THE INFLUENCE OF INDIVIDUAL DIFFERENCES
ON THE IOWA GAMBLING TASK AND
REAL-WORLD DECISION MAKING

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THE INFLUENCE OF INDIVIDUAL DIFFERENCES
ON THE IOWA GAMBLING TASK AND
REAL-WORLD DECISION MAKING

Thesis under the direction of Janine M. Jennings, Ph.D., Associate Professor of Psychology.

The Iowa Gambling Task (IGT) was created to assess real world decision making deficits in patients with damage to the ventromedial prefrontal cortex and has become a clinical diagnostic measure of real world decision-making for vulnerable populations (i.e., substance abusers, gambling addicts, depressives). To date, the research linking the IGT to real world decision making has been inferred from the poor performance of vulnerable groups in comparison to the performance of healthy controls. The current study was designed to fill a gap in the research literature by directly testing the extent to which the IGT assesses real world decision-making success, as measured by the Decision Outcome Inventory (DOI), in cognitively healthy young adults, and how the relationship between the IGT and real world decision-making may be impacted by individual differences in personality traits and decision-making styles. The results showed a weak correspondence between the IGT and real world decision-making (DOI). In addition, better scores on the IGT and DOI were associated with rational, non-impulsive decision-making while reward sensitivity accounted for lower scores on the two measures. Negatively valenced emotions predicted poor decision outcomes on the DOI but were not associated with IGT performance. Implications of the results are discussed in regards to the use of the IGT as a measure of real world decision-making and the debate about the extent to which the task measures emotional vs. rational decision making.
INTRODUCTION

According to Antonio Damasio’s somatic marker hypothesis (Damasio, 1994, 1998), decision making (DM) is influenced not only by reason, but also by emotion and feelings. Central to the somatic marker hypothesis is the idea that somatic markers, which are related to emotions, arise in the presence of situational information, such as social cues, environmental cues, and/or internal, goal-oriented thoughts. These cues or thoughts are believed to retrigger somatic states, which have been previously linked with similar cues or thoughts, and those states in turn influence one’s experience of the current situation. For example, when one is making a decision, contemplating a risky course of action may trigger a somatic state that corresponds to past punishments associated with a similar risky action, and thus implicitly (or explicitly, if the autonomic reaction is consciously felt) discourages that particular choice. In this way, the DM space becomes limited to courses of action that are linked to advantageous outcomes from the past as remembered via somatic states, thus making the process of DM more efficient. Damasio argues that without such limitations, logical reasoning processes would have to consider limitless reward and punishment contingencies, ranging from immediate to long-term considerations, rendering the DM process inefficient.

Iowa Gambling Task

The Iowa Gambling Task (IGT) was originally developed to test the somatic marker hypothesis by examining DM deficits in patients with lesions in the ventromedial prefrontal cortex (VM), a population which is known to experience difficulties with both DM and the processing of emotional information (Bechara et al., 1994). The task consists of 100 trials in which participants choose a card from one of four decks of cards. Participants start the task with $2000 of make believe "money." During each trial, after
choosing a deck, a monetary reward is presented to the participant. In addition to a
reward, there is sometimes a monetary punishment. For example, after a selection the
participant will see a message, such as, “You won $100” or “You won $100. You lose
$250.” Although rewards occur after each selection, there is no way for the participants
to know when they will lose money.

Two of the decks, A and B, are considered to be “bad” decks. They are associated
with a $100 reward for each selection. Selections from deck A result in frequent
punishments ranging from $150 to $300. Selections from deck B result in a loss of
$1250 once per ten trials on average. Both decks result in a net loss of $250 for every ten
selections from each deck. The other two decks, C and D, are considered to be “good”
decks. They are associated with a $50 reward for each selection and smaller overall
punishments. Selections from deck C result in punishments ranging from $25 to $75
while selections from deck D result in less frequent losses of $250 once per ten trials on
average. Both decks C and D result in a net gain of $250 for every ten selections from
each deck making them better options than decks A and B. The task is designed so that
the tendency to choose the decks with ostensibly larger rewards, A and B, must be
overcome in favor of the safer choice (decks C & D).

Two characteristics were considered to be important in developing the IGT as a
test of emotional DM. First, decision outcomes include monetary rewards or
punishments, which are believed to create an affective state associated with each
decision. This affective component is intended to aid participants in learning the task at
an emotional level. Second, the task was meant to be sufficiently complex so as to make
it difficult to learn the reward and punishment contingencies using rational calculations
alone, making success on the task largely dependent on emotional learning.
In a landmark study, VM patients were compared to healthy adults on the IGT (Bechara et al., 1997). The controls learned to gradually favor the good decks, C and D, more than the bad decks, A and B, as the task progressed. VM patients, however, showed deficits on the task and tended to choose more from the bad decks and did not learn over time to favor the good decks. In addition to scores on the IGT, skin conductance response (SCR), an index of emotional responding, was measured during each trial before a deck was chosen. It was found that the anticipatory SCR differed between control subjects and VM patients. Over time, controls developed an anticipatory SCR pattern that differentiated between good and bad decks, in which greater SCRs occurred before the selection from a bad deck, suggesting the decks were eliciting an emotional response correspondent with their reward/punishment contingencies. VM patients, though, generated very little, nonspecific SCRs in anticipation of deck selection regardless of which deck was chosen, suggesting that no influencing emotional reactions were being formed.

In addition to measuring task performance and anticipatory SCR during the IGT, after every ten trials participants were asked what they knew and how they felt about the gambling task in order to ascertain whether they had any conscious knowledge pertaining to the goodness or badness of the decks. Their responses were then classified into one of three stages of awareness (prehunch, hunch and conceptual). The prehunch stage was characterized by responses in which subjects showed no knowledge concerning the goodness or badness of the decks while the hunch stage consisted of responses that indicated participants had some intuition of the risk associated with the decks. In contrast, the conceptual stage was characterized by responses in which participants could articulate specific knowledge about which decks were most advantageous.
Among the healthy adults, most reached the hunch period somewhere near the midpoint of the task and the conceptual period by the end of the task. However, they began to choose more from the good decks during the prehunch stage before any conscious knowledge about which decks were advantageous had developed and were already generating differential patterns of anticipatory SCR. In other words, the healthy adults had a differential affective response to the good and bad decks, as signified by their SCR, and began to choose more from the good decks even before they had conscious knowledge of the advantageous strategy. This finding that control subjects generated differential physiological responses and changed their behavior to choose from the good decks before having any conscious knowledge pertaining to the decks was taken as support for the somatic marker hypothesis. It seemed that emotional information was influencing advantageous behavior before conscious knowledge had developed.

The VM patients, on the other hand, not only did not exhibit improved IGT performance but did not, for the most part, ever reach the hunch stage of knowledge. Interestingly, a few VM patients reached the conceptual stage but did not change their behavior to choose more from the good decks. In sum, lacking the ability to process affective feedback to benefit subsequent decisions, VM patients did not learn to make advantageous decisions during the IGT. Based on these results, Bechara concluded that VM patients’ deficits in emotional learning and DM on the IGT paralleled their deficits in everyday life and that the IGT served the purpose of distinguishing between DM abilities in VM patients relative to healthy controls. Moreover, the evidence of poor laboratory performance on the IGT by the VM patients combined with their history of poor real life outcomes was taken as evidence for the ecological validity of the IGT as a measure of real world DM ability.
The IGT as a Measure of Real-world DM

Bechara et al. (2000) claim that essential elements of real-world DM, such as uncertainty, reward and punishment, that are present in the IGT, make the task a good measure of real-world DM. Impaired IGT performance among such populations as VM patients, substance abusers, gambling addicts, children and older adults, who also seem to make poor real-world decisions, has been taken to suggest that the IGT is measuring something akin to real-world DM (Buelow & Suhr, 2009; Crone & van der Molen, 2004; Denburg et al., 2006; Evans et al., 2005; Figner et al., 2009; Goudriaan et al., 2004; Monterosso et al., 2001; Yechiam et al., 2005). However, such evidence is inferential, and to date there has been little direct evidence of a link between IGT performance and real-world DM ability. This lack of direct evidence is surprising given the IGT is now marketed to clinicians as measure of real-world DM.

Cognitive Penetrability

Another concern regarding the IGT (Dunn, Dalgleish, & Lawrence, 2005) involves the assumption that it taps mostly unconscious influences during DM as Bechara et al. (1994, 1996) have claimed (Evans, Bowman, & Turnbull, 2005; Hinson, Jameson, & Whitney, 2002; Maia & McClelland, 2004). Maia and McClelland have argued that the prompts used by Bechara et al. (1997) to assess whether or not participants have conscious knowledge of the advantageous decks, which simply ask participants to tell what they know about the task and how they feel about it (see above), are too vague and nonspecific to elicit all aspects of knowledge that may be present. Consequently, Maia and McClelland ran a study designed to assess conscious knowledge concerning which decks were most advantageous by asking participants more specific questions, including asking them to rate each deck on a Likert scale, to make predictions about how much and
how often they would expect to win and lose if they picked each deck exclusively 10 times in a row, and, finally, which deck they would choose if they could only pick from one deck for the remainder of the task. The results showed that participants developed conscious knowledge of the advantageous strategy earlier than Bechara et al. (1997) had reported, and that improved performance did not precede conscious knowledge, but instead, occurred concurrently with it. Specifically, Maia and McClelland found that participants first developed preferences for decks without being able to explain why but task performance showed no improvement at that stage. Participants then progressed to the equivalent of Bechara’s conceptual stage in which they could clearly articulate reasons for preferring the advantageous decks, and only then did performance improve.

The role of conscious knowledge has also been examined by adding a WM task to be performed concurrently with the IGT (Hinson, Jameson, & Whitney, 2002). If non-conscious emotional influences are the main drivers of improvement on the IGT, it follows that an occupied WM system should have little or no effect on IGT performance. However, Hinson et al. found that adding a WM load to a variant version of the IGT, consisting of three decks (a good, neutral and bad deck) instead of four decks as used in the original IGT, resulted in poorer performance in that participants made fewer selections from the good deck. In the WM load condition, participants were given a string of 5 digits to remember at the beginning of each IGT trial. After selecting from a deck and receiving reward/punishment feedback, they were prompted to identify the digit to the right of a randomly selected digit that had occurred in positions 1 through 4 of the string. The group under no working memory load was simply asked to perform the IGT and, after receiving their reward/punishment information, type a digit that was flashed on the screen. In addition to differences in IGT performance, Hinson et al. found that the
two groups differed in their SCR patterns. Only those in the control condition generated
differential anticipatory SCRs, suggesting that perhaps WM load interfered with the
development of differential physiological states related to the goodness and badness of
the decks. Based on these results, Hinson et al. concluded, that advantageous IGT
performance is dependent upon conscious processes associated with WM. However,
these findings have been subject to criticism due to Hinson et al.’s use of a variant
version of the IGT, which may have resulted in important changes in how the task was
learned (Dunn, Dalgleish, & Lawrence, 2005).

Bechara et al. (2005) have responded to criticisms that the IGT relies significantly
on conscious processing by asserting that the somatic marker hypothesis centrally states
that emotional signals influence advantageous DM, whether those signals are overt or
covert. This rebuttal has been seen as a retreat from the original emphasis they placed on
the nonconscious influences of somatic markers on IGT performance (Dunn, Dalgleish,
& Lawrence, 2005) and does not address evidence that participants’ conscious knowledge
of the decks’ contingencies seems to influence performance. In short, it seems the IGT
may rely significantly on both conscious and nonconscious processing, though the
relative contributions and nature of how each contributes to task performance remains
controversial.

**Previous study.** Previously, we examined two questions concerning the Iowa
Gambling Task (IGT) as a measure of unconscious decision making (DM) ability (Furl,
Jennings, & Stone, 2009). First, due to the lack of direct investigation into the real world
validity of the IGT, we examined IGT performance as a function of real world DM
success using the Decision Outcome Inventory (DOI) (Bruine de Bruin, Parker, &
Fischoff, 2007). The DOI is a survey consisting of a wide variety of everyday situations
in which poor DM can lead to negative outcomes. For each item on the survey, participants first indicate whether they have experienced a certain situation, and if so, whether they have experienced a negative outcome related to the situation. For example, one item asks participants to indicate whether they have ever done their own laundry, and if so, whether they have ruined clothes because they did not follow the laundry instructions on the label. The negative outcomes range in severity from letting food go bad to receiving more than three parking tickets to spending the night in jail. Scores on the DOI have been shown to predict performance on a variety of tasks measuring DM skills including the ability to recognize social norms, to recognize the extent of one’s knowledge, to correctly apply decision rules, to accurately perceive risk and to ignore prior investments (Bruine de Bruin et al., 2007).

We administered the DOI to 317 undergraduates who received course credit for participation, and selected participants scoring in the top and bottom quartiles, representing what we call the good DOI group (those who indicated fewer poor decision outcomes) and the poor DOI group (those who indicated more poor decision outcomes), to perform the IGT. Based on previous inferences of a link between impaired IGT performance and poor real-world DM, we predicted a direct relationship between IGT performance and DOI scores, such that poor IGT performance would be associated with poor life outcomes as measured by the DOI.

Second, in light of the controversy regarding the way in which conscious processes affect IGT performance, we sought to replicate the work of Hinson et al. (2002), who had shown that the addition of a working memory (WM) load decreased performance on a variant version of the IGT, while simultaneously exploring whether a disruption of conscious processing would have a differential effect on performance as a
function of one’s DOI score. To do so, we had some participants perform the IGT while under a WM load. Before each gambling trial, a string of 5 digits, composed of the numbers 1 through 5, were presented for two seconds accompanied by instructions indicating that participants were to learn and rehearse the five digits so that they would be able to retain them during the card/money part of the task. After making a deck choice, participants received immediate reward/punishment feedback, and were then asked to recall and type the digit to the immediate right of another digit from the string with the prompt “The number to the right of X.” In the control condition, after making a deck choice, a digit from 1 to 5 was presented and participants were asked to press the corresponding digit on the keypad. Thus, there was no information to be maintained in memory during the gambling trial. Our study thus consisted of four groups in a 2 (poor DOI/good DOI) X 2 (no WM load/WM load) design with 28-32 participants per group and with performance on the IGT across 100 trials as the dependent variable.

Given our assumption that Hinson et al.’s (2002) findings occurred because conscious processes do play a role in IGT performance and were not an artifact of the variant IGT task that was used, we believed that the addition of a WM load would lead to a decrement in IGT performance. Moreover, we expected this effect to be present for both DOI groups (i.e., a main effect). To further explore the cognitive penetrability of the IGT and the effect of a WM load on task performance, we also interviewed participants after every 10 trials to determine whether or not they had conscious knowledge of the advantageous decks with the hypothesis that those performing the task under a WM load would be less likely to pass through the “prehunch” and “hunch” stages to reach a conceptual understanding of the advantageous strategy. In other words, we predicted that
the WM load condition would lead to a decrement in IGT performance caused by an inability to reach a conceptual understanding of the task.

Contrary to our predictions, we found no main effects of DOI condition or WM load on IGT performance. In addition, there was no effect of the WM load task on achieving a conceptual understanding of the IGT. These results were surprising for two reasons. First, we expected the poor DOI group, who indicated a greater number of poor life outcomes, would show worse overall performance on the IGT, and second, we expected the disruption of conscious processing by the concurrent WM task to cause both decreased conceptual understanding and decreased IGT performance for both DOI groups. Instead, a pattern emerged suggesting that the poor DOI group under no WM load performed better than the other three groups. A direct comparison between the poor DOI/no WM load group and the good DOI/no WM load group revealed a surprising trend in which the poor DOI group performed marginally better than the good DOI group, who indicated fewer poor decision outcomes. As mentioned, this finding was the opposite of what we had expected based on previous claims regarding the IGT as a measure of real world DM. Although we did not find the expected WM load effect among the good DOI participants, we did find that the WM load condition hurt IGT performance for the poor DOI group, suggesting that a disruption of conscious processing can affect the IGT task under some circumstances. It is also noteworthy that conceptual understanding of the task was related to better IGT performance for both DOI groups, as expected, even though that understanding was not significantly affected by concurrent WM demands.

In order to better understand the successful performance of the poor DOI/no WM load participants we examined preferences for each of the four decks individually for all four groups. These analyses revealed that the poor DOI/no WM load group had no
overall preference for any particular deck and rapidly decreased selections from deck B by the second block, whereas the other three groups preferred deck B more than the other decks and maintained this preference throughout the entire task. In other words, preference patterns for decks A, C, and D were relatively equal, with the major difference between the poor DOI/no WM load group and the other groups manifest in their preference for selecting from deck B. A salient feature that distinguishes deck B from the other decks is the magnitude of the punishment, a loss of $1250. This loss is three to sixteen times greater than the punishments associated with the other decks. Another important feature of deck B is the infrequency of punishments resulting from selection in which nine of ten selections result in a gain of $100 with no loss. The poor DOI/no WM group decreased frequency of deck B selection after receiving the first $1250 punishment, whereas the other groups continued to select from that deck.

These findings led us to consider the role of punishment sensitivity in explaining successful IGT performance. To examine whether sensitivity to punishment differed between our DOI groups, we investigated whether punishments affected performance on the WM task. We reasoned that greater sensitivity to punishment feedback might cause a greater disruption in maintenance of the digit string in WM, thereby resulting in poorer WM performance. We found that the poor DOI group did, in fact, perform worse on the WM task following punishment trials relative to non-punishment trials whereas punishment did not affect performance of the WM task in the good DOI group.

**Implications of previous study.** The relationship between the DOI and IGT identified in our previous study suggests that the IGT is sensitive to real world DM abilities among cognitively healthy individuals. However, our findings suggest a puzzling inverse relationship. It is unclear how the IGT could be positively related to
DM abilities among a host of vulnerable populations including VM patients, substance abusers, gambling addicts, children and older adults, and other clinical populations have shown poor IGT performance compared to healthy adults (Bechara et al., 1997; Buelow & Suhr, 2009; Crone & van der Molen 2004; Denburg et al., 2006; Evans et al., 2005; Figner et al., 2009; Goudriaan et al., 2004; Monterosso et al., 2001; Yechiam et al., 2005), yet inversely related to DM ability among healthy young adults.

Related to this lack of clarity is the increasing evidence that a large portion of seemingly healthy adults show impaired performance on the IGT at levels similar to VM patients (Bechara et al., 2000; Crone & van der Molen, 2004; Lin et al., 2007). To explore these findings from the perspective of the somatic marker hypothesis, Bechara and Damasio (2002) measured SCR in healthy adults, almost a third of whom showed impaired IGT performance. Among the impaired individuals, there was a subgroup who did not generate the normal pattern of differential anticipatory SCR when selecting from good vs. bad decks while there was another subgroup of participants who did do so. The impaired performance of those with abnormal SCRs fits with the somatic marker hypothesis, but it is unclear why the individuals with normal SCRs showed impaired IGT performance. The authors suggest that because these individuals also tended to describe themselves as high-risk takers, thrill seekers, or gamblers that their DM was still being affected by emotional signals during the IGT but not in a manner that led to advantageous performance. The notion that individual differences such as risk-taking propensity could account for IGT performance among cognitively healthy adults led us to consider their potential for understanding the nature of the relationship between the IGT and the DOI. Thus, in order to form hypotheses about which individual difference variables might
account for the relationship between the IGT and DOI, we looked for clues from our previous study’s results.

**Hypotheses about individual differences underlying IGT/DOI relationship.**

Two patterns found in the previous study could be interpreted to suggest that sensitivity to punishment could help account for the IGT/DOI relationship. First, the poor DOI group showed a rapid decrease in deck B selection after receiving punishment, and second, they performed more poorly than the good DOI group on the WM task following only the punishment trials. In further support of this idea, other IGT research has shown that performance can be related to one’s sensitivity to reward and punishment. For example, Van Honk et al. (2002) tested the effect of psychopathic traits on IGT performance among college students using the BIS/BAS scale (Carver & White, 1994). This scale measures the BIS, behavior inhibition system, which is synonymous with sensitivity to punishment, and the BAS, behavior activation system, which is synonymous with sensitivity to reward. Using the BIS/BAS scale (Carver & White, 1994), Van Honk et al.'s (2002) operationalized high psychopathy as high levels of sensitivity to reward in conjunction with low levels of sensitivity to punishment, and low psychopathy as low levels of sensitivity to reward in conjunction with high levels of sensitivity to punishment. Participants were pre-screened with the BIS/BAS scale and divided into two groups, representing high and low trait psychopathy. The authors found that the low psychopathic group performed normally on the IGT whereas the high psychopathic group showed impaired performance at levels similar to VM patients. In another study, Davis et al. (2007) tested the independent effects of sensitivity to punishment and reward on the IGT, using the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (Torrubia et al., 2001), and found that sensitivities to punishment
and reward were inversely related to the IGT, suggesting that greater levels of reactivity to affective outcomes, both positive and negative, hurt IGT performance.

An alternative explanation for successful IGT performance in our previous study may lie with individual differences in DM styles that have previously been associated with real world outcomes (Bruine de Bruin et al., 2007). For example, the DOI has been shown to be related to the tendency to decide rationally, to experience regret following decision making, to maximize when making decisions, and to avoid decision making (Bruine de Bruin et al., 2007). Consequently, one means of accounting for the relationship between the IGT and DOI is to try to determine participants’ DM style based on their IGT and DOI results. Of the different DM styles that have been associated with the DOI (Bruine de Bruin et al., 2007), a maximizing, as opposed to a satisficing, style seemed to fit the profiles of deck selection shown by the poor and good DOI groups in our earlier experiment. Maximizers are characterized by a tendency to survey widely for information before making decisions in an attempt to make the very best decision. For example, maximizers tend to channel surf when watching television even while attempting to watch one program, in order to make sure “nothing better is on.” Such exploration is often effortful and time consuming. Satisficers, on the other hand, tend to make decisions with less effort and are content to choose an option that is “good enough” (Parker, de Bruin, & Fischhoff, 2007). In addition, Parker et al. (2007) found that maximizers report having experienced worse real world decision outcomes on the DOI compared to satisficers. These poor decision outcomes reported by maximizers are believed to be due to some of the more problematic aspects associated with their style of decision making. For example, relative to satisficers, maximizers exhibit less behavioral
coping, an overdependence on others to make decisions, a tendency to avoid DM, and more regret (Parker et al., 2007).

In our previous work, the poor DOI group under no WM load showed behavior that seems to parallel that of maximizers by surveying equally across decks, as if to consider all their options. In addition, the effect of WM load seen only in the poor DOI group suggests that DM during the IGT may have been more cognitively consuming for the poor DOI group. The good DOI group, on the other hand, preferred deck B, which offered large rewards of $100 ninety percent of the time and seemed to be good enough. This preference was not affected by WM load, suggesting that decisions may have been made with less cognitive effort in a manner characteristic of satisficers. As mentioned, maximizers also experience more regret concerning decisions, and are more likely to wonder about “what might have been.” The poor DOI group seemed to show evidence of these feelings in that they reacted more to the large punishments of deck B, and their WM performance was more affected by punishments compared to the good DOI group. In sum, the parallels between patterns that emerged in deck preference, WM performance, and DOI scores in the current study, and the DM styles of maximizers vs. satisficers, suggest the IGT may differentiate between DM styles, such as maximizing vs. satisficing.

**Current Study**

Based on the results of our previous work and the implications described above, the current study was designed to try to replicate our finding of an inverse relationship between IGT performance and real-world DM, as measured by the DOI. We also wanted to investigate which individual difference variables may account for that relationship, and specifically, the hypotheses that maximizing and sensitivity to punishment are positively related to IGT performance and negatively related to DOI scores thus accounting for the
inverse IGT/DOI relationship. To try to replicate our earlier results, we again administered the DOI and IGT but did not include a WM load, nor did we interview participants about their conscious experiences. We also extended the task from 100 trials to 160 trials to observe performance over a longer period. We reasoned that both poor and good DOI individuals may be capable of learning to choose more advantageously over time but that learning may occur at different rates. Thus, by extending the length of the task we sought to determine if differences in performance diminish over time between good and poor scorers on the DOI.

To test for a relationship between IGT performance and maximizing, participants were given Schwartz et al.’s (2002) Maximization Scale. We chose this scale, which is designed to measure the tendency to maximize when making decisions, because it has been related to the DOI, such that high levels of maximizing predict poorer decision outcomes (Bruine de Bruin et al., 2007). As discussed previously, better IGT performance among the poor DOI group in our previous experiment may have been due to a tendency to maximize. Thus, we expected that scores on the Maximization Scale (Schwartz et al., 2002) may account for the relationship between IGT performance and scores on the DOI. However, Diab et al. (2008) argue that the Maximization Scale does not specifically measure maximizing, which is the tendency to search for the optimal choice, but rather taps the tendency to overmaximize, that is to maximize when it is unnecessary or counterproductive to do so, and thus, is maladaptive. Consequently, we also administered Diab et al.’s (2008) Maximizing Tendency Scale, which measures maximizing as it is more narrowly defined, and has not been compared to either the IGT or DOI. Unlike the Maximization Scale, the Maximizing Tendency Scale has been shown to be unrelated to negative or maladaptive DM constructs with the exception of
the tendency to experience regret (Diab, Gillespie, & Highhouse, 2008). We reasoned that using both scales would allow us to determine whether performance on the IGT is related to maximizing versus overmaximizing.

We also hypothesized that sensitivity to reward and punishment may be related to advantageous performance on the IGT. Due to the mixed findings regarding this relationship found in other studies (Davis et al., 2007; Van Honk et al., 2002) (see above), we intended to further clarify its nature. We also expected that sensitivity to punishment may be related to DOI scores based on findings from our previous study in which the relationship between DOI scores and the reactions to punishment were seen in deck preference and WM performance. A relationship with both the IGT and DOI would suggest sensitivity to punishment may account for the relationship between those two measures of decision making. To examine those ideas, participants were given Carver and White’s (1994) Behavioral Inhibition System/Behavioral Activation System (BIS/BAS) scale, a widely used measure of punishment and reward sensitivity that has been used in previous studies exploring the relationship between the IGT and reward/punishment sensitivity (Suhr & Tsanadis, 2008; Van Honk et al., 2002).

We also extended our investigation of the relationship between IGT performance, the DOI, and variables that reflect either personality differences or DM styles by assessing a number of individual difference constructs that have either been shown to be related to the IGT or the DOI or that we thought may be related. By examining the relationship of those variables to both IGT performance and responses on the DOI, we hoped to further our understanding of the relationship between the IGT and real-world DM by identifying variables that may account for the relationship between the DOI and IGT found in our previous work.
**Individual difference variables previously examined in relation to the IGT.** To explore these questions, we first examined risk-taking propensity and impulsivity, which have both been shown to be related to the IGT but have not been examined in conjunction with the DOI. Evidence for a relationship between risk-taking and IGT performance has been obtained through both self-report and objective measures. For example, Bechara and Damasio (2002) found that individuals who performed poorly on the IGT tended to describe themselves as risk takers while Farah et al. (2008) found a negative correlation between the number of risky maneuvers in a driving simulation and IGT scores, along with a positive correlation between the number of aborted risky passing maneuvers on a two-lane road and IGT performance.

To examine the relationships between risk taking, the IGT and the DOI we administered a self-report measure of risk-taking. The risk-taking scale assesses risk preference when presented with outcome probabilities by asking participants to rate whether they would rather receive a small but guaranteed financial reward or take a chance on winning a much larger reward, although it could mean they will win nothing in the end (Keeney & Raiffa, 1976). Based on previous studies comparing risk-taking and IGT performance, we predicted an inverse relationship between risk-taking and IGT scores.

As for impulsivity, previous research relating it to IGT performance has proven ambiguous. Using the UPPS Impulsivity scale (Whiteside et al., 2005), which measures four factors of impulsivity (urgency, lack of preméditation, lack of perseverance, and sensation seeking), Zermatten et al. (2005) found that IGT performance was inversely related to only one aspect of impulsivity, lack of preméditation, whereas Xiao et al. (2009) found another aspect of impulsivity, urgency, to be related to both poor IGT
performance and increased binge drinking among Chinese adolescents. However, other researchers using different measures of impulsivity have found no relationship between impulsivity and the IGT (Goudriaan, Grekin, & Sher, 2007; Sweitzer, Allen, & Kaut, 2008). These contradictory findings may be due to the use of different impulsivity scales as the IGT may be differentially related to various aspects of impulsivity. Thus, measures that are sensitive to subfactors of impulsivity, such as the UPPS Impulsivity scale, may be better suited to detect associations between the IGT and impulsivity than those measuring impulsivity as a single construct. In the current study, we administered the UPPS Impulsivity scale to further explore the association between several subfactors of impulsivity with the IGT, to determine whether impulsivity is at all related to the DOI, and whether impulsivity mediates the relationship between IGT performance and the DOI.

**Individual difference variables previously examined in relation to the DOI.**

Several DM styles including a) the tendency to decide rationally (e.g., “I make decisions in a logical and systematic way.”) versus intuitively (e.g., “When making decisions, I rely upon my instincts.”), b) to avoid DM c) to decide spontaneously (e.g., “I generally make snap decisions.”) and d) to experience regret have been shown to be related to the DOI (Bruine de Bruin et al., 2007) but have not been compared with the IGT. To test whether these DM constructs are also related to IGT performance and potentially account for the relationship between the IGT and DOI, we administered two measures previously related to the DOI, including Scott and Bruce’s (1995) Decision Styles Survey, which measures five DM styles (rational, intuitive, dependent, avoidant, and spontaneous), and Schwart et al.’s (2002) tendency to feel regret scale For each measure, we expected to replicate the
previous associations found with the DOI and find that one or more of these constructs can account for the relationship between the IGT and DOI.

Individual difference variables not previously compared with the IGT or DOI. In addition, because the extent to which the IGT depends on nonconscious and conscious processing remains controversial, we were particularly interested in examining the contributions of rational and intuitive DM styles to IGT performance. To explore this question, we administered Pacini and Epstein’s (1999) Rational- Experiential Inventory, a self-report measure that assesses one’s preferences for a rational vs. experiential/intuitive DM style, and Frederick’s (2005) Cognitive Reflection Test, which measures a reflective vs. impulsive approach to problems by testing one’s ability to overcome the impulse to respond with intuitive but incorrect answers. Because the DOI has previously been shown to be related to rational and intuitive DM styles, as measured by the Decision Styles Survey, we predicted that the DOI should also be related to the Rational- Experiential Inventory and the Cognitive Reflection Test. Similarly, because the IGT was designed to tap emotional or intuitive DM but has been shown to entail some degree of conscious processing (Evans, Bowman, & Turnbull, 2005; Hinson, Jameson, & Whitney, 2002; Maia & McClelland, 2004), we expected it to also be related to both intuitive and rational DM to some extent. However, we were less sure about which aspects of these two styles of DM, and therefore which measures, would be the most strongly associated with IGT performance.

The individual difference variables described above are a mix of DM styles and personality traits, however, there is a good deal of conceptual overlap between the two classes of constructs. For example, we expect impulsivity to be strongly related to spontaneous decision making, and the BIS to avoidant decision making. We also expect
some of the measures of decision style to be interrelated. For example, we expect Scott and Bruce’s (1995) measures of rational and intuitive decision styles to be related to Pacini and Epstein’s (1999) measures of rational and intuitive decision styles, and Schwart et al.’s (2002) and Diab et al.’s (2008) measures of maximizing to be related to one another. Similarly, we expect some the individual difference variables to be interrelated, including the BAS subfactor for fun seeking and the impulsivity factor for sensation seeking. In order to simplify our analysis and interpretation of which constructs account for the IGT/DOI relationship, we carried out a factor analysis of those variables found to be related to both the IGT and DOI. We then carried out a series of hierarchical regressions to determine which, if any, of those factors accounts for the relationship between IGT performance and DOI scores.
METHODS

Participants
A total of 229 undergraduate students, 121 female and 108 male, from Wake Forest University, aged 18-22, received credit for an introduction to psychology class completed the Iowa Gambling Task and a battery of surveys measuring real-world decision outcomes (DOI), maximizing, sensitivity to rewards and punishments, other decision making styles besides maximizing, risk-taking propensity, and impulsivity. The research was approved by the Institutional Review Board at Wake Forest University, and all participants provided written informed consent.

Materials

DOI. The DOI (see Appendix A) was adapted from the original version (Bruine de Bruin et al., 2007) to be more appropriate for college age students. Items pertaining to decision scenarios geared towards adults, such as declaring bankruptcy and being responsible for a mortgage were omitted. We also changed the original instructions, which prompted participants to consider the last 10 years of their lives, to the last 5 years. Because the scenarios presented on the DOI are intended to measure adult decision outcomes, considering a 10 year time frame did not seem reasonable for college aged students. Additionally, certain items asked about specific numbers of occurrences of outcomes, such as five speeding tickets, or specific monetary amounts, such as accruing $5000 in credit card debt, that were deemed unlikely to be relevant for most college students, or reasonable within a five year time period. We changed such items, for example, to three speeding tickets, and $2500 in credit card debt. This revised version of the DOI consisted of 25 decision-making scenarios.
On the survey, participants indicate whether or not they have experienced each scenario during the previous five years. Some examples of the scenarios include, “Driven a car,” “Rented a movie,” and “Loaned more than $25 to someone.” If the participant has been in a scenario, and thus has had the opportunity to make a decision related to the scenario, the next item asks him/her to indicate whether a specific negative outcome has been the result. Such outcomes include, “Been accused of causing a car accident while driving,” “Gotten more than 3 parking tickets,” “Returned a movie you rented without having watched it at all,” and “Loaned more than $25 to someone and never got it back.”

Following administration, the DOI was scored by assigning different weights to outcomes depending on their severity. In order to create the weighting system, four members of the lab previously rated each outcome on a scale from 1-4, with 1 being least severe and 4 being most severe. A composite score, representing a combination of frequency and magnitude of poor decision outcomes, was then calculated for each participant by summing the weighted outcome scores and dividing by the total number of scenarios the participant indicates they have experienced. We subtracted these scores from zero so that higher scores indicate fewer poor outcomes.

**Measures of decision making styles.** The Maximization Scale (Schwartz et al., 2002) is a 13-item scale with items such as “When I watch TV, I channel surf, often scanning through the options even while attempting to watch one program” and “Renting dvds is really difficult. I’m always struggling to pick the best one.” The Maximizing Tendency Scale (Diab, Gillespie, & Highhouse, 2008) consists of three items taken from Schwartz et al.’s (2002) Maximization Scale in addition to six original items (e.g., “I will wait for the best option, no matter how long it takes” and “I never settle”). For both
scales participants indicate how much they agree with each statement on a 5-point Likert scale (1 = complete disagreement to 5 = complete agreement). The maximizing score for each measure was calculated by averaging scores across all items (Appendix B).

The General Decision Making Style Inventory (Scott & Bruce, 1995) consists of 24 items and measures five decision styles, which include making decisions rationally (e.g., “I make decisions in a logical and systematic way”), basing decisions on intuitions (e.g., “I generally make decisions that feel right to me”), depending on others (e.g., “I often need the assistance of other people when making important decisions”), avoiding decisions (e.g., “I postpone decision making whenever possible”), and making decisions spontaneously (e.g., “I generally make snap decisions”). Items are answered on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree), and scores were averaged across items for each decision style (Appendix C).

The Rational-Experiential Inventory (Pacini & Epstein, 1999) assesses preferences for a rational vs. experiential, or intuitive, processing style and is made up of the following four subscales: a) Rational Ability, the ability to think logically and analytically (e.g., “I have a logical mind.”), b) Rational Engagement, a reliance on and enjoyment of thinking in an analytical, logical manner (e.g., “I enjoy intellectual challenges.”), c) Experiential Ability, the ability to go with one's intuitive impressions and feelings (e.g., “I believe in trusting my hunches.”), and d) Experiential Engagement, a reliance on and enjoyment of feelings and intuitions in making decisions (e.g., “I like to rely on my intuitive impressions.”). The scale consists of 40 items rated on a 5-point Likert scale (1 = definitely not true of myself to 5 = definitely true of myself), and scores were calculated by averaging across the items related to each corresponding subscale (Appendix D).
The Cognitive Reflection Test is a three question test that differentiates between impulsive and reflective DM styles. Each question has a seemingly intuitive but incorrect answer that comes to mind quickly (Appendix E). To answer the questions correctly it is necessary to override the initial impulse to decide on the intuitive answer and instead give the question more careful thought. For example, “A bat and a ball together cost 110 cents. The bat costs 100 cents more than the ball. How much does the ball cost?” For this question, the impulsive answer would be 10 cents whereas the correct answer is 5 cents. The CRT score was simply the number of correct answers.

**Risk-taking.** Participants were given a 5-item risk-taking survey, adapted from a measure first developed by Keeney and Raiffa (1976) to assess risk-taking propensity under conditions in which varying probabilities of reward outcomes are presented. For each item participants indicate their preference for two options with equal expected value, one of which entails risk and the other is risk free (e.g., “Would you rather receive $10 for sure, or have a 10% chance of winning $100 and a 90% chance of winning nothing?”). Risk-taking propensity was scored by summing the number of risky options chosen (Appendix F).

**Personality variables.** Sensitivities to reward and punishment were measured with the BIS/BAS scale (Carver & White, 1994). This 20-item measure assesses four factors, one reflecting sensitivity of the Behavioral Inhibition System (BIS) (e.g., “I worry about making mistakes”), and three reflecting dimensions of sensitivity of the Behavioral Activation System (BAS), including Drive (e.g., “If I see a chance for something I want, I move on it right away”), Fun Seeking (e.g., “I often act on the spur of the moment”), and Reward Responsiveness (e.g., “When good things happen to me, it affects me strongly”). For each item participants rated how true the statement is of them.
on a 4-point Likert scale (1 = very true for me to 4 = very false for me). Each subscale was scored by averaging across the respective items (Appendix G).

Impulsivity was assessed with the UPPS Impulsive Behavior scale (Whiteside & Lynam, 2001). The UPPS is a 45-item scale measuring four factors of impulsivity including Lack of Premeditation (e.g., “I have a reserved and cautious attitude about life”), Urgency (e.g., “I have trouble resisting my cravings”), Sensation Seeking (e.g., “I’ll try anything once”), and Lack of Perseverance (e.g., “I tend to give up easily”), with items rated on a 4-point Likert scale (1 = Agree Strongly to 4 = Disagree Strongly). Scores for each subscale were calculated by appropriately reverse coding and averaging across items (Appendix H).

The tendency to feel regret scale (Schwartz et al., 2002) is a 5-item scale assessing proneness to feel regret when making and evaluating decisions (e.g., “Whenever I make a choice, I try to get information about how the other alternatives turned out”), with items rated on a 5-point Likert scale (1 = complete disagreement to 5 = complete agreement). Regret scores were calculated by averaging across the five items (Appendix I).

**Iowa Gambling Task (IGT).** A computerized version of the IGT, programmed in Eprime, was used. Participants began the task with five practice trials to familiarize themselves with the task, followed by 160 real trials, in which they were given $2000 of imaginary money to gamble. For each trial, participants were prompted to choose from one of four decks of cards, which are represented by rectangles roughly the size of playing cards displayed in the middle of the computer screen, by pressing one of four keys: 1 for deck A, 2 for deck B, 3 for deck C, and 4 for deck D. As mentioned earlier, decks A and B result in $100 rewards, and decks C and D result in $50 each time they are
selected. The punishment schedules, however, differ between the decks. Deck A results in punishments ranging from $150-350 five times in every ten trials, and deck B results in a punishment of $1250 once per ten trials. Both decks A and B yield net losses of $250 per every ten times chosen. In contrast, Deck C results in punishments ranging from $25-75 five times in every ten trials and deck D results in a punishment of $250 once per 10 trials. Both decks C and D yield a net gain of $250 per every ten times chosen. After selecting from a deck, participants were presented with feedback indicating their monetary rewards/punishments for that trial. Feedback was shown for two seconds and consisted of either the statement “You won $X” or “You won $X. You lost $Y.” Participants were also shown a running total of their amount of money that changes according to the wins or losses resulting from each trial. Before beginning the task, participants were given the following instructions:

In this experiment, you will be asked to make hypothetical gambles in a simulated card game. You will start with a fixed sum of money, and the computer will prompt you to choose one of four cards for each trial. For each choice, you will sometimes lose money and sometimes win. Your task is to discover the best way to make card choices so that, at the end of the session, you will have the highest amount of money possible.

There is no way for you to figure out when you lose money. All I can say is that some decks are worse than others. You may find all of them bad, but some are worse than others. No matter how much you find yourself losing, you can still win if you stay away from the worst decks. Please treat the play money in this game as real money and any decision on what to do with it should be made as if you were using your own money. You will not know when the game will end. Please keep on playing until you are told to stop.
Procedure

The survey data was collected at two different times to minimize potential fatigue effects. Participants completed three surveys including the DOI (Bruine de Bruin et al., 2007), the maximizing questions, which were combined into a single questionnaire, (Diab, Gillespie, & Highhouse, 2008; Schwartz et al., 2002) and the BIS/BAS (Carver & White, 1994) during general departmental testing sessions administered to all Introductory Psychology students at Wake Forest University. We chose to administer these three surveys first because they were involved in our most important hypotheses. In another hour long session, after providing consent, participants carried out 160 trials of the computerized version of the IGT in individual testing rooms. Following performance of the IGT, they were given a packet of surveys to complete in the following order: (a) Decision Styles Survey (Scott & Bruce, 1995), (b) the Cognitive Reflection Test (Frederick, 2005), (c) the UPPS Impulsive Behavior Scale (Whiteside & Lynam, 2001), (d) the Rational-Experiential Inventory (Pacini & Epstein, 1999), (e) the Regret Scale (Schwartz et al., 2002) and (f) the Risk-Taking Propensity Survey (Keeney & Raiffa, 1976). Upon completion of the surveys, participants were briefed on the general purpose of the study.
RESULTS

To determine whether IGT performance improves across trials, as would be expected, we calculated the percentage of cards chosen from the good decks (C and D combined) across blocks of 20 trials for all 160 trials (see Figure 1). We then carried out a one-way repeated measures ANOVA with block as the independent variable and percentage of selections from the good decks as the dependent variable. In other research employing the IGT with 100 trials, individuals learned to choose more from the good decks over time (Bechara et al., 1997), which is what we found in the current study, \( F(7, 1575) = 52.91, p < .001 \).

Figure 1

Percentage of Cards Chosen from the Good Decks as a Function of Block.

IGT/DOI Relationship

We made two predictions about the relationship between DOI scores and the IGT. First, we expected that improvement across the task would be greater for those with lower DOI scores across the first 100 trials, as was found in our previous 100-trial IGT
study (Furl et al., 2009), and consequently lead to better overall performance. Thus, we predicted an inverse relationship between the IGT and DOI over the first 100 trials. Furthermore, we expected those with higher DOI scores, and fewer poor real world outcomes, would learn to perform as well as those with lower DOI scores by the final 60 trials, which were added in the current study. Contrary to our predictions and previous findings, while we did find a significant relationship between IGT performance and DOI scores over the first 100 trials, \( r(29) = .150, p = .023 \), that relationship was in the opposite direction from what we expected, such that those scoring higher on the DOI (i.e., fewer poor outcomes) tended to perform better on the IGT.

Nonetheless, we remained interested in whether the relationship between IGT performance and DOI scores would decrease over time. In other words, we wanted to see if individuals with lower DOI scores were capable of performing similarly to those with higher scores when there are more trials in which to learn the task. If so, we would expect the IGT/DOI relationship to disappear such that we would see a decrement in the strength of the correlation between the DOI and IGT across trials. To test this idea, we correlated the DOI with IGT performance across the first 100 trials and then for the last 60 trials of the task, and used a Hotelling-Williams test (Steiger, 1980) to evaluate whether the magnitude of these correlations decreased. We found the correlation for the first 100 trials, \( r(229) = .15, p = .023 \), was greater than for the last 60 trials, \( r(229) = .073, p = .27 \), but the difference was not statistically significant.

**Individual Difference Variables Accounting for the IGT/DOI Relationship**

As outlined in the introduction, one of the main goals of the current study was to identify variables that account for the relationship between the DOI and IGT. Because the relationship between the IGT and DOI was the opposite of what we had expected, our
original hypotheses that maximizing and sensitivity to punishment could explain why those with poor DOI scores would do better on the IGT were no longer viable. However, better understanding of the relationship that we did find between the DOI and IGT and any individual difference variables that may contribute to that relationship was still of interest.

**Variables related to the IGT and DOI.** To explore this question, we first examined all of the individual difference variables we had assessed to determine which ones showed the same relationship with either the IGT and/or DOI as had been found in previous research (Carver & White, 1994; Diab, Gillespie, & Highhouse, 2008; Frederick, 2005; Pacini & Epstein, 1999; Schwartz et al., 2002; Scott & Bruce, 1995; Whiteside & Lynam, 2001). Correlations, p-values, and an indication of whether the variable has been associated with the IGT or DOI in previous prior research are included in Table 1.

Consistent with previous findings, the IGT was inversely related to two aspects of the the BAS scale (Carver & White, 1994), which were fun seeking and reward response (Suhr & Tsanadis, 2006), two characteristics from the UPPS Impulsivity Scale (Whiteside et al., 2005), namely urgency and lack of premeditation (Xiao et al., 2009; Zermatten et al., 2005), and unrelated to the UPPS measures of lack of perseverance and sensation seeking (Xiao et al., 2009; Zermatten et al., 2005) as well as Carver and White’s (1994) BIS scale (Suhr & Tsanadis, 2006). Contrary to previous findings, the IGT was inversely related to the BAS measure for drive, which has not been found elsewhere (Suhr & Tsanadis, 2006). In addition, we identified a number of novel relationships between the IGT and individual difference variables that have not previously been explored. These
Table 1

IGT Performance and DOI Scores Correlated with Individual Difference Variables

<table>
<thead>
<tr>
<th>Individual difference variables</th>
<th>IGT</th>
<th>DOI</th>
<th>Previously published associations (IGT or DOI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schwartz et al.’s Maximizing Scale</td>
<td>-.058</td>
<td>-.098</td>
<td>DOI (-)</td>
</tr>
<tr>
<td>Diab et al.’s Maximizing Tendency Scale</td>
<td>-.006</td>
<td>.112+</td>
<td></td>
</tr>
<tr>
<td>BIS</td>
<td>-.069</td>
<td>-.169*</td>
<td>IGT (n.s.)</td>
</tr>
<tr>
<td>BAS Drive</td>
<td>-.131*</td>
<td>-.110+</td>
<td>IGT (n.s.)</td>
</tr>
<tr>
<td>BAS Reward response</td>
<td>-.120+</td>
<td>-.069</td>
<td>IGT (-)</td>
</tr>
<tr>
<td>BAS Fun seeking</td>
<td>-.156*</td>
<td>-.276**</td>
<td>IGT (-)</td>
</tr>
<tr>
<td>Scott and Bruce’s Decision Styles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rational</td>
<td>.115+</td>
<td>.200**</td>
<td>DOI (+)</td>
</tr>
<tr>
<td>Intuitive</td>
<td>-.079</td>
<td>-.056</td>
<td>DOI (+)</td>
</tr>
<tr>
<td>Dependent</td>
<td>-.004</td>
<td>-.068</td>
<td>DOI (n.s.)</td>
</tr>
<tr>
<td>Avoidant</td>
<td>-.035</td>
<td>-.127+</td>
<td>DOI (-)</td>
</tr>
<tr>
<td>Spontaneous</td>
<td>-.162*</td>
<td>-.197**</td>
<td>DOI (-)</td>
</tr>
<tr>
<td>Regret</td>
<td>-.034</td>
<td>-.159*</td>
<td>DOI (-)</td>
</tr>
<tr>
<td>UPPS Impulsivity Subfactors:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urgency</td>
<td>-.209**</td>
<td>-.234**</td>
<td>IGT (-)</td>
</tr>
<tr>
<td>Lack of premeditation</td>
<td>-.188**</td>
<td>-.308**</td>
<td>IGT (-)</td>
</tr>
<tr>
<td>Lack of perseverance</td>
<td>-.092</td>
<td>-.292**</td>
<td>IGT (n.s.)</td>
</tr>
<tr>
<td>Sensation seeking</td>
<td>.011</td>
<td>-.105</td>
<td>IGT (n.s.)</td>
</tr>
<tr>
<td>Rational-Experiential Inventory:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rational ability</td>
<td>.310**</td>
<td>.233**</td>
<td></td>
</tr>
<tr>
<td>Rational engagement</td>
<td>.152*</td>
<td>.211**</td>
<td></td>
</tr>
<tr>
<td>Experiential ability</td>
<td>-.078</td>
<td>-.038</td>
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</tr>
<tr>
<td>Experiential engagement</td>
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<td>-.042</td>
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</tr>
<tr>
<td>Cognitive Reflection Test</td>
<td>.117+</td>
<td>.170*</td>
<td></td>
</tr>
<tr>
<td>Risk Taking</td>
<td>-.118+</td>
<td>-.145*</td>
<td></td>
</tr>
</tbody>
</table>

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).
+ Correlation is marginally significant, p < .10 (2-tailed).

Note, the blank cells in the fourth column indicate that the variable has never been tested with the IGT or DOI.
included positive correlations with rational ability and, rational engagement, as measured by Pacini and Epstein’s (1999) Rational Experiential Inventory (Pacini & Epstein, 1999), and a rational decision-making style, as indexed by Scott and Bruce’s (1995) Decision Styles Survey, as well as the Cognitive Reflection Test (Frederick, 2005). We also found negative associations between the IGT and with spontaneous decision-making (Scott and Bruce, 1995) and risk-taking (Keeney & Raiffa, 1976).

The DOI, as seen in previous work, was positively related to Scott and Bruce’s (1995) rational decision-making style, negatively related to their measures of avoidant and spontaneous decision-making styles, while being unrelated to their index of dependent decision-making. The DOI was also negatively related to the tendency to feel regret scale (Schwartz et al., 2002). However, we did not fully replicate previous patterns of relationships with the DOI, as we unexpectedly found it to be unrelated to both Scott and Bruce’s (1995) intuitive decision-making style and Schwartz et al.’s (2002) Maximization Scale (Bruine de Bruin et al., 2007). In the same way that we examined previously untested relationships with the IGT, we also identified relationships between individual difference variables and the DOI that have not been examined before. These relationships consisted of positive correlations between the DOI and Diab et al.’s (2008) Maximizing Tendency Scale, rational ability and rational engagement as indexed by Pacini and Epstein’s (1999) Rational Experiential Inventory, and the Cognitive Reflection Test (Frederick, 2005) along with negative relationships involving the BIS, the BAS subfactors for drive and fun seeking (Carver & White, 1994), the UPPS measures of urgency, lack of premeditation and lack of perseverance (Whiteside et al., 2005), as well as risk taking (Keeney & Raiffa, 1976).
Creation of factors to explain the IGT/DOI relationship. Of the correlations described above, we were particularly interested in determining which ones were significantly \( p < .05 \) or marginally \( p < .10 \) related to both DOI scores and IGT performance, as we thought these would be the most useful in helping to understand the relationship between the IGT and DOI. We found ten variables to be related to both the DOI and IGT, including the BAS subfactors of drive and reward responsiveness (Carver & White, 1994), rational and spontaneous decision making styles (Scott & Bruce, 1995), the UPPS measures of urgency and lack of premeditation (Whiteside et al., 2005), rational ability and rational engagement (Pacini & Epstein, 1999), performance on the Cognitive Reflection Test (Frederick, 2005), and risk-taking (Keeney & Raiffa, 1976).

Because many of these variables seemed to be conceptually related, as discussed in the introduction, and proved to be correlated with one another (see Appendix J), we decided to carry out a factor analysis to determine which variables grouped together into meaningful factors. Our goal was to use these factors to simplify our subsequent analysis and interpretation of which constructs may account for the IGT/DOI relationship. We followed our factor analysis with a series of hierarchical regression analyses to determine which, if any, of those factors accounted for the relationship between the IGT and DOI.

Using a promax rotation which allows the vectors associated with the factors to be nonorthogonal, the scree plot revealed one particularly robust factor with an eigenvalue of 3.29 (see Table 2), followed by a more gradual leveling off of the slope beginning with the second factor (eigenvalue = 1.42). Because of the gradual leveling off of the screen plot’s slope, we initially used SPSS’s default extraction of factors with eigenvalues greater than 1, which yielded three factors. In interpreting these factors, we considered a variable to load cleanly on a factor if it had a load value greater than .4 for only that
Table 2

Factor Analysis Results for Variables Related to Both the IGT and DOI

(Factor Loadings and Intercorrelations Among Factors)

<table>
<thead>
<tr>
<th></th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
<th>Factor 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eigenvalues</td>
<td>3.29</td>
<td>1.42</td>
<td>1.15</td>
<td>.91</td>
</tr>
<tr>
<td><strong>Factor Loadings</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BAS Drive</td>
<td>.13</td>
<td>.78</td>
<td>-.20</td>
<td>-.28</td>
</tr>
<tr>
<td>BAS Fun seeking</td>
<td>.11</td>
<td>.86</td>
<td>.06</td>
<td>-.04</td>
</tr>
<tr>
<td>Scott and Bruce’s Decision Styles:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rational</td>
<td>.66</td>
<td>.06</td>
<td>-.15</td>
<td>-.29</td>
</tr>
<tr>
<td>Spontaneous</td>
<td>-.34</td>
<td>.51</td>
<td>-.06</td>
<td>.21</td>
</tr>
<tr>
<td>Cognitive reflection test (CRT)</td>
<td>.23</td>
<td>-.10</td>
<td>-.21</td>
<td>.91</td>
</tr>
<tr>
<td>UPPS Impulsivity Subfactors:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urgency</td>
<td>-.65</td>
<td>.16</td>
<td>-.07</td>
<td>-.15</td>
</tr>
<tr>
<td>Lack of Premeditation</td>
<td>-.49</td>
<td>.38</td>
<td>.20</td>
<td>.14</td>
</tr>
<tr>
<td>Rational-Experiential Inventory:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rational ability</td>
<td>.86</td>
<td>.11</td>
<td>-.04</td>
<td>.26</td>
</tr>
<tr>
<td>Rational engagement</td>
<td>.91</td>
<td>.19</td>
<td>.26</td>
<td>.16</td>
</tr>
<tr>
<td>Risk</td>
<td>.12</td>
<td>-.06</td>
<td>1.03</td>
<td>-.22</td>
</tr>
<tr>
<td><strong>Correlations Between Factors</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Factor</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>-.38</td>
<td>-.34</td>
<td>-.17</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>.16</td>
<td>.11</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td>.35</td>
<td></td>
</tr>
</tbody>
</table>

factor. Upon examination of the factor loadings, we found seven of the ten variables loaded cleanly. To determine whether there was a solution that would include all 10 of our variables, we carried out a second factor analysis extracting four factors, the fourth factor having an eigenvalue of .912, and found this to be the best factor solution with all
10 of the variables loading cleanly on one of the factors (see Table 2). It is important to note that there appears to be a moderate degree of collinearity among the factors from that solution (Table 2).

As can be seen in Tables 2 and 3, Factor 1 consisted of Scott and Bruce’s (1995) rational decision making, the Rational-Experiential Inventory’s rational ability and rational engagement (Pacini & Epstein, 1999), and the UPPS impulsivity subscales for urgency and lack of premeditation (Whiteside et al., 2005). Based on these components, Factor 1 appears to represent rational, non-impulsive aspects of DM. Factor 2 consisted of fun seeking and drive from the BAS along with spontaneous DM as measured by Scott and Bruce’s (1995) survey, and thus seems to be related to reward sensitivity or a tendency to seek reward. Factors 3 and 4 each consisted of single variables, including the risk-taking scale (Keeney & Raiffa, 1976) and the Cognitive Reflection Test (Frederick, 2005), respectively.

Table 3
Factors and the Individual Difference Variables that Comprise Them

<table>
<thead>
<tr>
<th>Factor</th>
<th>Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor 1 - Rational DM/Lack of impulsivity</td>
<td>Scott and Bruce’s rational decision-making style; Rational-Experiential Inventory’s rational ability and rational engagement; UPPS impulsivity measures of urgency and lack of premeditation</td>
</tr>
<tr>
<td>Factor 2 – Reward sensitivity</td>
<td>BAS fun seeking; BAS drive; Scott and Bruce’s spontaneous decision-making style</td>
</tr>
<tr>
<td>Factor 3 – Risk Taking</td>
<td>Risk Taking scale</td>
</tr>
<tr>
<td>Factor 4 – Cognitive Reflection</td>
<td>Cognitive Reflection Test</td>
</tr>
</tbody>
</table>

Determining which factors account for the IGT/DOI relationship. Before carrying out the regression analyses to determine which, if any, of these factors accounted for the IGT/DOI relationship, we formed composite variables for Factors 1 and 2 by
combining all of the variables that loaded cleanly on each factor (Table 3). For Factor 1 (rational/non-impulsive), we reverse scored the UPPS impulsivity subfactors for urgency and lack of preméditation, converted the data for all five contributing variables to z-scores, and then averaged the z-scores. For Factor 2 (reward sensitivity), we converted the data from the individual measures to z-scores and averaged the scores for the three variables.

Next, we carried out a series of eight two-model hierarchical regressions predicting either the IGT or DOI, one at a time, with each of the four factors. For the first four regressions, IGT performance was the criterion variable and DOI score was the predictor for Model 1. Model 2 of each regression consisted of the DOI paired with one of the four factors (see Table 4). For the other four regressions, DOI score was the criterion variable and IGT performance was the predictor for Model 1. Similar to the first

Table 4

Model 1 and Model 2 Statistics for Four Hierarchical Regressions Predicting IGT

<table>
<thead>
<tr>
<th>Predictor Variable</th>
<th>DOI (β)</th>
<th>p (DOI β)</th>
<th>Factor (β)</th>
<th>p (Factor β)</th>
<th>Sobel (t)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DOI:</td>
<td>.15</td>
<td>.02</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model 2:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Factor 1 – Rational DM/Lack of Impulsivity</td>
<td>.07</td>
<td>.28</td>
<td>.24</td>
<td>&lt;.001</td>
<td>1.93</td>
<td>.054</td>
</tr>
<tr>
<td>Factor 2 – Reward Sensitivity</td>
<td>.10</td>
<td>.12</td>
<td>-.17</td>
<td>.01</td>
<td>-1.72</td>
<td>.1</td>
</tr>
<tr>
<td>Factor 3 – Risk Taking</td>
<td>.13</td>
<td>.05</td>
<td>-.10</td>
<td>.14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Factor 4 - Cognitive Reflection</td>
<td>.13</td>
<td>.04</td>
<td>.10</td>
<td>.16</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
four regressions, each Model 2 consisted of the addition of one of the four factors, this
time paired with the IGT (see Table 5). For each regression we were interested in
determining whether the IGT or DOI remained a significant predictor when a factor was
added to Model 2. If the IGT or DOI (standardized Beta value) dropped to non-
significance as a predictor variable in Model 2 upon the inclusion of one of the four
factors, then we could conclude that factor at least partially accounted for the IGT/DOI
relationship. This is the same method developed by Baron and Kenny (1986) to test for
mediation effects, although in the current study we were not attempting to establish
causal directions between variables. In order to determine whether the factor accounts
for a statistically significant portion of the IGT/DOI relationship, we followed up with a
Sobel (1990) test. It is important to note, recognize though, that the p-values and
standardized Betas associated with the standardized Betas for the DOI in Models 1 and 2
(Table 4) will be the same as the p-values and standardized for the standardized Betas
associated with the IGT in the subsequent regressions (Table 5). This occurs because the
shared variance between the IGT and DOI, not accounted for by one of the four factors,
remains the same regardless of which variable is the predictor and which one is the
criterion. However, because each of the four factors tested in Model 2 is differentially
related to the IGT and the DOI, they will have different standardized Beta and p-values
depending on whether the IGT or DOI is the criterion variable.

For the series of regression analyses in which the IGT was the criterion variable
and DOI was the target predictor, the standardized Beta value for the DOI dropped to
non-significance upon the inclusion of Factor 1 (rational/non-impulsive) and Factor 2
(reward sensitivity) in the models (Table 4). However, the Sobel test conducted for each
of these factors revealed that only Factor 1 significantly accounted for the IGT/DOI association (see Table 4).

For the regression analyses in which the DOI was the criterion variable and IGT was the target predictor, the standardized Beta for the IGT also dropped to non-significance upon the inclusion of Factors 1 (rational/non-impulsive) and 2 (reward sensitivity) into the model (Table 5). In this case though, the Sobel test revealed that both Factors 1 and 2 accounted for significant portions of the IGT/DOI relationship.

**Variables That Account for Additional Variance in the IGT or DOI**

Finally, to more fully understand the nature of the IGT and DOI, we switched the focus of our investigation from which variables were correlated with both the IGT and DOI to which variables related to each of them distinctly. Specifically, we were
interested in whether any of the decision-related constructs measured in our study accounted for variance in either the IGT or DOI beyond what was accounted for by Factors 1 and 2. To do so, we first examined whether any of the individual difference constructs were related to the IGT but not the DOI (see Table 1), and found BAS reward responsiveness to be the only such variable. We then tested whether BAS reward responsiveness accounted for variance in the IGT beyond what was accounted for by Factors 1 and 2 by entering it as a predictor into Model 2 of a hierarchical regression, which also contained Factors 1 and 2 as predictors for Model 1 but did not include the DOI. A significant $R^2$ change for Model 2 would indicate that BAS reward responsiveness did account for additional unique variance in the IGT. However, we found that the $R^2$ change was not significant, meaning BAS reward responsiveness did not account for any additional unique variance in IGT performance (Table 6).

Similarly, we examined the constructs that were related to the DOI but not the IGT (see Table 1), including the Maximization Tendency Scale (Diab et al., 2008), the BIS, the tendency to feel regret (Schwartz et al., 2002), Scott and Bruce’s (1995) avoidant decision style, and lack of perseverance as measured by the UPPS (Whiteside et al.,

Table 6

Model 1 and Model 2 Statistics for Hierarchical Regressions Predicting IGT.

<table>
<thead>
<tr>
<th>Predictor Variables</th>
<th>$R^2$ change</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Model 1:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Factor 1 and Factor 2</td>
<td>.082</td>
<td>&lt; .001</td>
</tr>
<tr>
<td><strong>Model 2:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BAS Reward Responsiveness</td>
<td>.005</td>
<td>.287</td>
</tr>
</tbody>
</table>
2005), to determine whether any of those variables accounted for variance in the DOI beyond Factors 1 and 2. To test these variables, we again ran a series of hierarchical regressions with Factors 1 and 2 as predictors in Model 1, leaving out the IGT as a predictor, with one of the individual difference constructs of interest added to Factors 1 and 2 those predictors in a series of Model 2’s (see Table 7). We found that the addition of the BIS and UPPS' lack of perseverance resulted in a significant $R^2$ change between Models 1 and 2, while the tendency to feel regret yielded a marginally significant $R^2$ change, suggesting these three variables accounted for unique variance in the DOI beyond Factors 1 and 2.

Table 7
Model 1 and Model 2 Statistics for Five Hierarchical Regressions Predicting DOI

<table>
<thead>
<tr>
<th>Predictor Variables</th>
<th>$R^2$ change</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Model 1:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Factor 1 and Factor 2</td>
<td>.127</td>
<td>&lt;.001</td>
</tr>
<tr>
<td><strong>Model 2:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximizing – Diab</td>
<td>.021</td>
<td>.019</td>
</tr>
<tr>
<td>BIS</td>
<td>.029</td>
<td>.005</td>
</tr>
<tr>
<td>Regret</td>
<td>.010</td>
<td>.059</td>
</tr>
<tr>
<td>Scott and Bruce – avoidant DM</td>
<td>.005</td>
<td>.253</td>
</tr>
<tr>
<td>UPPS lack of perseverance</td>
<td>.001</td>
<td>.627</td>
</tr>
</tbody>
</table>
DISCUSSION

Based on our previous work in which we found a negative relationship between the DOI and IGT (Furl et al., 2009), we designed the current study to determine whether an inverse relationship between the DOI and IGT could be replicated and if it would change over time. With the expectation of replicating the inverse relationship, we further planned to investigate what types of individual differences in decision making style and personality characteristics might account for the DOI/IGT relationship. We approached our investigation of individual differences from two perspectives. First, we developed specific hypotheses concerning the IGT/DOI relationship, and predicted that variance in sensitivity to punishment and a tendency to maximize would account for that relationship. Second, we used a more exploratory approach in which we selected variables that had previously been shown to be related to either the IGT or DOI to see if any of them could account for the IGT/DOI relationship. We reasoned that because both the IGT and DOI were DM measures and related to one another than the decision related personality variables and decision making style constructs we chose would predict any variance common to both measures.

Why No Inverse Relationship Between the IGT and DOI?

Surprisingly, we found that the IGT was positively related to the DOI, which was the opposite of our previous study (Furl et al., 2009). To attempt to understand why we obtained this unexpected result, we compared the levels of performance between the poor and good DOI conditions across our two experiments. Because participants in the current study were not pre-selected based on their DOI scores, as in our original experiment, which consisted of a high and low DOI group, we first selected a subset of our current participants who could be classified as either the top and bottom scorers on
the DOI using the quartile cutoffs from our previous work (Furl et al., 2009). We then calculated each group’s IGT performance across five blocks for both studies (see Figure 2), and compared the groups by carrying out a 5 (block) X 2 (DOI condition) X 2 (study) mixed ANOVA.

**Figure 2**

Percentage of Cards Chosen from the Good Decks as a Function of Block across Experiments

![Graph showing percentage of cards chosen from good decks across blocks.](image)

The analysis revealed a marginally significant block X study interaction, $F(4, 604) = 2.33, p = .055$, which was due to a greater increase in IGT performance across blocks in the current study, and a block X DOI group X study interaction, $F(4, 604) = 5.98, p < .001$, that appeared to be largely driven by a greater increase in performance by the good DOI group in the current study compared to the good DOI group in the previous experiment (Figure 2). To test whether this pattern was significant, we carried out a 5 (block) X 2 (study) ANOVA for both the good and bad DOI groups, and found a significant block X study interaction for the good DOI group, $F(4, 292) = 5.96, p < .001$, but not for the poor DOI group, $F(4, 312) = 1.63, p = .167$. We also examined individual deck selection and found that the preference for deck B by the good DOI group relative to the poor DOI group, which had driven our original findings of an inverse IGT/DOI
relationship (Furl et al., 2009), had reversed such that the poor DOI group now preferred deck B while the good DOI group did not. This reversal in the association between DOI scores and deck B selection between the previous and current work seemed to be responsible for the directional change in the overall IGT/DOI relationship.

The most likely cause for this reversal in the IGT/DOI association lays in the methodology of the two studies. In our original work, there was a time lag between each trial during which participants either completed a WM task or a keypad-entry control task. In addition, participants were given a brief interview after every 10 trials. It seems quite possible that these experimental differences may have affected rational and emotional decision making across the two studies. With respect to rational decision making, increased time between trials may have made it likely that less information pertaining to the reward and punishment contingencies associated with the four decks could be maintained, while the interview questions may have switched attention away from the task, making it even more difficult to attend to and maintain the information pertinent for good IGT performance in WM. As a result, the good DOI participants, in particular, may have shifted from a strategy of keeping track of overall gains and losses associated with each deck (an outcome dependent strategy) to a less cognitively demanding strategy of remembering each trial as simply a win or a loss (frequency dependent strategy) while disregarding the exact amounts of gains and losses.

In studies in which selections from each deck have been analyzed, some authors have found a preference for deck B among cognitively healthy adults suggesting that a preference for deck B may not necessarily be indicative of poor real world DM abilities (Dunn, Dalgleish, & Lawrence, 2005; Lin et al., 2007; Maia & McClelland, 2004; Wilder, Weinberger, & Goldberg, 1998). In fact, Lin et al. (2007) hypothesized that the
frequency of trials resulting in a net gain is a greater determinant of deck preference than overall wins and losses among cognitively healthy adults, and consequently, a preference for deck B can be seen as normal DM. To test this hypothesis, Lin et al. (2007) developed two variant versions of the IGT. In one version, the good and bad decks had an equal frequency of wins and losses, though the good decks resulted in better outcomes in the long run, and in the other version, the good decks had a higher frequency of wins in addition to a better long-term outcome. The results showed that participants tended to prefer any deck with a high frequency of wins even if that deck did not mean overall success on the task, leading the authors to conclude that the frequency of trials resulting in gains relative to punishments for each deck may be more salient and influential in normal DM than the overall outcomes associated with the decks.

It makes sense that keeping track of decision outcomes using a binomial categorization, gain or loss as in frequency dependent DM, would be an effective way to conserve cognitive resources and result more often than not in advantageous DM. However, the IGT was designed so that the advantageous rational strategy is an outcome dependent strategy in which one must account for the actual amounts of gains and losses, and overcome the tendency to rely on a frequency dependent strategy. To explain the opposing IGT/DOI relationships found across our work, we suggest that in everyday DM, the most rational DM strategy is outcome dependent DM when one has the cognitive resources to maintain the number of rewards and losses, and frequency dependent DM when the resources needed to keep track of actual outcomes is lacking. In our initial study (Furl et al., 2009), the additional time between trials and the attention switching caused by the interview periods may have rendered the task of keeping track of actual
outcomes too difficult and resulted in the need for participants to use the less demanding frequency dependent strategy in which deck B is preferable.

Although this explanation seems to account for the good DOI group’s preference for deck B and poor performance in our previous study, it does not explain why the poor DOI group did not prefer deck B in our earlier work but did so in the current study. It is doubtful that the poor DOI group utilized more rational DM in our first study given our current finding that poor DOI scores are related to less rational DM and more impulsivity, which means there must be another influence to explain why the poor DOI group chose deck B less and performed better previously. One possibility is that there may be an emotional influence on performance that can account for why the poor DOI group selected less from deck B in our initial work. As discussed in the introduction, the poor DOI group seemed to exhibit greater sensitivity to punishment in the previous study, which we thought might account for the lack of preference for deck B given that deck results in the greatest single punishment relative to the other decks even though the punishments are infrequent. In keeping with this, our current data show that DOI scores were negatively related to sensitivity to punishment, meaning greater sensitivity to punishment as measured by the BIS (Carver & White, 1994) was related to poorer DOI scores. We believe then that this greater sensitivity to punishment may have interacted with the methodological differences between the studies. In particular, the presence of an interviewer for the duration of the task, who repeatedly asked participants what they knew about the IGT, may have been an additional source of pressure in our earlier work (Furl et al., 2009), and that pressure may have affected the more emotionally reactive poor DOI group differently than the good DOI group, such that they reacted more strongly to the punishments associated with deck B. It is likely that increased emotional
arousal due to the presence of the interviewer would have been less for the good DOI group based on evidence for an inverse relationship between emotional reactivity (indexed by both the BIS and BAS) and DOI scores found in the current work. Consequently, the poor DOI group's greater emotional reactivity may have resulted in an avoidance of deck B after the first punishment compared to the good DOI group, producing better scores for the poor DOI group in the first study even though this “strategy” was not rational. In sum, the difference in IGT performance between the good and poor DOI groups across our two studies may be due to interactions between the different methodologies with individual differences in rationality and emotionality between the good and poor DOI groups.

The Role of Sensitivity to Punishment (BIS) and Maximizing on the IGT and DOI

Sensitivity to punishment. Though our specific hypotheses regarding the existence and cause of an inverse IGT/DOI relationship were no longer relevant upon finding a positive correlation in the current study, we remained interested in whether sensitivity to punishment, as measured by the BIS (Carver & White, 1994), and maximizing (Diab et al., 2008; Schwartz et al., 2002) were related to either the IGT or DOI. As seen in Table 1, the BIS was not related to IGT performance, contrary to previous research and hypotheses based on inferences from our previous study. The contradiction between the lack of an IGT/sensitivity to punishment relationship in the current study and the presence of one in previous research (Davis et al., 2007; Van Honk et al., 2002) may be due to differences in the analyses and measures used in that previous work. For example, Van Honk et al. (2002) found that those with low BIS scores in conjunction with high BAS scores (high sensitivity to reward) performed poorly on the IGT. However, his participants were selected to have either low BIS scores with high
BAS scores or high BIS scores with low BAS scores. This pairing of characteristics within his sample obscures any conclusions regarding the independent effect of punishment sensitivity on IGT performance across a range of BAS scores. In contrast, Davis et al. (2007) did find an independent inverse relationship between sensitivity to punishment and IGT performance, but used the Sensitivity to Reward and Sensitivity to Punishment scale (Torrubia et al., 2001) instead of the BIS scale rendering comparisons with the current study unclear.

Consistent with our predictions, the BIS was negatively related to the DOI in the present work. Our prediction of a DOI/BIS relationship was largely based on the evidence from our previous study (Furl et al., 2009) that had also led us to predict an IGT/BIS relationship. Specifically, changes in deck B preference after the first punishment associated with deck B and a decline in WM performance after punishment trials occurred among the poor DOI group. This led us to hypothesize that greater sensitivity to punishment would be associated with poor DOI scores. This finding is also in line with previous research in which the DOI shows a negative relationship with decision styles that seem related to punishment sensitivity, such as regret in DM and avoidant DM (Bruine de Bruin et al., 2007). For example, chronic doubt or fear regarding punishment following a decision could lead to avoidance of decision making. Because decisions often have a limited window of time to be made, such avoidance could result in poor life outcomes.

**Maximizing.** We had also predicted that Schwartz et al.’s (2002) Maximization Scale would be inversely related to DOI scores, as shown in previous research (Bruine de Bruin et al., 2007), and to greater IGT performance based on patterns of deck selection in our previous study. In contrast, we expected Diab et al.’s (2008) Maximizing Tendency
Scale, which excludes the negative aspects of maximizing (with the exception of regret) measured with Schwartz et al.’s (2002) Maximization Scale, would be positively related to the DOI. However, we found that neither of the maximizing scales was significantly related to the IGT while only Diab et al.’s (2008) Maximizing Tendency Scale was positively, albeit marginally, related to the DOI.

Of these findings, we were the most puzzled that we did not replicate the significant negative relationship between the DOI and Schwartz et al.'s (2002) Maximization Scale, found elsewhere (Bruine de Bruin et al., 2007) and so decided to examine the construct of maximizing more closely to determine whether other relationships found in previous work were replicated in the current study (Bruine de Bruin et al., 2007; Diab et al., 2008). Specifically, we looked at correlations among the two maximizing scales and the tendency to feel regret (Schwartz et al., 2002). We found that both maximizing scales were related to one another and to regret. Though the maximizing scales proved to be positively related with each other as expected, they are thought to diverge in the degree to which they reflect the positive and negative influences of maximizing on decision outcomes (Diab et al., 2008). We thought this difference could help explain why the two scales were differentially related to the DOI. To explore this possibility, we entered both maximizing measures into a regression predicting DOI scores. The results showed both to be significant predictors of the DOI but in opposite directions, Beta (Maximization Scale) = -.216, \( p = .005 \), and Beta (Maximizing Tendency Scale) = .226, \( p = .003 \). Thus, when paired with Diab et al.’s (2008) Maximizing Tendency Scale, Schwartz et al.’s (2002) Maximization Scale significantly predicted DOI scores. Given these findings, it seems possible that the positive and negative aspects of maximizing tapped within each scale may have combined to weaken the individual
correlation between that scale and the DOI. However, when entered together into a regression, Diab et al.’s (2008) Maximizing Tendency Scale may have accounted for more of the variance in DOI scores arising from the positive aspects of maximizing while Schwartz et al.’s (2002) Maximization Scale accounted for more of the negative aspects, thus eliminating any dilution effect that may have occurred when each scale was examined independently.

Nonetheless, the question remains as to why Bruine de Bruin et al. (2007) were able to find a significant correlation between the DOI and Schwartz et al.’s (2002) Maximization Scale, \( r(360) = -.26 \), and we were not. One possibility is they used a larger sample \((n = 360)\) than we did and the benefit of greater statistical power may have contributed to their significant finding. However, the discrepancy between the magnitude of the two correlations suggests that other factors may have led to the differing results. Most notably, there is an age difference across the two studies with older participants tested in Bruine de Bruin et al.’s (2007) experiment \((M = 47.7 \text{ years})\) compared to the current work’s sample of college undergraduates. It is possible that age may impact the relationship between maximizing and the DOI because the negative effects of overmaximizing could become increasingly detrimental as the number and seriousness of responsibilities, including those related to careers and family, increase into adulthood. That is, as long as the quantity and importance of real world decisions remains at a manageable threshold, as could be the case for college students, inefficiency in decision-making, which is the hallmark of overmaximizing, may not lead to as great a number of poor decision outcomes. In fact, it may be the case that once a critical threshold is reached and the DM load becomes unmanageable for an overmaximizer, the resultant poor outcomes could spark a feedback loop by reinforcing and intensifying the
overmaximizer's desire to make the best possible decisions, in turn leading to even more poor outcomes.

**Individual Difference Variables that Account for the IGT and DOI Relationship**

Our original intention to explore the possible involvement of other individual difference variables in accounting for the relationship between the IGT and DOI remained given we did find a significant correlation, albeit weak and in the opposite direction of what we had predicted. After carrying out a factor analysis on all the variables that were correlated with both the IGT and DOI, and then entering the resulting factors into two series of regressions in which the IGT acted as the criterion variable with the DOI as the predictor variable and vice versa, we found that two factors, one related to rationality and one related to emotionality, were of interest in accounting for IGT performance and DOI scores.

The rationality factor significantly accounted for the IGT/DOI relationship regardless of whether the IGT or DOI was entered into the regressions as a predictor or criterion variable, and was comprised of a combination of variables tapping both rational DM and non-impulsivity. We had not anticipated that these constructs would be closely related, but in retrospect, the convergence of rational DM and non-impulsivity measures into a single factor is sensible. A review of the literature revealed that an inverse relationship between impulsivity and aspects of intelligence, including verbal intelligence (Harmon-Jones et al., 1997) and working memory (Whitney et al., 2004) has previously been established. In one study employing event related potentials, Russo et al. (2008) found that a specific electromagnetic wave (P300), the amplitude of which is inversely related to trait impulsivity, was positively related to intelligence, and that impulsivity and IQ scores were inversely related. These authors suggest that high impulsivity and the
corresponding low amplitude of the P300 wave may be related to a deficit in inhibiting task-irrelevant information, an aspect of attentional processing that is necessary for tasks, such as intelligence tests, that require sustained and exclusive attention.

We had expected rationality and impulsivity to be related to both the IGT and DOI, consistent with findings from previous research. The positive relationship found here with the IGT further supports the idea that there is a significant influence of rational DM processes on IGT performance (Hinson et al., 2002; Maia & McClelland, 2004) in apparent contradiction with the original emphasis on the impact of emotion on the IGT. Similarly, the DOI has been positively related to rational DM styles in earlier work (Bruine de Bruin et al., 2007). As for impulsivity, we found the IGT to be associated with two subcomponents of Whiteside et al.’s (2005) UPPS impulsivity scale, specifically lack of premeditation and urgency, which have been previously related to IGT performance (Xiao et al., 2009; Zermatten et al., 2005). Because the DOI though has never been compared to impulsivity, or any personality traits, in fact, the current findings offer a new perspective for research using the DOI, suggesting that individual differences in personality traits may be used, in addition to DM styles, when examining DM and real world decision outcomes.

The second factor of interest consisted of measures related to reward sensitivity. Similar to the rational/non-impulsive factor, the second factor included both personality traits and DM style variables, including the fun seeking component of the BAS, drive as measured by the BAS (Carver & White, 1994) and a spontaneous DM style (Scott & Bruce, 1995). We view this factor as reflecting reward sensitivity because fun seeking and drive are seen as components of that trait (Carver & White, 1994) while spontaneous decision-making seems to correspond with the type of active or seeking behavioral style
which fits descriptions of the reward sensitivity (Carver & White, 1994). Contrary to the rational/non-impulsive factor, the reward sensitivity factor was not significantly related to both the IGT and DOI independently. Instead, the second factor accounted for a significant portion of the IGT/DOI relationship when predicting the DOI, but accounted for only a marginally significant portion of variance when predicting the IGT. Such a difference can occur statistically because the Beta weights for the factor, which were used in the Sobel significant tests, can vary depending on whether the IGT or DOI is entered as either the predictor or the criterion variable. Because reward sensitivity was a significant predictor variable when predicting the DOI and marginally significant when predicting the IGT, we cautiously treat it here as accounting for a portion of the IGT/DOI relationship, and note that the direction of the relationships with the IGT and DOI, respectively, are both negative. The negative association with IGT performance makes sense given that the decks offering the highest rewards, which would be attractive to those with greater reward sensitivity, are the bad decks and result in net losses over the long run. The relationship with the DOI is also sensible as it corresponds with previous findings of an inverse relationship between the DOI and one of the variables composing the reward sensitivity factor, which is the spontaneous DM style (Bruine de Bruin et al., 2007). Moreover, the presence of fun seeking and drive in this factor and its relationship with the DOI further suggests that personality variables might be of interest in future research involving the DOI and decision making styles.

**Individual Difference Variables that Account for DOI vs. IGT Scores**

Though the emphasis of the current study was to explore how the IGT and DOI were related, we also examined how the two measures differ. Specifically, we set out to determine whether any individual difference variables accounted for variance in the IGT
or DOI beyond the two factors that were found to account for the common variance shared between them. To do so we carried out an additional series of two-model hierarchical regressions, which included the rational DM/non-impulsivity and reward sensitivity factors in Model 1 and individual difference variables in a set of Model 2’s. We found none of the variables accounted for additional variance in IGT scores. Additional variance in the DOI, however, was accounted for by sensitivity to punishment (BIS), regret, and lack of perseverance (UPPS subcomponent of impulsivity), each in the negative direction. This means the DOI may be sensitive to some decision-related constructs not reflected by the IGT. Two of these variables in particular, punishment sensitivity and regret, seem to be substantially different from the rationality and reward sensitivity factors found to account for common variance in the IGT and DOI, and thus indicate a potentially important difference between the measures. Both sensitivity to punishment and regret share a common negative affective valence suggesting the DOI may be sensitive to individual differences involving negative affect in line with our predictions and previous research (Bruine de Bruin et al., 2007). Contrary to our predictions however, was the lack of association between variables involving negative affect and the IGT.

As discussed previously, it is not clear why this relationship was found in other research and not the current study but we offer a couple of possible explanations. First, there are potentially important methodological differences between the current study and the other studies that examined the IGT and sensitivity to punishment (Davis et al., 2007; Van Honk et al., 2002) which diminish the ability to draw direct comparisons. As already described, Van Honk et al. (2002) selected only participants with certain combinations of extreme sensitivity to reward and punishment, and Davis et al. (2007) used a different
measure of punishment sensitivity in their study. It should also be noted that these two studies found opposite effects of punishment sensitivity and thus did not guide the direction of our hypothesis. Second, the design of the IGT task itself is set up such that greater sensitivity to punishment should lead to better performance, the opposite of its effect on real world DM as indexed by the DOI. In the same way that greater reward sensitivity should lead to worse IGT performance, because the decks with the largest rewards are the bad decks, sensitivity to punishment should lead to better performance because the decks with the largest punishments are also the bad decks. This reveals a potential weakness in the use of the IGT as a measure of real world DM, if punishment sensitivity is detrimental to real world DM, as the relationships found here with the DOI indicate. However, it also means one would predict a significant positive relationship between punishment sensitivity and the IGT, which was not seen in the current study. In other words, we would have expected symmetry between reward sensitivity's detrimental influence on IGT performance and punishment sensitivity's beneficial effects. A closer look at the IGT's design though, reveals that rewards and punishments are not symmetrically related to the good and bad decks. Specifically, the frequency and magnitude of reward is constant - $50 and $100 respectively, for the good and bad decks – while the frequency of punishments varies across trials. Furthermore, this variance is not systematically related to the valuation of the deck, good or bad. For example, the frequency of punishments for deck B, a bad deck, is the same as the frequency of punishments for deck D, a good deck. As discussed previously, both frequency and magnitude have been shown to influence the perceived value of the IGT decks (Lin et al., 2007). In sum, we suggest that the IGT is designed so that greater reward sensitivity, and
not punishment sensitivity, should lead to poor IGT scores and may explain why only
reward sensitivity accounted for a portion of the IGT/DOI relationship.

**Implications for the Somatic Marker Hypothesis**

Because the current study focused on questions related to the IGT, the results are
relevant to the theory that led to its creation, the somatic marker hypothesis. Two
findings, in particular, raise questions about that hypothesis. The first is the inverse
relationship between the emotion-related reward sensitivity and rationality factors \(r = - .38\) found here. On the one hand, this is not surprising given the somatic marker
hypothesis advocates a view in which the influence of reason is inextricably linked with
the influence of emotion with any distinction between the two influences seen as
artificial. On the other hand, the negative correlation between the two factors that was
found is interesting because it suggests that the nature of the interdependence is inverse,
which is not proposed by the somatic marker hypothesis. The second finding relevant to
the somatic marker hypothesis is the suggestion that the emotion-related factor, reward
sensitivity, was inversely related to both the IGT and DOI, whereas the rationality factor
was positively related to the IGT and DOI. We had expected rational processing, as well
as variables indicative of emotionality, such as the BIS/BAS measures and intuitive DM,
to be positively related to both the IGT and DOI. At first blush our results seem to
contradict what we should predict based on the somatic marker hypothesis. As discussed,
the IGT was first used to provide evidence for the prominent influence of emotion on
advantageous DM while de-emphasizing the influence of reason. This was demonstrated
in VM patients, who despite their intact reasoning abilities, showed impaired IGT
performance and real world DM along with deficient emotional responding compared to
healthy controls (Bechara et al., 1997). The current findings, in contrast, seem to suggest that advantageous DM is related to greater reasoning and less emotionality.

However, in consideration of an alternative, and perhaps less contradictory, interpretation of our results as they relate to the somatic marker hypothesis, we focus on another view, or perhaps clarification, of that hypothesis (Bechara, Damasio, & Tranel, 2005). Specifically, although seen as backtracking by some researchers, Bechara et al. have softened their stance by claiming the somatic marker hypothesis only suggests that emotional signals are a necessary component of advantageous DM, but do not necessarily result in advantageous DM (Dunn, Dalgleish, & Lawrence, 2005). In other words, emotion is necessary but not sufficient for advantageous DM. Taking this view, our finding that increased emotional influence is related to poor DM may not necessarily contradict the somatic marker hypothesis. We offer one possible explanation to reconcile our finding that less emotionality relates to better IGT performance and real world DM (DOI), and Bechara et al.'s (1997) finding that less of an influence of emotion leads to worse IGT performance and real world DM. It seems a curvilinear association between IGT performance and emotional reactivity could account for both findings. According to this idea, a certain level or threshold of emotional influence, which is not present in VM patients, is necessary for advantageous performance. Beyond this threshold, greater emotional reactivity impairs performance. If this is the case, then the linear relationship between the IGT and reward sensitivity seen in the current study would indicate that the threshold beyond which emotional reactivity impairs performance is at the higher end of the distribution. In other words, among the current sample of cognitively healthy young adults, most participants would have been at or above the threshold at which emotional reactivity helps IGT performance. It seems then that a curvilinear relationship could, in
fact, account for the discrepancy between the current findings and Bechara et al.’s (1997) results. However, cautious consideration seems warranted based on both the lack of clarity concerning the degree of emotion's influence on DM proposed by the somatic marker hypothesis, and by the lack of consensus about which aspects of emotion influence IGT performance.

**Future Directions**

Due to the weakness of the IGT/DOI association found here, we suggest that further research directly addressing the validity of the IGT as a predictor of real world DM is needed. Given the unexpected findings of an inverse relationship between the IGT and reward sensitivity, and the lack of relationship between the IGT and measures of emotion, we suggest three issues that could be explored more fully to clarify the effect of emotion relationship on the IGT. First, as discussed above, it is problematic if the IGT is designed so that emotions with a negative valence, such as sensitivity to punishment and regret, can lead to better IGT scores but are inversely related to real world DM success, as indicated by the DOI in the current study. It is important for clinicians and researchers using the IGT as a measure of real world DM to know with certainty that the IGT may not accurately reflect the influence that negative emotions have on real world DM. Second, it is also important to establish if the effect of emotion on the IGT is represented by a curvilinear relationship, such that a certain amount of emotion is necessary for success on the IGT but too much harms performance, as we suggest here to explain the discrepancy between our findings and those of Bechara et al. (1997). Third, it would be interesting to test the idea that increased emotional arousal, as we expect might have occurred in the presence of an interviewer in our initial study, may lead poor DM makers to avoid selecting from deck B, resulting in better IGT performance.
Other aspects of the IGT that would be interesting to explore based on our work could include determining whether taxing working memory by increasing the time lags between IGT trials or other manipulations can cause a switch from use of an outcome dependent to a frequency dependent strategy during task performance. In addition, future research could be designed to investigate the underpinnings of the inverse relationship between rationality and emotionality that was found here and the implications of that relationship for the somatic marker hypothesis.
REFERENCES


Bechara, A., Tranel, D., Damasio, H., & Damasio, A. (1996). Failure to respond autonomically to anticipated future outcomes following damage to prefrontal cortex. *Cerebral Cortex, 6*, 215-225.


APPENDICES

Appendix A

Decision Outcome Inventory

**Instructions:**
The following questions ask whether different events have happened to you in the last 5 years. Please indicate “yes” or “no” for each.

**In the last 5 years, have you ever...**

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<th>Yes</th>
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<td>4a</td>
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<td>6a</td>
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<td>7a</td>
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<td>b</td>
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<td>8a</td>
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<td>b</td>
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<td>c</td>
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<td>12a</td>
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<td>b</td>
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<tr>
<td>13a</td>
<td>Yes</td>
<td>No</td>
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</tbody>
</table>
b  __Yes __No  Had the key to your home replaced because you lost it
   c  __Yes __No  Locked yourself out of your home
14a  __Yes __No  Used checks
   b  __Yes __No  Had a check bounce
15a  __Yes __No  Had a credit card
   b  __Yes __No  Had more than $2500 in credit card debt
16a  __Yes __No  Invested in the stock market
   b  __Yes __No  Lost more than $1000 on a stock-market investment
17a  __Yes __No  Been to a bar, restaurant, or hotel
   b  __Yes __No  Been kicked out of a bar, restaurant, or hotel by someone who
                      works there

**In the last 5 years, have you ever…**

18a  __Yes __No  Loaned more than $25 to someone
   b  __Yes __No  Loaned more than $25 to someone and never got it back
19a  __Yes __No  Had a romantic relationship that lasted for at least 1 year
   b  __Yes __No  Cheated on your romantic partner of 1 year
20a  __Yes __No  Had an alcoholic drink
   b  __Yes __No  Consumed so much alcohol you vomited
   c  __Yes __No  Received a DUI for drunk driving
21a  __Yes __No  Been out in the sun
   b  __Yes __No  Got blisters from sun burn
22a  __Yes __No  Been in a jail cell overnight for any reason
23a  __Yes __No  Been in a public fight or screaming argument
24a  __Yes __No  Forgotten a birthday of someone close to you and did not realize
                      until the next day or later.
25a  __Yes __No  Broke a bone because you fell, slipped, or misstepped
Appendix B

Maximization Scale and the Maximizing Tendency Scale

Instructions:
Indicate how much you agree with each of the following by circling the appropriate number:

1. No matter how satisfied I am with my job, it’s only right for me to be on the lookout for better opportunities.

1 2 3 4 5
Completely Disagree

2. When I am in the car listening to the radio, I often check other stations to see if something better is playing, even if I am relatively satisfied with what I’m listening to.

1 2 3 4 5
Completely Disagree

3. When I watch TV, I channel surf, often scanning through the available options even while attempting to watch one program.

1 2 3 4 5
Completely Disagree

4. I treat relationships like clothing: I expect to try a lot on before finding the perfect fit.

1 2 3 4 5
Completely Disagree

5. I often find it difficult to shop for a gift for a friend.

1 2 3 4 5
Completely Disagree
6. Renting dvds is really difficult. I’m always struggling to pick the best one.

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<tr>
<td></td>
<td>Completely</td>
<td>Disagree</td>
<td></td>
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<td></td>
<td>Agree</td>
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7. When shopping, I have a hard time finding clothing that I really love.

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8. I’m a big fan of lists that attempt to rank things (the best movies, the best singers, the best athletes, the best novels, etc.).

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9. I find that writing is very difficult, even if it’s just writing a letter to a friend, because it’s so hard to word things just right. I often do several drafts of even simple things.

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10. No matter what I do, I have the highest standards for myself.

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11. I never settle for second best.

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12. Whenever I’m faced with a choice, I try to imagine what all the other possibilities are, even ones that aren’t present at the moment.

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<td></td>
<td>Agree</td>
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13. I often fantasize about living in ways that are quite different from my actual life.

1 2 3 4 5
Completely Disagree Completely Agree

14. No matter what it takes, I always try to choose the best thing.

1 2 3 4 5
Completely Disagree Completely Agree

15. I don’t like having to settle for “good enough”.

1 2 3 4 5
Completely Disagree Completely Agree

16. I am a maximizer.

1 2 3 4 5
Completely Disagree Completely Agree

17. I will wait for the best option, no matter how long it takes.

1 2 3 4 5
Completely Disagree Completely Agree

18. I am uncomfortable making decisions before I know all of my options.

1 2 3 4 5
Completely Disagree Completely Agree

19. I never settle.

1 2 3 4 5
Completely Disagree Completely Agree

* The Maximization Scale (Schwartz et al., 2002) consists of numbers 1-13.
* The Maximizing Tendency Scale (Diab, Gillespie, & Highhouse, 2008) consists of numbers 10-12 and 14-19.
Appendix C
Decision Styles Survey

**Instructions:**
Listed below are statements describing how individuals go about making *important decisions*. Please indicate how much you agree with each statement by circling a number on the accompanying scale. It ranges from 1 (completely disagree) to 5 (completely agree).

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.  I double-check my information sources to be sure I have the right facts before making decisions.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>2.  I make decisions in a logical and systematic way.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>3.  My decision making requires careful thought.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>4.  When making a decision, I consider various options in terms of a specific goal.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>5.  When making decisions, I rely upon my instincts.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>6.  When I make decisions, I tend to rely on my intuition.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>7.  I generally make decisions that feel right to me.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>8.  When I make a decision, it is more important for me to feel the decision is right than to have a rational reason for it.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>9.  When I make a decision, I trust my inner feelings and reactions.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>10. I often need the assistance of other people when making important decisions.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>11. I rarely make important decisions without consulting other people.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>12. If I have the support of others, it is easier for me to make important decisions.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>13. I use the advice of other people in making my important decisions.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>14. I like to have someone to steer me in the right direction when I am faced with important decisions.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>15. I avoid making important decisions until the pressure is on.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>16. I postpone decision making whenever possible.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>17. I often procrastinate when it comes to making important decisions.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>18. I generally make important decisions at the last minute.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>19. I put off making many decisions because thinking about them makes me uneasy.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>20. I generally make snap decisions.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>21. I often make decisions on the spur of the moment.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>22. I make quick decisions.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
<tr>
<td>23. I often make impulsive decisions.</td>
<td>1 2 3 4 5</td>
<td></td>
</tr>
</tbody>
</table>
24. When making decisions, I do what seems natural at the moment.  1 2 3 4 5
25. I double-check my information sources to be sure I have the right facts before making decisions.  1 2 3 4 5
26. I make decisions in a logical and systematic way.  1 2 3 4 5
27. My decision making requires careful thought.  1 2 3 4 5
28. When making a decision, I consider various options in terms of a specific goal.  1 2 3 4 5
29. When making decisions, I rely upon my instincts.  1 2 3 4 5
30. When I make decisions, I tend to rely on my intuition.  1 2 3 4 5
31. I generally make decisions that feel right to me.  1 2 3 4 5
32. When I make a decision, it is more important for me to feel the decision is right than to have a rational reason for it.  1 2 3 4 5
33. When I make a decision, I trust my inner feelings and reactions.  1 2 3 4 5
34. I often need the assistance of other people when making important decisions.  1 2 3 4 5
35. I rarely make important decisions without consulting other people.  1 2 3 4 5
36. If I have the support of others, it is easier for me to make important decisions.  1 2 3 4 5
37. I use the advice of other people in making my important decisions.  1 2 3 4 5
38. I like to have someone to steer me in the right direction when I am faced with important decisions.  1 2 3 4 5
39. I avoid making important decisions until the pressure is on.  1 2 3 4 5
40. I postpone decision making whenever possible.  1 2 3 4 5
41. I often procrastinate when it comes to making important decisions.  1 2 3 4 5
42. I generally make important decisions at the last minute.  1 2 3 4 5
43. I put off making many decisions because thinking about them makes me uneasy.  1 2 3 4 5
44. I generally make snap decisions.  1 2 3 4 5
45. I often make decisions on the spur of the moment.  1 2 3 4 5
46. I make quick decisions.  1 2 3 4 5
47. I often make impulsive decisions.  1 2 3 4 5
48. When making decisions, I do what seems natural at the moment.
Appendix D

Epstein’s Rational-Experiential Inventory

Instructions:
Read each statement and circle the answer that best describes yourself.

<table>
<thead>
<tr>
<th>Definitely not true of myself</th>
<th>Definitely true of myself</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I try to avoid situations that require thinking in depth about something.</td>
<td>1</td>
</tr>
<tr>
<td>2. I’m not that good at figuring out complicated problems.</td>
<td>1</td>
</tr>
<tr>
<td>3. I enjoy intellectual challenges.</td>
<td>1</td>
</tr>
<tr>
<td>4. I am not very good at solving problems that require careful logical analysis.</td>
<td>1</td>
</tr>
<tr>
<td>5. I don’t like to have to do a lot of thinking.</td>
<td>1</td>
</tr>
<tr>
<td>6. I enjoy solving problems that require hard thinking.</td>
<td>1</td>
</tr>
<tr>
<td>7. Thinking is not my idea of an enjoyable activity.</td>
<td>1</td>
</tr>
<tr>
<td>8. I am not a very analytical thinker.</td>
<td>1</td>
</tr>
<tr>
<td>9. Reasoning things out carefully is not one of my strong points.</td>
<td>1</td>
</tr>
<tr>
<td>10. I prefer complex problems to simple problems.</td>
<td>1</td>
</tr>
<tr>
<td>11. Thinking hard and for a long time about something gives me little satisfaction.</td>
<td>1</td>
</tr>
<tr>
<td>12. I don’t reason well under pressure.</td>
<td>1</td>
</tr>
<tr>
<td>13. I am much better at figuring things out logically than most people.</td>
<td>1</td>
</tr>
<tr>
<td>14. I have a logical mind.</td>
<td>1</td>
</tr>
<tr>
<td>15. I enjoy thinking in abstract terms.</td>
<td>1</td>
</tr>
<tr>
<td>16. I have no problem thinking things through carefully.</td>
<td>1</td>
</tr>
<tr>
<td>17. Using logic usually works well for me in figuring out problems in my life.</td>
<td>1</td>
</tr>
<tr>
<td>18. Knowing the answer without having to understand the reasoning behind it is good enough for me.</td>
<td>1</td>
</tr>
<tr>
<td>19. I usually have clear, explainable reasons for my decisions.</td>
<td>1</td>
</tr>
<tr>
<td>20. Learning new ways to think would be very appealing to me.</td>
<td>1</td>
</tr>
<tr>
<td>21. I like to rely on my intuitive impressions.</td>
<td>1</td>
</tr>
<tr>
<td>22. I don’t have a very good sense of intuition.</td>
<td>1</td>
</tr>
<tr>
<td>23. Using my gut feelings usually works well for me in figuring out problems in my life.</td>
<td>1</td>
</tr>
<tr>
<td>24. I believe in trusting my hunches.</td>
<td>1</td>
</tr>
<tr>
<td>25. Intuition can be a very useful way to solve problems.</td>
<td>1</td>
</tr>
<tr>
<td>26. I often go by my instincts when deciding on a course of action.</td>
<td>1</td>
</tr>
<tr>
<td>27. I trust my initial feelings about people.</td>
<td>1</td>
</tr>
<tr>
<td>28. When it comes to trusting people, I can usually rely on my gut feelings.</td>
<td>1</td>
</tr>
</tbody>
</table>
29. If I were to rely on my gut feelings, I would often make 1 mistakes.  & 2 & 3 & 4  
30. I don’t like situations in which I have to rely on intuition.  & 1 & 2 & 3 & 4  
31. I think there are times when one should rely on one’s intuition.  & 1 & 2 & 3 & 4  
32. I think it is foolish to make important decisions based on feelings.  & 1 & 2 & 3 & 4  
33. I don’t think it is a good idea to rely on one’s intuition for important decisions.  & 1 & 2 & 3 & 4  
34. I generally don’t depend on my feelings to help me make decisions.  & 1 & 2 & 3 & 4  
35. I hardly ever go wrong when I listen to my deepest gut feelings to find an answer.  & 1 & 2 & 3 & 4  
36. I would not want to depend on anyone who described himself or herself as intuitive.  & 1 & 2 & 3 & 4  
37. My snap judgments are probably not as good as most people’s.  & 1 & 2 & 3 & 4  
38. I tend to use my heart as a guide for my actions.  & 1 & 2 & 3 & 4  
39. I can usually feel when a person is right or wrong, even if I can’t explain how I know.  & 1 & 2 & 3 & 4  
40. I suspect my hunches are inaccurate as often as they are accurate.  & 1 & 2 & 3 & 4  

Appendix E

Cognitive Reflection Test

1. A bat and a ball cost $1.10 in total. The bat costs $1.00 more than the ball. How much does the ball cost? _____ cents

2. If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets? _____ minutes

3. In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake? _____ days
Appendix F
Risk-Taking Propensity

1. Which of the following would you prefer?
   a) receive $10 for sure
   b) have a 10% chance of winning $100 and a 90% chance of winning nothing

2. Which of the following would you prefer?
   a) receive $30 for sure
   b) have a 30% chance of winning $100 and a 70% chance of winning nothing

3. Which of the following would you prefer?
   a) receive $50 for sure
   b) have a 50% chance of winning $100 and a 50% chance of winning nothing

4. Which of the following would you prefer?
   a) receive $70 for sure
   b) have a 70% chance of winning $100 and a 30% chance of winning nothing

5. Which of the following would you prefer?
   a) receive $90 for sure
   b) have a 90% chance of winning $100 and a 10% chance of winning nothing
Appendix G

BIS/BAS Scale

Instructions: Each item of this questionnaire is a statement that a person may either agree with or disagree with. For each item, indicate how much you agree or disagree with what the item says. Please respond to all the items; do not leave any blank. Choose only one response to each statement. Please be as accurate and honest as you can be. Respond to each item as if it were the only item. That is, don't worry about being "consistent" in your responses.

1. A person's family is the most important thing in life.

   |   |   |   |   |
   | 1 | 2 | 3 | 4 |
   | very true | somewhat true | somewhat false | very false for me for me for me for me

2. Even if something bad is about to happen to me, I rarely experience fear or nervousness.

   |   |   |   |   |
   | 1 | 2 | 3 | 4 |
   | very true | somewhat true | somewhat false | very false for me for me for me for me

3. I go out of my way to get things I want.

   |   |   |   |   |
   | 1 | 2 | 3 | 4 |
   | very true | somewhat true | somewhat false | very false for me for me for me for me

4. When I'm doing well at something I love to keep at it.

   |   |   |   |   |
   | 1 | 2 | 3 | 4 |
   | very true | somewhat true | somewhat false | very false for me for me for me for me

5. I'm always willing to try something new if I think it will be fun.

   |   |   |   |   |
   | 1 | 2 | 3 | 4 |
   | very true | somewhat true | somewhat false | very false for me for me for me for me

6. How I dress is important to me.

   |   |   |   |   |
   | 1 | 2 | 3 | 4 |
   | very true | somewhat true | somewhat false | very false for me for me for me for me
7. When I get something I want, I feel excited and energized.

<table>
<thead>
<tr>
<th></th>
<th>1 very true for me</th>
<th>2 somewhat true for me</th>
<th>3 somewhat false for me</th>
<th>4 very false for me</th>
</tr>
</thead>
</table>

8. Criticism or scolding hurts me quite a bit.

<table>
<thead>
<tr>
<th></th>
<th>1 very true for me</th>
<th>2 somewhat true for me</th>
<th>3 somewhat false for me</th>
<th>4 very false for me</th>
</tr>
</thead>
</table>

9. When I want something I usually go all-out to get it.

<table>
<thead>
<tr>
<th></th>
<th>1 very true for me</th>
<th>2 somewhat true for me</th>
<th>3 somewhat false for me</th>
<th>4 very false for me</th>
</tr>
</thead>
</table>

10. I will often do things for no other reason than that they might be fun.

<table>
<thead>
<tr>
<th></th>
<th>1 very true for me</th>
<th>2 somewhat true for me</th>
<th>3 somewhat false for me</th>
<th>4 very false for me</th>
</tr>
</thead>
</table>

11. It's hard for me to find the time to do things such as get a haircut.

<table>
<thead>
<tr>
<th></th>
<th>1 very true for me</th>
<th>2 somewhat true for me</th>
<th>3 somewhat false for me</th>
<th>4 very false for me</th>
</tr>
</thead>
</table>

12. If I see a chance to get something I want I move on it right away.

<table>
<thead>
<tr>
<th></th>
<th>1 very true for me</th>
<th>2 somewhat true for me</th>
<th>3 somewhat false for me</th>
<th>4 very false for me</th>
</tr>
</thead>
</table>

13. I feel pretty worried or upset when I think or know somebody is angry at me.

<table>
<thead>
<tr>
<th></th>
<th>1 very true for me</th>
<th>2 somewhat true for me</th>
<th>3 somewhat false for me</th>
<th>4 very false for me</th>
</tr>
</thead>
</table>

14. When I see an opportunity for something I like I get excited right away.

<table>
<thead>
<tr>
<th></th>
<th>1 very true for me</th>
<th>2 somewhat true for me</th>
<th>3 somewhat false for me</th>
<th>4 very false for me</th>
</tr>
</thead>
</table>
15. I often act on the spur of the moment.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>very true for me</td>
<td>somewhat true for me</td>
<td>somewhat false for me</td>
<td>very false for me</td>
</tr>
</tbody>
</table>

16. If I think something unpleasant is going to happen I usually get pretty "worked up."

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>very true for me</td>
<td>somewhat true for me</td>
<td>somewhat false for me</td>
<td>very false for me</td>
</tr>
</tbody>
</table>

17. I often wonder why people act the way they do.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>very true for me</td>
<td>somewhat true for me</td>
<td>somewhat false for me</td>
<td>very false for me</td>
</tr>
</tbody>
</table>

18. When good things happen to me, it affects me strongly.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>very true for me</td>
<td>somewhat true for me</td>
<td>somewhat false for me</td>
<td>very false for me</td>
</tr>
</tbody>
</table>

19. I feel worried when I think I have done poorly at something important.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>very true for me</td>
<td>somewhat true for me</td>
<td>somewhat false for me</td>
<td>very false for me</td>
</tr>
</tbody>
</table>

20. I crave excitement and new sensations.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
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<td>somewhat true for me</td>
<td>somewhat false for me</td>
<td>very false for me</td>
</tr>
</tbody>
</table>

21. When I go after something I use a "no holds barred" approach.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>very true for me</td>
<td>somewhat true for me</td>
<td>somewhat false for me</td>
<td>very false for me</td>
</tr>
</tbody>
</table>

22. I have very few fears compared to my friends.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>very true for me</td>
<td>somewhat true for me</td>
<td>somewhat false for me</td>
<td>very false for me</td>
</tr>
</tbody>
</table>
23. It would excite me to win a contest.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>very true for me</td>
<td>somewhat true for me</td>
<td>somewhat false for me</td>
<td>very false for me</td>
<td></td>
</tr>
</tbody>
</table>

24. I worry about making mistakes.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
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<tr>
<td>very true for me</td>
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<td>somewhat false for me</td>
<td>very false for me</td>
<td></td>
</tr>
</tbody>
</table>
Appendix H
UPPS Impulsive Behavior Scale

**Instructions:**
Indicate how much you agree with each of the following by **circling the appropriate number**:

## Premeditation

1. I have a reserved and cautious attitude toward life.
   - 1 Strongly agree
   - 2 Somewhat agree
   - 3 Somewhat disagree
   - 4 Strongly disagree

2. My thinking is usually careful and purposeful.
   - 1 Strongly agree
   - 2 Somewhat agree
   - 3 Somewhat disagree
   - 4 Strongly disagree

3. I am not one of those people who blurt out things without thinking.
   - 1 Strongly agree
   - 2 Somewhat agree
   - 3 Somewhat disagree
   - 4 Strongly disagree

4. I like to stop and think things over before I do them.
   - 1 Strongly agree
   - 2 Somewhat agree
   - 3 Somewhat disagree
   - 4 Strongly disagree

5. I don't like to start a project until I know exactly how to proceed.
   - 1 Strongly agree
   - 2 Somewhat agree
   - 3 Somewhat disagree
   - 4 Strongly disagree

6. I tend to value and follow a rational, "sensible" approach to things.
   - 1 Strongly agree
   - 2 Somewhat agree
   - 3 Somewhat disagree
   - 4 Strongly disagree

7. I usually make up my mind through careful reasoning.
   - 1 Strongly agree
   - 2 Somewhat agree
   - 3 Somewhat disagree
   - 4 Strongly disagree
8. I am a cautious person.

   1  2  3  4
Strongly agree  Somewhat agree  Somewhat disagree  Strongly disagree

9. Before I get into a new situation I like to find out what to expect from it.

   1  2  3  4
Strongly agree  Somewhat agree  Somewhat disagree  Strongly disagree

10. I usually think carefully before doing anything.

    1  2  3  4
Strongly agree  Somewhat agree  Somewhat disagree  Strongly disagree

11. Before making up my mind, I consider all the advantages and disadvantages.

    1  2  3  4
Strongly agree  Somewhat agree  Somewhat disagree  Strongly disagree

**Urgency**

1. I have trouble controlling my impulses.

   1  2  3  4
Strongly agree  Somewhat agree  Somewhat disagree  Strongly disagree

2. I have trouble resisting my cravings (for food, cigarettes, etc.).

   1  2  3  4
Strongly agree  Somewhat agree  Somewhat disagree  Strongly disagree

3. I often get involved in things I later wish I could get out of.

   1  2  3  4
Strongly agree  Somewhat agree  Somewhat disagree  Strongly disagree

4. When I feel bad, I will often do things I later regret in order to make myself feel better now.

   1  2  3  4
Strongly agree  Somewhat agree  Somewhat disagree  Strongly disagree
5. Sometimes when I feel bad, I can't seem to stop what I am doing even though it is making me feel worse.

1  2  3  4
Strongly agree  Somewhat agree  Somewhat disagree  Strongly disagree

6. When I am upset I often act without thinking.

1  2  3  4
Strongly agree  Somewhat agree  Somewhat disagree  Strongly disagree

7. When I feel rejected, I will often say things that I later regret.

1  2  3  4
Strongly agree  Somewhat agree  Somewhat disagree  Strongly disagree

8. It is hard for me to resist acting on my feelings.

1  2  3  4
Strongly agree  Somewhat agree  Somewhat disagree  Strongly disagree

9. I often make matters worse because I act without thinking when I am upset.

1  2  3  4
Strongly agree  Somewhat agree  Somewhat disagree  Strongly disagree

10. In the heat of an argument, I will often say things that I later regret.

1  2  3  4
Strongly agree  Somewhat agree  Somewhat disagree  Strongly disagree

11. I am always able to keep my feelings under control.

1  2  3  4
Strongly agree  Somewhat agree  Somewhat disagree  Strongly disagree

12. Sometimes I do things on impulse that I later regret

1  2  3  4
Strongly agree  Somewhat agree  Somewhat disagree  Strongly disagree
Sensation Seeking

1. I generally seek new and exciting experiences and sensations.
   1          2          3          4
   Strongly agree Somewhat agree Somewhat disagree Strongly disagree

2. I'll try anything once.
   1          2          3          4
   Strongly agree Somewhat agree Somewhat disagree Strongly disagree

3. I like sports and games in which you have to choose your next move very quickly.
   1          2          3          4
   Strongly agree Somewhat agree Somewhat disagree Strongly disagree

4. I would enjoy water skiing.
   1          2          3          4
   Strongly agree Somewhat agree Somewhat disagree Strongly disagree

5. I quite enjoy taking risks.
   1          2          3          4
   Strongly agree Somewhat agree Somewhat disagree Strongly disagree

6. I would enjoy parachute jumping.
   1          2          3          4
   Strongly agree Somewhat agree Somewhat disagree Strongly disagree

7. I welcome new and exciting experiences and sensations, even if they are a little frightening and unconventional.
   1          2          3          4
   Strongly agree Somewhat agree Somewhat disagree Strongly disagree

8. I would like to learn to fly an airplane.
   1          2          3          4
   Strongly agree Somewhat agree Somewhat disagree Strongly disagree
9. I sometimes like doing things that are a bit frightening.
   1 2 3 4
   Strongly agree Somewhat agree Somewhat disagree Strongly disagree

10. I would enjoy the sensation of skiing very fast down a high mountain slope.
   1 2 3 4
   Strongly agree Somewhat agree Somewhat disagree Strongly disagree

11. I would like to go scuba diving.
   1 2 3 4
   Strongly agree Somewhat agree Somewhat disagree Strongly disagree

12. I would enjoy fast driving.
   1 2 3 4
   Strongly agree Somewhat agree Somewhat disagree Strongly disagree

   **Perseverance**

1. I generally like to see things through to the end.
   1 2 3 4
   Strongly agree Somewhat agree Somewhat disagree Strongly disagree

2. I tend to give up easily.
   1 2 3 4
   Strongly agree Somewhat agree Somewhat disagree Strongly disagree

3. Unfinished tasks really bother me.
   1 2 3 4
   Strongly agree Somewhat agree Somewhat disagree Strongly disagree

4. Once I get going on something I hate to stop.
   1 2 3 4
   Strongly agree Somewhat agree Somewhat disagree Strongly disagree

5. I concentrate easily.
   1 2 3 4
   Strongly agree Somewhat agree Somewhat disagree Strongly disagree
6. I finish what I start.

1 2 3 4
Strongly agree Somewhat agree Somewhat disagree Strongly disagree

7. I'm pretty good about pacing myself so as to get things done on time.

1 2 3 4
Strongly agree Somewhat agree Somewhat disagree Strongly disagree

8. I am a productive person who always gets the job done.

1 2 3 4
Strongly agree Somewhat agree Somewhat disagree Strongly disagree

9. Once I start a project, I almost always finish it.

1 2 3 4
Strongly agree Somewhat agree Somewhat disagree Strongly disagree

10. There are so many little jobs that need to be done that I sometimes just ignore them all.

1 2 3 4
Strongly agree Somewhat agree Somewhat disagree Strongly disagree
Appendix I

Regret Scale

Indicate how much you agree with each of the following by circling the appropriate number:

1. Once I make a decision, I don’t look back.

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<td>Completely Disagree</td>
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2. Whenever I make a choice, I’m curious about what would have happened if I had chosen differently.

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3. Whenever I make a choice, I try to get information about how the other alternatives turned out.

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4. If I make a choice and it turns out well, I still feel like something of a failure if I find out that another choice would have turned out better.

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5. When I think about how I’m doing in life, I often assess opportunities I have passed up.

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Appendix J

Intercorrelations among individual difference decision-related variables.

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UPPS Impulsivity Subfactors

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Scott and Bruce DM styles

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Rational-Experiential Inventory

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**Correlation is significant at the 0.01 level (2-tailed).
*Correlation is significant at the 0.05 level (2-tailed).
+Correlation is marginally significant, p < .10 (2-tailed).
Brent A. Furl
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August 2010

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Research and Teaching Assistant, Wake Forest University:  
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Ph.D.

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Gambling Task, real-world decision outcomes and working memory.
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