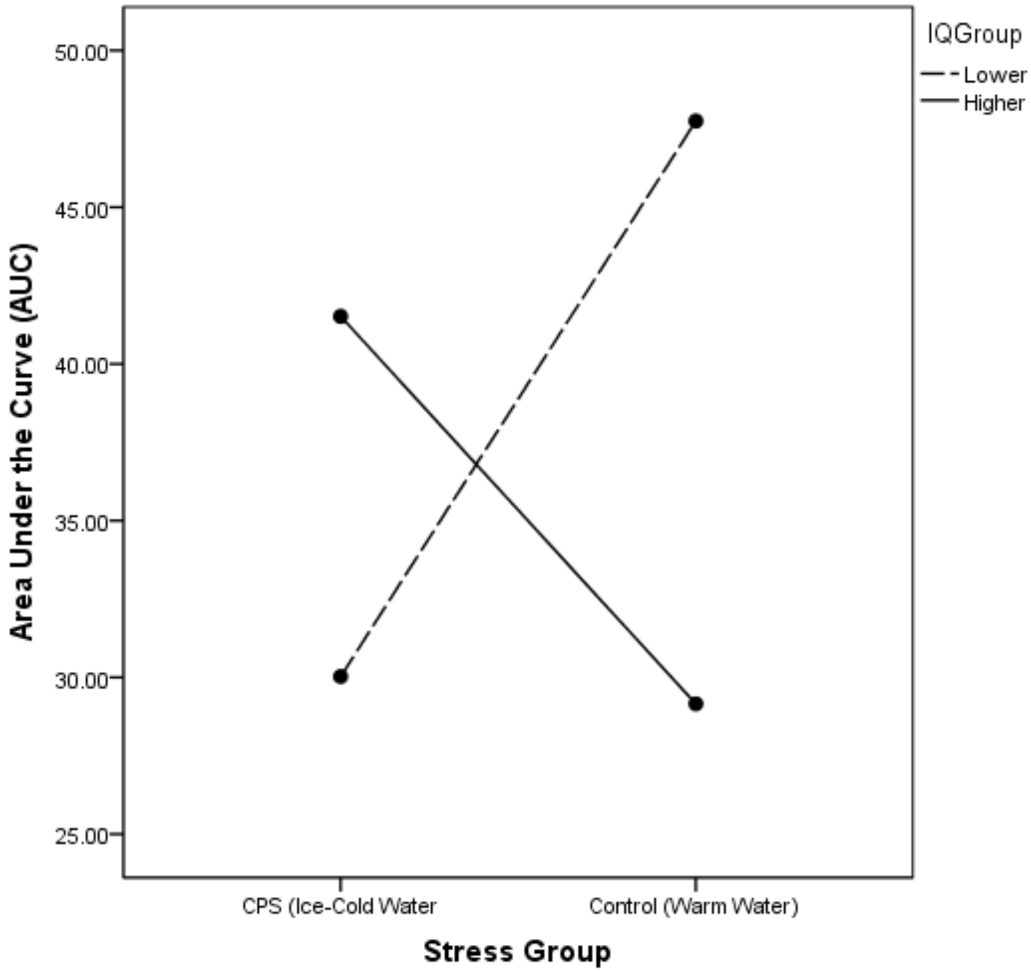

Figure 2. The Area Under the Curve (AUC) for the small DD reward condition as a function of stress group and IQ group.

Figure 3 demonstrates the difference in DD performance during the large reward condition for the four different groups. A 2 (Stress group: CPS or control) x 2 (IQ Group: lower or higher) between subjects analysis of variance (ANOVA) was conducted on the area under the curve (AUC) for the large reward condition. Neither the main effect of the stress group or the main effect of the IQ group were significant, $F(1,79) = .63$, $p = .430$, and $F(1,79) = 1.99$, $p = .162$. Furthermore, the stress group x IQ group interaction did not reach significance, $F(1, 79) = 2.35$, $p = .130$. Although the interaction was not significant, it approached significance similar to the interaction found for the small reward condition, so follow-up t-tests were conducted. These independent groups t-tests revealed that under conditions of no stress the two IQ groups did not differ, t(36) = .075, p = .941, but under conditions of high stress, the higher IQ group performed significantly better than the lower IQ group, t(43) = -2.40, p = .021.

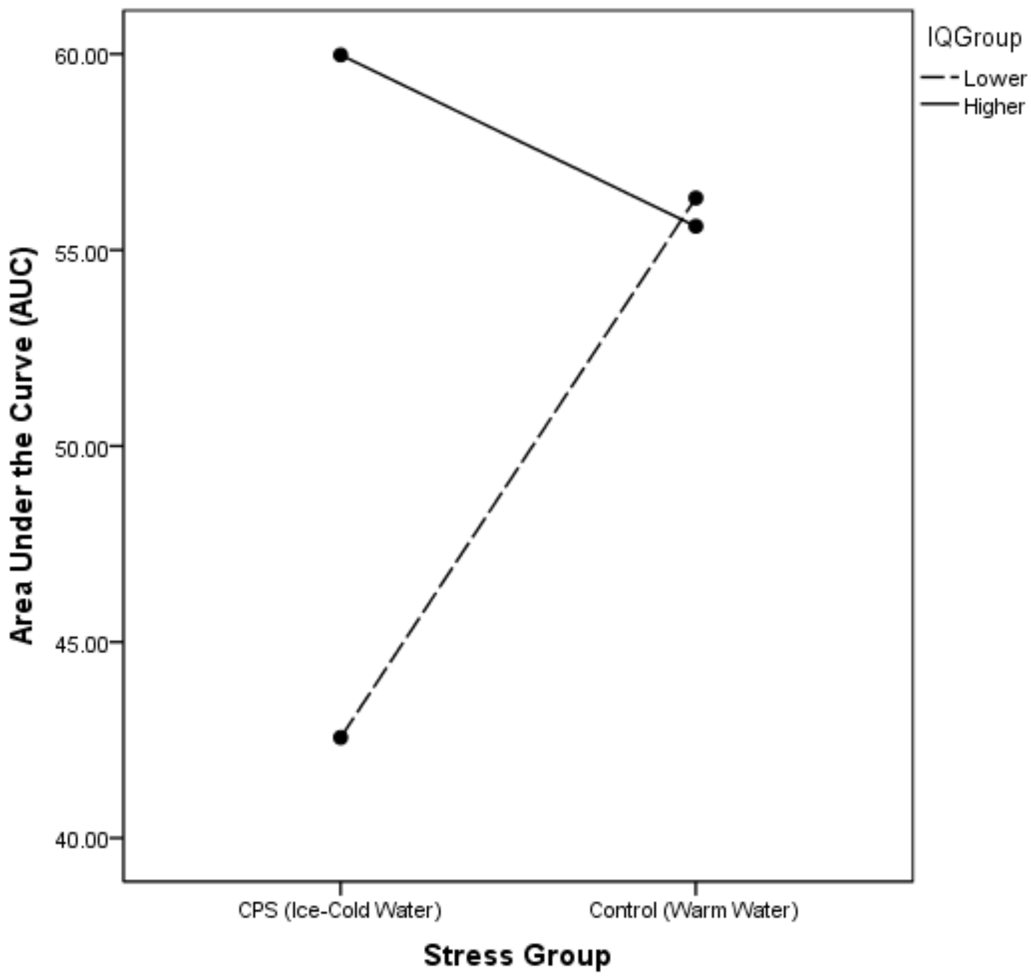

Figure 3. The Area Under the Curve (AUC) for the large DD reward condition as a function of stress group and IQ group.

Discussion

The present study was designed to test the combined effects of stress (high and low) and IQ level (high and low) on delay discounting (DD). The first hypothesis predicted higher IQ individuals to delay discount less than lower IQ individuals, on average choosing the delayed rewards more often. Although previous studies have demonstrated this finding, the present study failed to find this result. Instead, high IQ individuals, while they delay discounted less when they were in the stress condition, performed slightly worse than the low IQ individuals in the no-stress group during the large reward condition, and considerably worse in the small reward condition. It was also hypothesized that individuals in the stress condition would delay discount more than those in the no-stress condition. However, the main effect of stress was not significant. Although this hypothesis was not fully supported, this was due to the fact that IQ interacted with stress to affect DD. Lastly, it was hypothesized that the negative effects of stress on delay discounting would be minimized for more intelligent individuals. This prediction generally held true, and was especially found for participants in the large reward condition. In this condition, higher IQ participants delay discounted significantly less than lower IQ participants, suggesting that they better dealt with stress.

The present study provides the first evidence that higher IQ individuals are better adept at delaying gratification than lower IQ individuals after being exposed to stress. This result not only helps strengthen past research emphasizing the notion that more intelligent individuals better cope with stress, but it also demonstrates that higher IQ individuals have the ability to withstand the impediments of stress on self-control. While many researchers claim that individuals experiencing stress have difficulties maintaining self-control, the current study challenges this idea, showing that stress does not affect more intelligent individuals' abilities to self-control (Oaten & Cheng, 2005; Muraven & Baumeister, 2000; Wang, Karns & Meredith, 2003). Although this result was found for the large reward condition, significance was not found for the small reward condition, and higher IQ individuals did not delay discount significantly less than the lower IQ individuals in the stress condition, although the results were clearly in the same direction. One reason for the weaker effect with the small reward condition may be because more than half the participants had family incomes of 100,000 dollars or more (the highest possible choice on the demographic questionnaire). Perhaps these individuals were unable to fully appreciate the lower presented values in the small reward condition, causing them to devalue having to wait, and consequently more often choosing the more immediate rewards.

Given past research it was surprising not to find a main effect of intelligence on DD. Many other studies have found that in no stress conditions, higher IQ individuals perform better on DD tasks than lower IQ individuals. Shamosh and Gray (2008) determined this to be true in their 24-study-meta-analysis, demonstrating that across the board, various studies investigating the connection between IQ and DD found a negative correlation. Previous research demonstrating a significant negative correlation between IQ and DD suggest that researchers should not use chance payoffs in their DD task, should have enough participants with a higher socioeconomic status, and should measure general intelligence rather than verbal intelligence (Shamosh and Gray, 2008). Although the current study followed these suggested guidelines, a negative correlation between the two variables was not found. For studies that have shown little to no connection between the two variables, Shamosh and Gray (2008) suggest the lack of a relationship is possibly because of motivational individual differences, urging people to make decisions based on their own preferences.

While much can be determined from this study, there exist some limitations which help highlight why the interaction between IQ and DD may not have occurred. First, the sample only consisted of 83 participants, making it difficult to show significance with approximately only 20 participants in each of the four main groups. Second, the participants were all college students, ages 18 to 22. Given that the students were enrolled at a highly selective college, the range of SAT and ACT scores they provided was narrow, with the lowest IQ score = 108.74. The mean IQ score was 126.66, possibly making it difficult to see significance for IQ and DD, considering the lower IQ individuals had above average IQs. Third, the students self-reported their SAT or ACT scores, possibly resulting in an inflation of scores. While they were asked to look up their scores using the College Board website prior to the study, there was no way of ensuring the participants followed through with this request. Since their scores were self-reported, the findings in this study may not be completely accurate. However, the mean level of accuracy for reported SAT or ACT scores was 8.30, which is relatively high considering 10 signified completely accurate reported scores.

Future research on the combined effects of IQ and stress on self-control would be helpful to strengthen the results of this study. While it was difficult to get non-students to participate, future research might include participants from different types of educational backgrounds, not only from well-respected universities. To validate the results, researchers should obtain participants' actual SAT or ACT scores, or if possible assess participants' IQ scores directly.

While the current study looked at DD specifically, future research may investigate whether a combined effect of IQ and stress occurs for other self-control measures. If similar results exist, the findings could be generalized to explain that high IQ individuals, regardless of the stress they may be experiencing, have the capability to continue making decisions with a high degree of self-control.

The present study projects that higher IQ individuals may be capable of ignoring the negative effects of stress and focusing on the task at hand: self-controlling during a DD task. While research has shown that experiencing stress limits peoples' abilities to self-control, this study shows that individuals, even if they are experiencing stress, may be able to self-control if they have a high intellectual capacity. The results might explain why individuals with high IQs do well in high-stress jobs, and maintain the ability to make smart decisions. Perhaps higher IQ individuals, regardless of the amount of stress they may be experiencing in their lives, resist certain impulses and refrain from making rash decisions, like turning toward drugs or binge eating. While Oaten and Cheng (2005) proved that participants exposed to stress demonstrated an increased desire to seek out pleasure-invoking rewards, perhaps the higher IQ individuals resisted their impulses more so than lower IQ individuals. Lower IQ individuals could benefit from these findings too, and learn to take preventative measures to maintain self-control during a time of increased stress. These results may also be important to competitive businesses, taking into account the level of intelligence their future employees demonstrate. While some high-stress companies hire employees for their charisma and great interpersonal skills, they may want to emphasize employee intelligence as well.

Future research may wish to investigate what encourages or allows high IQ individuals to delay gratification and resist choosing the immediate rewards. Past research shows that higher IQ individuals carefully make decisions by thinking about the broader picture, justifying each decision with a reasonable answer (Frederick, 2005). It would be interesting to see whether or not high IQ individuals in the stress condition had specific reasons for making their decisions. Do these individuals continue to think logically about their decisions even after they completed a stress-inducing task, or do they make decisions at an implicit level? It would be noteworthy to discover whether or not high IQ individuals are still able to give a good reason for delaying gratification even when they are experiencing increased stress. Similarly, it seems critically important to understand the changes that occur in lower IQ individuals under stressful conditions that cause the decrease in self-control.

Appendices

Appendix A

SUBJECT NUMBER________

Please record either one of the two scores, SAT scores are preferred; however, if you only took the ACT or can more accurately remember your ACT score, please record that instead.

SAT Math Score__________

SAT Verbal Score___________

SAT Writing Score___________ or ACT Total Score___________

Total SAT Score______________

Indicate how accurate you believe these scores are on a scale from 1 to 10; 1 meaning these scores are definitely not correct and 10 meaning these scores are definitely correct.
____

Circle One:

1. Male Female

2. Freshman Sophmore Junior Senior

3. What do you consider your family income to be?

   Low Income (10,000-40,000) Middle Income (50,000-90,000) High Income (100,000 and up)

4. How many siblings do you have?

   None One Two Three More than Three

5. What is the highest level of education your parents have completed?

   Mother: Less than High School High School College Degree

Master's Degree Doctoral Degree

Father: Less than High School High School College Degree

Master's Degree Doctoral Degree

Appendix B

Below you will find a number of statements that people have used to describe themselves. Read each statement and then choose the most appropriate number to indicate how you generally feel, on any given day. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your general feelings.

1	2	3	4	5	6	7
Disagree Strongly Strongly	Disagree Slightly	Disagree	Neutral/Mixed	Agree Slightly	Agree	Agree Agree

___1. I am calm.

___2. I am secure.

___3. I am tense.

___4. I am regretful.

___5. I am at ease.

___6. I am upset.

___7. I have misfortunes.

___8. I am rested.

___9. I am anxious.

___10. I am comfortable.

___11. I am self-confident.

___12. I am nervous.

___13. I am jittery.

___14. I am high-strung.

___15. I am relaxed.

___16. I am content.

___17. I am worried.

___18. I am over-excited.

___19. I am joyful.

___20. I am pleasant.

Appendix C

Please report the level of discomfort you experienced during the water task on a scale of 1 to 100, 1 representing no pain and 100 representing the worst physical pain you have ever experienced in your life.

The number level of discomfort you experienced during the task: _______

Below you will find a number of statements that people have used to describe themselves. Read each statement and then choose the most appropriate number to indicate how you are **feeling RIGHT NOW.** There are no right or wrong answers Do not spend too much time on any one statement but give the answer which seems to describe your feelings best.

1	2	3	4	5	6	7
Disagree Strongly	Disagree Slightly	Disagree	Neutral/ Mixed	Agree Slightly	Agree	Agree Strongly

___ 1. I am calm.

___ 2. I am secure.

___ 3. I am tense.

___ 4. I am regretful.

___ 5. I am at ease.

___ 6. I am upset.

___ 7. I get have misfortunes.

___ 8. I am rested.

___ 9. I am anxious.

___ 10. I am comfortable.

___ 11. I am self-confident.

___ 12. I am nervous.

___ 13. I am jittery.

___ 14. I am high-strung.

___ 15. I am relaxed.

___ 16. I am content.

___ 17. I am worried.

___ 18. I am over-excited.

___ 19. I am joyful.

___ 20. I am pleasant.

References

Barber, L.K., Munz, D.C., Bagsby, P.G., & Powell, E.D. (2010). Sleep consistency and sufficiency: Are both necessary for less psychological strain? *Stress and Health*, 26, 186–193.

Benjamin, D. J., Brown , S. A., & Shapiro, J. M. (2006). Who is “behavioral”? Cognitive ability and anomalous preferences. Harvard University. Retrived February 27, 2011 from http://www.nber.org/public_html/confer/2005/si2005/ls/shapiro.pdf

Bobova, L., Finn P. R., Rickert, M. E., & Lucas, J. (2009) Disinhibitory psychopathology and delay discounting in alcohol dependence: Personality and cognitive correlates. *Experimental and Psychopharmacology,* 17(1), 51-61.

Breslau, N., Lucia, V. C., & Alvarado, G. F. (2006). Intelligence and other predisposing factors in exposure to trauma and posttraumatic stress disorder. *American Medical Association,* 63, 1238-1245.

Cahill, L., Gorski, L., & Le, K. (2003). Enhanced human memory consolidation with post-learning stress: interaction with the degree of arousal at encoding. *Learning and Memory,* 10, 270-274.

de la Jara, Rodrigo. SAT I to IQ Estimator. Retrieved from http://www.iqcomparisonsite.com/SATIQ.aspx.

Draine, Sean. Inquisit: Millisecond Software [computer software]. Washington: Seattle.

Engle, R. W. (2002). Working memory capacity as executive attention. *Current Directions in Psychological Science*, 11(1), 19-23.

Evans, J. (2003). In two minds: dual-process accounts of reasoning. *Trends in Cognitive Sciences,* 7(10), 454-500.

Fergusson, D. M., & Lynskey, M. T. (1996). Adolescent resiliency to family adversity. *Journal of Child Psychology and Psychiatry,* 37(3), 281-292.

Frederick, S. (2005). Cognitive reflection and decision making. *Journal of Economic Perspectives,* 19(4), 25-42.

Gale, C. R., Hatch, S. L., Batty, G. D., & Deary, I. J. (2009). Intelligence in childhood and risk of psychological distress in adulthood: The 1958 national child development survey and the 1970 british cohort study. *ScienceDirect*, 37, 592-599.

Glass, D. C., Singer, J. E., & Friedman, L. N. (1969). Psychic cost of adaptation to an environmental stressor. *Journal of Personality and Social Psychology,* 12(3), 200-210.

Green, L., Fry, A. F., & Myerson, J. (1994). Discounting of delayed rewards: A life-span comparison. *Psychological Science,* 5(1), 33-36.

Hagger, M. S. (2010). Sleep, self-regulation, self-control and health. *Stress and Health,* 26, 181-185.

Harrison, Y., & Horne, J. A. (2000). Impact of sleep deprivation on decision making: a review. *Journal of Experimental Psychology: Applied,* 6(3), 236-249.

Hinson, J. M., Jameson, T. L., & Whitney, P. (2003). Impulsive decision making and working memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition,* 29(2), 298-306.

Hisli Sahin, N., Guler, M., & Basim, H. N. (2009). The relationship between cognitive intelligence, emotional intelligence, coping and stress symptoms in the context of type a personality pattern. *Turkish Journal of Psychiatry,* 1-10.

Kane, M. J., Hambrick, D. Z., & Conway, A. R. A. (2005). Working memory capacity and fluid intelligence are strongly related constructs: comment on Ackerman, Beier, and Boyle (2005). *Psychological Bulletin,* 131(1), 66-71.

Keinan, G. (1987). Decision making under stress: scanning of alternatives under controllable and uncontrollable threats. *Journal of Personality and Social Psychology,* 52(3), 639-644.

Kirby, K. N., Winston, G. C., & Santiesteban, M. (2002). Impatience and grades: Delay-discount rates correlate negatively with college GPA.

Klein, K., & Barnes, D. (1994). The relationship of life stress to problem solving: task complexity and individual difference. *Social Cognition*, 12(3), 187-204.

Krietler, S., & Zigler, E. (1990). Motivational determinants of children's probability learning. *The Journal of Genetic Psychology,* 151(3), 301-316.

Metcalfe, J., & Mischel, W. (1999). A Hot/cool-system analysis of delay of gratification: dynamics of willpower. *Psychological Review,* 106(1), 3-19.

Mischel, W & Metzner, R. (1962). Preference for delayed reward as a function of age, intelligence, and length of delay interval. *Journal of Abnormal and Social Psychology,* 64(6), 425-431.

McNally, R. J., & Shin, L. M. (1995). Association of intelligence with severity of posttraumatic stress disorder symptoms in vietnam combat veterans. *The American Journal of Psychiatry,* 153(6), 936-938.

Monterosso, J., Ehrman, R., Napier, K. L., O'Brien, C. P., & Childress, A. R. (2001). Three decision-making tasks in cocaine-dependent patients: do they measure the same construct? *Addiction,* 96, 1825-1837.

Muraven, M & Baumeister, R. F. (2000). Self-Regulation and depletion of limited resources: Does self-control resemble a muscle? *Psychological Bulletin,* 126(2), 247-259.

Myerson, J., Green, L., & Warusawitharana, M. (2001). Area under the curve as a measure of discounting. *Journal of the Experimental Analysis of Behavior,* 76(2), 235-243.

Oaten, M & Cheng, K. (2005). Academic examination stress impairs self-control. *Journal of Social and Clinical Psychology,* 24(2), 254-279.

Rachlin, H., Raineri, A., & Cross, D. (1991). Subjective probability and delay. *Journal of the Experimental Analysis of Behavior*, 55, 233-244.

Rakow, T., Newell, B. R., & Zougkou, K. (2010). The role of working memory in information acquisition and decision-making: lessons from the binary prediction task. *The Quarterly Journal of Experimental Psychology,* 23(7), 1335-1360.

Rodriguez, M. L, Mischel, W., & Shoda, Y. (1989). Cognitive person variables in the delay of gratification of older children at risk. *Journal of Personality and Social Psychology,* 57(2), 358-367.

Schoofs, D., Wolf, O. T., & Smeets, T. (2009). Cold pressor stress impairs performance on working memory requiring executive functions in healthy young men. *Behavioral Neuroscience,* 123(5), 1066-1075.

Shamosh, N. A., & Gray, J. R. (2007). The relation between fluid intelligence and self-regulatory depletion. *Cognition and Emotion,* 21(8), 1833-1843.

Shamosh, N. A., & Gray, J. R. (2008). Delay discounting and intelligence: A meta-analysis. *Science Direct*, 36, 289-305.

Shamosh, N. A., DeYoung, C. G., Green, A. E., Reis, D. L., Johnson, M. R., Conway, A. R. A., Engle, R. W., Braver, T. S., & Gray, J. R. (2008). Individual differences in delay discounting: Relation to intelligence, working memory, and anterior prefrontal cortex. *Psychological Science,* 19(9), 904-911.

Shoda, Y., Mischel, W., & Peake, P. K. (1990). Predicting adolescent cognitive and self-regulatory competencies from preschool delay of gratification: Identifying diagnostic conditions. *Developmental Psychology,* 26(6), 978-986.

Suß, H-M., Oberauer, K., Wittmann, W. W., Wilhelm, W., & Schulze, R. (2002). Working-memory capacity explains reasoning ability—a little bit more. *Intelligence,* 30, 261-288.

Tice, D. M., Bratslavsky, E., & Baumeister, R. F. (2001). Emotional distress regulation takes precedence over impulse control: if you feel bad, do it! *Journal of Personality and Social Psychology,* 80(1), 23-67.

Wang, A., Karns, J. T., & Meredith, W. (2003). Motivation, stress, self-control ability, and self-control behavior of preschool children in China. *Journal of Research in Childhood Education*, 17(2), 175-187.