Performance on the Iowa Gambling Task in Individuals with Affect Dysregulation

by

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Abstract

Despite considerable research on the decision making skills of individuals with clinically-diagnosed affect dysregulation disorders, few studies have looked at a spectrum of affect dysregulation characteristics within the context of a single study. In the present study, we tested the relationship between an individual's levels of depression, posttraumatic stress, anxiety, and borderline personality and decision making performance on the Iowa Gambling Task (IGT). We found that cognitive depression and affective depression predict Iowa Gambling Task performance. Specifically, cognitive depression is positively related to IGT score, and, when controlling for cognitive depression, affective depression is negatively related to IGT score. We speculate as to why this relationship between depressive symptoms and decision behavior is observed, citing ruminative thinking patterns or risk aversion for the relationship seen with cognitive depression, and citing impaired somatic markers for the relationship seen with affective depression.

Introduction

For twenty years, the Iowa Gambling Task (IGT) has been a critical diagnostic test for assessing decision making skills and impairments. Individuals showing poor performance on the task include those with affective disorders such as depression (DEP), posttraumatic stress disorder (PTSD), borderline personality disorder (BPD), and generalized anxiety (ANX). However, there are high comorbidity rates amongst these disorders, so it is unclear what symptoms of affect dysregulation are most strongly associated with impaired IGT performance. The purpose of this investigation is to assess what symptoms of affect dysregulation most strongly predict performance on the Iowa Gambling Task by considering individuals with a variety of symptoms of affect dysregulation in a single study. It is our hope that this finding will shed light on the affective mechanisms underlying successful performance on the IGT.

Origins of the IGT

The IGT, developed by Bechara, Damásio, Damásio, and Anderson in 1994, is a computerized gambling task used to evaluate decision making. In the task, there are four decks of cards (see Figure 1). Each card has written on its face a monetary gain and a monetary loss. The first two decks contain large gains but even larger losses, resulting in a net loss across cards; the second two decks contain small gains but even smaller losses, resulting in a net gain across cards. This structure is not revealed to participants. Participants are instructed to pick cards from any decks they wish, one at a time, with the goal of earning as much money as possible. After 100 trials, the

task is ended. Performance is calculated as the total number of times the advantageous decks were chosen minus the number of times the disadvantageous decks were chosen. One must learn the structure of the environment, and must prioritize gaining money in the long run over the potential for immediate high reward in order to be successful, similar to many everyday situations involving reward and uncertainty.

The original findings from Bechara et al.'s (1994) experiment were that although it took individuals time to show explicit preference for the more advantageous decks in their choices, implicitly they more quickly sensed that some decks were advantageous and some were disadvantageous. Such implicit learning was demonstrated through the use of skin conductance response (SCR), a measure of psychological and physiological arousal that is linked to emotional response. With this method, Bechara et al. (1994) provided evidence of high anticipatory arousal levels before participants picked from disadvantageous decks, suggesting that the participants developed a "gut feeling" that a deck was disadvantageous even before explicitly learning to avoid it. They contrasted this performance with that of individuals with damage to the ventromedial prefrontal cortex (VMPFC), an area of the brain associated with emotion regulation. Individuals with a lesion in the VMPFC did not develop an anticipatory SCR before picking from disadvantageous decks during the IGT, and did not learn to eventually pick from the advantageous decks. The authors and others concluded that the VMPFC appears vital for affective judgment, which is, in turn, necessary for learning to make optimal decisions on the IGT (Northoff et al., 2006).

Somatic marker hypothesis

One of the most prominent frameworks for decision making under uncertainty that grew out of the IGT is the "somatic marker hypothesis." The somatic marker hypothesis (SMH), developed in 1994 by Antonio Damásio, is essentially a broader exposition of the argument that the act of making decisions is not rooted solely in rational cognitive reasoning, but is also guided by emotions. The argument is that all of the choices in one's life are marked with affective association; a person may mentally go through all the rational dimensions of a decision, but a gut feeling may lead someone to feel that one alternative is better than the other. One contributor to difficulty on a task is the breakdown of the affective component of the response, such as through damage to the VMPFC. The somatic marker hypothesis provides broad insight into how emotion can bias and guide decision making. It is now broadly assumed that affective cues can influence decision making.

Damásio developed the SMH in 1994 to explain the deficits of individuals with VMPFC damage in making advantageous decisions. The idea came from the insight that because these VMPFC patients have trouble learning from their mistakes, and because they are also characteristically emotionally flat in everyday life, that emotional markers might generally play an important role in guiding decision making behavior. Bechara et al. (1994) found that SCR's for control participants were larger immediately before choosing from the disadvantageous decks than when choosing from advantageous decks when completing the IGT. In the participants with VMPFC lesions, there was no difference between the SCR's when picking from a disadvantageous deck versus an advantageous deck. Additionally, since that time, the

amplitude of the SCR (not just the presence) has been found to be positively correlated with performance on the IGT (Miu, Heilman & Houser, 2008). The somatic markers were, at this time, thought to reflect implicit knowledge that a deck has a negative long-term outcome, though alternative interpretations have arisen in recent years.

Alternative sources of affective cues

There have been further arguments about and refinements of the notion of somatic markers. Originally, Damásio (1994) assumed that somatic markers were based on the expected value of each deck in the long run. Chiu et al. (2008) provided evidence that somatic markers may instead more closely map onto a deck's "gain-loss frequency," the relative number of times a deck has been associated with a gain or a loss in the past. In particular, Chiu et al. (2008) found that non-impaired individuals sometimes prefer Deck B, with its high-frequency gains, even though the deck has a few very large losses. In other words, the large number of trials on which a positive outcome occurred outweighed the net loss associated with the deck. This research suggests that somatic markers may be computed from a different source than that which Damásio (1994) originally proposed, and that such markers might not always signal the most desirable outcome. However, this work, as with the original Damásio (1994) study, continues to support the role of affective processes in decision making.

In another reconsideration of the source of somatic cues, Maia and McClelland (2004) compared an analysis of IGT data based on a "trial-based" versus a "deck-based" method. The deck-based method is the original approach to scoring the IGT, which characterizes the decks as disadvantageous or advantageous based on their

long-term yields. The trial-based method dynamically labels the decks as advantageous or disadvantageous on each trial of a study, based on the net yield from that deck to that point in the study (Visagan, Xiang & Lamar, 2012). The re-analysis suggested that individuals choose decks that maximize their gains based on prior experience to date, not based on the overall expected values of the decks. This is not surprising given that participants did not know anything about the decks except from past experience, but the work provides a more precise model for predicting future behavior in the IGT. Regardless of how performance is analyzed, the physiological responses to the IGT, or the somatic markers, remain the same (Visagan et al., 2012).

Other sources of IGT performance variation

While the ventromedial prefrontal cortex is known to be involved in somatic marker generation, there are likely many other brain areas and systems associated with learning, responding to affective cues, and inhibiting poor responses. For example, impulsivity—acting without appropriate deliberation and choosing short term over long-term gains—is associated with communication between the striatum (a subcortical structure) and prefrontal cortex. Individuals who score high on self-report measures of impulsivity tend to make risky choices on the IGT. Because the prefrontal cortex develops through adolescence, its role in IGT performance can be assessed with developmental studies. Smith, Xiao and Bechara (2012) found that younger children (ages 8-12 years) performed better on the IGT than early-adolescents (ages 10-13 years); peak performance was found to be towards the end of adolescence (ages 14-17 years). The younger children failed to show a preference for either the advantageous or disadvantageous decks, which resulted in a better outcome

than the performance of those in early adolescence, who made impulsive and risky decisions on the task (Smith et al., 2012). Older adolescents showed a clear preference for the advantageous decks.

Although most cognitive development progresses linearly, this non-linear progression surrounding the performance on the IGT can be explained by neural development of regions associated with executive functioning. Their development may cause impulsive reward-driven responses in IGT performance in early adolescence that the inhibitory regions of the brain cannot check because they are not yet fully developed (Smith et al., 2012). It is thought that low IGT scores in young adolescents are due to their overactive and underdeveloped emotional or impulsive system, or by an inability to inhibit their actions. This area of research needs further development and it is not clear how this source of variation in IGT performance is related to others. But, the work is an important illustration that there are likely many component systems involved in decision making under uncertainty.

Performance on the IGT is also related to level of education and to psychosocial stress. As level of education of a participant increases, he or she is able to improve more rapidly and reach a higher positive score on the task (Davis et al., 2008). The relationship between education and performance on the IGT remains unclear. More schooling might improve the cognitive skills needed to make informed decisions, therefore leading to a better performance (Davis et al., 2008). In particular, those with more education could be better equipped to see long-term outcomes. Performance on the IGT is also related to psychosocial stress. A high stress response is associated with poor performance, where stress is designated by higher levels of

salivary cortisol when completing the task (Santos-Ruiz et al., 2012).

Other clinical disorders and related poor decision behaviors have also been associated with poor IGT performance. For example, suicide attempters underperform on the IGT in comparison to adolescent non-suicide attempters, which has led researchers to conclude that suicide attempters have poor decision making skills (Bridge et al., 2012). For those who are overweight who go on a diet, the individuals who perform best on the IGT also have more fat loss (Witbracht, Laugero, Van Loan, Adams & Keim, 2012). Poor decision making skills have also been found amongst obese subjects, who also perform poorly on the IGT when compared to controls (Witbracht et al., 2012). Those suffering from anorexia nervosa and bulimia nervosa have impaired performance as well (Brogan, Hevey & Pignatti, 2010). Substance abusers perform worse on the IGT (Upton, Bishara, Ahn & Stout, 2011), and IGT performance has been found to predict drug relapse for opiate outpatients (Verdejo-Garcia et al., 2012). Impaired IGT performance has been found in those with obsessive-compulsive disorder and pathological gambling disorders (Northoff et al., 2006). Researchers have tried to predict indebtedness using the IGT, but this has not been successful (Ottaviani & Vandone, 2011). Overall, there is much evidence of impaired performance on the IGT, but the mental and neural processes underlying impairment for different groups of individuals, and whether there is a common mental or neural impairment, are unclear.

Disorders of emotion regulation and IGT

In the case of clinical disorders of emotion regulation, such as depression, anxiety, borderline personality and posttraumatic stress, it has been suggested that the

development and expression of somatic markers in decision making might be impacted, leading to impaired IGT performance (Mardaga & Hansenne, 2012). Because these clinical disorders, all of which are the focus of the present work, may be unfamiliar to readers, the IGT findings as they pertain to each disorder will be prefaced with a short description of each disorder. In all of the IGT studies that are discussed, individuals who reached the threshold for a diagnosis of a clinical disorder were compared with healthy controls. The focus of the present research, however, is not on treating these as distinct diagnostic categories but, rather, on thinking about the disruptions in mental processes associated with each of these related states.

Depression. Depression is a mood disorder in which feelings of sadness, loss, anger, or frustration interfere with everyday life for two weeks or longer. It characterized by a combination of many affective (e.g., low mood), cognitive (e.g., self-defeating thoughts), and physiological (e.g., nervousness) symptoms. Stress and trauma in a person's life is related to depression (Watts & Markham, 2005), but individuals with low self-esteem and who focus on negative features of themselves, their environments, and their future may be most susceptible. Depression is often comorbid with anxiety. Individuals with posttraumatic stress disorder are also often depressed.

Past research has shown that depression does impact IGT performance, but the results have been mixed. In one study, depressed individuals learned to avoid risky decisions faster than healthy controls (Smoski et al., 2008). Depressive behavior is associated with the avoidance of potentially rewarding environments, so IGT behavior could speak to an avoidance of reward rather than a conscious avoidance of

risk, since the risky decks in the task also provide higher rewards. Regardless, depressed individuals still performed better on that task (Smoski et al., 2008). However, it has also been observed that the inability to concentrate, a common symptom of depression, can impair performance on the IGT (Han, 2012). Overall, an explanation for decision making behavior in those suffering from depression is altered sensitivity to reward and punishment, but perhaps also an inability to adjust to a changing environment (Cella, Dymond & Cooper, 2010).

Generalized anxiety. Generalized anxiety is characterized by excessive anxiety and worry, across many different activities and events, such that it interferes with daily functioning. The worry seems to move from one situation to the next and, even when it is acknowledged that there is little reason for the worry, it is difficult to control. Feelings of restlessness, fatigue, irritability, problems concentrating, sleep disturbance, and muscle tension often accompany the worry (Oltmanns & Emery, 2011).

High levels of anxiety have been associated with poor performance on the IGT, but results have been mixed. Those who are anxious may use fewer emotional cues and be more easily distracted by emotions; they may also have anticipatory stress that is more generalized (Miu, Heilman & Houser, 2008). On the other hand, other studies have found that those with anxiety disorders are risk aversive, and have an enhanced sensitivity for unpredictable loss in the long-term (Mueller, Nguyen, Ray, & Borkovec, 2010). Mueller et al. (2010) found that participants suffering from generalized anxiety learned to avoid decks with long-term loss much faster than controls.

Borderline personality. Borderline personality disorder is marked by a pervasive pattern of instability of interpersonal relationships, self-image, and affect, and marked impulsivity beginning by early adulthood and present in a variety of contexts, as indicated by frantic efforts to avoid real or imagined abandonment, a pattern of unstable and intense interpersonal relationships, unstable self image or sense of self, impulsivity, affective instability due to reactive mood, and difficulty controlling anger.

Few studies have isolated borderline personality and the IGT, but one such study found that those with borderline personality showed less advantageous choices on the task than healthy controls (Haaland & Landrø, 2007). In this same study, Haaland and Landrø found that performance was worse when participants had comorbid substance abuse (2007). Their poor performance has been suggested to result from trait impulsivity, inefficient planning abilities, and lack of behavioral control (Haaland & Landrø, 2007).

Posttraumatic stress disorder. To experience posttraumatic stress disorder, an individual must have witnessed a traumatic event involving threat of death or serious injury, and have experienced intense fear, helplessness or horror. The traumatic event is then persistently re-experienced as recurrent and intrusive distressing recollections, dreams, or flashbacks of the event, including images, thoughts, or perceptions. Individuals with posttraumatic stress disorder typically feel detached or estranged from others, have a restricted range of affect, have a foreshortened sense of the future, and have difficulty concentrating.

Research looking at decision making skills in those specifically with

posttraumatic stress is sparse, but it has been found that those with posttraumatic stress have impaired performance on the IGT, and it generally takes these participants more trials to distinguish the advantageous from the disadvantageous decks (Aupperle, Melrose, Stein, & Paulus, 2012). It has also been found that memory impairment, another symptom associated with posttraumatic stress, can impair decision making (Borges et al., 2011).

Overview of Present Research

There have been numerous studies examining IGT performance in those with clinical disorders of generalized anxiety, traumatic stress, depression, and borderline personality. However, most investigations have looked at each disorder in isolation, and have compared clinical groups to healthy controls. With the high comorbidity associated with these disorders, it is important to comprehensively look at these disorders as spectrum of affective dysregulation to determine what aspects of this dysregulation are detrimental to decision making skills and might be giving rise to difficulty across diverse groups of individuals. The goal of this study is to better understand the components of affective dysregulation most related to impaired performance on the IGT.

To achieve this goal, we recruited individuals from the community, oversampling those likely to have some difficulty regulating affect. We administered a Personality Assessment Inventory, a personality test designed to provide information on dimensions of personality and psychopathology evaluation including depression, borderline personality, anxiety, and traumatic stress. We also administered other standard tests including a drug screening. Participants then completed the Iowa

Gambling Task. Our focus was on the relationship between IGT performance and these dimensions of personality related to affect regulation.

Method

Participants

Participants were 35 women between the ages of 22 and 50 (M = 36, SD = 10, range = 22 - 50) from the central Connecticut area who responded to advertisements posted on flyers and placed in local papers throughout Middletown, CT. Some ads were for individuals with difficulty regulating their emotions; others did not mention this criterion. The goal was to recruit individuals along a continuum on the dimensions of depression, anxiety, borderline, and posttraumatic stress, but to ensure that there was an oversampling of individuals who were high on one or more of these dimensions. Participants spent between 2 and 2.5 hours in the lab completing the study, and were compensated at a rate of $10 per hour.

Materials

Personality Assessment Inventory (PAI). The Personality Assessment Inventory (PAI; Morey, 2007) is a self-administered personality test. It is designed to provide information on dimensions of personality and psychopathology evaluation. The PAI consists of 344 questions, and a four-point response scale (1 = Totally False, 2 = Slightly True, 3 = Mainly True, and 4 = Very True). There are 11 clinical scales, 5 validity scales, and 4 treatment scales, all with subscales. Raw scores on each subscale are transformed into standardized T scores. The mean T score in a sample of 1000 is 50 with a standard deviation of 10; T scores above 69 are clinically elevated and above 50 demonstrate severe symptoms on the subscale.

Thirteen PAI subscales were used in this study (see Appendix A for sample items). Three were associated with depression: cognitive depression (DEPC), affective depression (DEPA) and physiological depression (DEPP). Three were associated with anxiety: affective anxiety (ANXA), cognitive anxiety (ANXC) and physiological anxiety (ANXP). Four were associated with borderline personality: affective instability (BORA), identity problems (BORI), negative relationships (BORN) and self-harm (BORS). And, one subscale each was associated with traumatic stress (ARDT), alcohol problems (ALC) and drug problems (DRG). We also looked at the validity scales of inconsistency (ICN) and infrequency (INF). The PAI took about 45 minutes to complete.

Indecisiveness Scale (IS). Frost and Show's (1993) Indecisiveness Scale is a self-report decision making questionnaire with 15 items. Participants indicated how much they agreed with each statement related to difficulty making decisions, such as "When ordering from a menu, I usually find it difficult to decide what to get," and responded on a Likert scale, which ranged from 1 (Highly Agree) to 5 (Highly Disagree). After reverse coding of appropriate items, higher average scores across the items are associated with greater indecisiveness. It was included as a self-report measure of decision making, as a complement to the behavioral IGT measure.

Iowa Gambling Task (IGT). In this computerized decision task, individuals were presented with four decks of cards and asked to select, one at a time, a card from any of the decks. After selecting a card, the participant was presented, on the screen, with the numerical monetary gain and loss value associated with the card. This value was based on a schedule unknown to the individual, based on the deck and the card's

position in the deck. Participants started out with a hypothetical pool of money that could either grow or diminish, but no actual monetary compensation was given. Participants were instructed to try to gain as much money as they could, but no additional guidance was given, nor were participants told how many times they would be able to pick a card before the task ended. In fact, the task stopped after 100 card choices had been made. For scoring purposes, each set of 20 card picks will be considered a block of trials, for a total of 5 blocks. See Appendix B for full task instructions.

Two of the decks were advantageous, (Decks C and D) with small gains but even smaller loses, resulting in an overall gain; the other two decks were disadvantageous (Decks A and B) with steep gains but even steeper loses, resulting in a net loss over time. Each card in Deck A always had of a gain of $100, but frequent loses that ranged from $150 - $350. Each card in Deck B also always had a gain of $100, but had an infrequent loss of $1250. If a participant only selected cards from Deck A or only selected cards from Deck B for the $100 trials, she would have a net loss of $2500. Deck C, an advantageous deck, always had gains of $50 and had small but frequent losses of $25 - $75. Deck D, another advantageous deck, always had a gain of $50 as well, but had an infrequent loss of $250. If a participant only selected cards from Deck C or Deck D during the 100 trials, she would have a net gain of $2500. See Appendix C for full gain-loss schedule. This task took approximately 15 min to complete on the computer.

After completing the task, participants were asked to fill out a written questionnaire inquiring about their strategies for completing the task, which decks

they thought were more advantageous, and what information they used to make their decisions.

Other tasks. While in the lab, the participants completed the Wechsler Adult Intelligence Scale (WAIS; Wechsler, 1939) and the National Adult Reading Test (NART; Nelson, 1982). In addition, each participant was given a standard urine drug-screening test, which screened for methamphetamines, amphetamines, marijuana, cocaine, and opiates at the time that they were in the lab.

Other tests administered to some participants but unrelated to the present goals include the Adult Decision Making Competence Inventory (ADMC; Brune de Bruin, Parker, & Fischhoff, 2007), the Decisions Outcome Inventory (DOI; Brune de Bruin et al., 2007), and the Positive and Negative Affect Schedule (PANAS; Watson, Clark & Tellegan, 1988).

Procedure

When participants visited the lab, they gave their written informed consent and then took the standard urine drug-screening test. They then completed the PAI, the IGT and its accompanying questionnaire, the IS, the WAIS and the NART.

Results

Of the 35 participants, 1 did not complete the PAI, 9 did not complete the IS, 9 did not complete the IGT, 13 did not complete the WAIS, 14 did not complete the NART and 5 did not complete a drug screening. Participants were included in the analyses for which they completed the tasks. Among 10 individuals who tested positive for drug use, 3 tested positive for methamphetamines, 3 tested positive for marijuana, 4 tested positive for cocaine, and 5 tested positive for opiates in their

system at the time of the study (i.e. some tested positive for multiple drugs). The data were analyzed separately for those who tested positively versus negatively for drugs, but no statistically significant differences were found between the two groups, so results are collapsed across groups. Similarly, there were no differences in performance based on high and low scores in the WAIS and NART so this is not included in analyses.

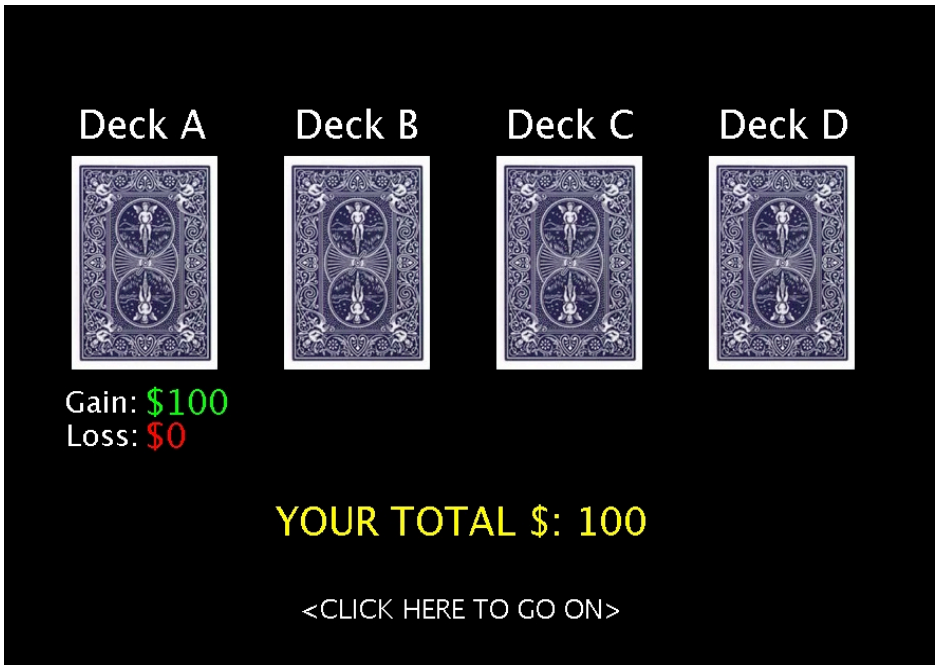

Figure 1. Screen shot of Iowa Gambling Task.

Personality Assessment Inventory

On the 2 PAI scales of validity, every participant had a score within the normal range (X < 70), so no individual's performance was ruled out of analyses because of validity issues. In Table 1 the descriptive statistics for the remaining 11 PAI subscales

are presented, also showing what percentage of participants scored above a 69, which is considered an extreme score.

Table 1

Descriptive Statistics for PAI Subscales

PAI Subscale	M	SD	Range	X > 69
ANXA	63.1	15.7	34 - 96	31.4%
ANXC	64.8	14.2	36 - 87	37.1%
ANXP	65.4	15.3	38 - 97	28.6%
ARDT	69.5	19.3	41 - 99	40.0%
BORA	63.1	14.3	36 - 91	37.1%
BORI	64.0	15.2	36 - 89	34.3%
BORN	68.5	13.7	34 - 91	40.0%
BORS	55.9	18.0	37 - 107	14.3%
DEPA	64.8	17.0	39 - 105	34.3%
DEPC	57.7	16.0	37 - 96	17.1%
DEPP	61.9	13.0	36 - 86	14.3%
ALC	50.8	7.9	41- 73	5.7%
DRG	67.0	18.8	42 - 104	34.3%

Note. N =34; X > 69 refers to percentage of *P*s with clinically significant score.

As shown in Table 2, strong positive correlations were found between every pair of PAI scales (except for alcohol use, which is omitted from the table); drug use was correlated with every PAI scale except with alcohol use. These correlations are consistent with the comorbidity that is commonly found among affect regulation disorders. The correlation with drug use is also consistent with the high rates of drug abuse among those suffering from disorders of affect regulation.

Table 2

Correlations Between PAI Subscales

	ANXA	ANCX	ANXP	ARDT	BORA	BORI	BORN	BORS	DEPA	DEPC	DEPP
ANCX	.91**										
ANXP	.82**	.82**									
ARDT	.76**	.67**	.60**								
BORA	.77**	.75**	.60**	.65**							
BORI	.72**	.70**	.71**	.70**	.67**						
BORN	.56**	.57**	.54**	.71**	.61**	.68**					
BORS	.57**	.43*	.63**	.45**	.45**	.47**	.50**				
DEPA	.76**	.68**	.57**	.59**	.81**	.78**	.55**	.42*			
DEPC	.74**	.69**	.63**	.66**	.76**	.79**	.66**	.46**	.83**		
DEPP	.72**	.67**	.62**	.72**	.56**	.48**	.60**	.52**	.60**	.62**	
DRG	.36*	.35*	.50**	.41*	.47**	.43*	.51**	.74**	.40*	.48**	.51**

Note. $**p < 0.01$, $*p < .05$; $N = 34$.

IGT, PAI, and Indecisiveness

IGT score was computed by subtracting the total number of times a participant chose a disadvantageous deck (Deck A or B) from the number of times she chose an advantageous deck (Deck C or D). This was done for each block and across the entire task. Choosing only from Decks C and D would result in an optimal score of 100 overall (or 20 for each block), while choosing only from Decks A and B would result in a score of -100 overall (or -20 per block). Actual overall scores on the IGT (from now on referred to as IGT Score) were generally low (M = -2.38, SD = 24.15, range = -50 – 44), though 10 had positive scores overall. Across all participants, there was little evidence of learning across blocks, though again there were large individual differences, ($F(4, 21) = 1.89$, $MSE = 29.96$, $p = .119$).

Correlations between IGT score and PAI subscales are shown in the first column of Table 3. There was a reliable positive correlation between IGT score and DEPC such that as cognitive depression increased, IGT score increased; in other words, cognitive depression was associated with better performance (see Figure 2). Surprisingly, all other measures, though not reliably, were also positively correlated with IGT performance. However, when controlling for DEPC score (the second column of Table 3), IGT score is now negatively correlated with other scales. In particular, after controlling for DEPC, there is now a reliable negative correlation between IGT score and DEPA. In addition, scores on the IS were significantly correlated with all of the PAI subscales except for ARDT, BORS, and DEPP; this is in line with the literature that finds indecisiveness as a common symptom of the affective disorders seen in this investigation. However, IGT score is not reliably correlated with IS score ($r(21) = .18$, $p = .406$), suggesting that indecisiveness and the IGT tap into different aspects of decision making.

Table 3
Correlations Between PAI Subscales, IGT Score, and IS Score

PAI Subscale	IGT	IGT Controlling for DEPC	IS
ANXA	.20	-.09	.45
	.35	.66	.02
ANXC	.18	-.06	.48
	.40	.79	.01
ANXP	.23	.00	.40
	.28	.99	.04
ARDT	.32	.07	.34
	.12	.76	.09
BORA	.04	-.33	.52
	.84	.12	.01
BORI	.27	-.03	.56
	.20	.90	.00
BORN	.30	.00	.40
	.15	1.00	.04
BORS	.17	-.06	.16
	.41	.77	.43
DEPA	.06	**-.39**	.53
	.78	**.06**	.01
DEPC	**.37**	--	.56
	.07	--	.00
DEPP	.16	-.11	.31
	.46	.61	.13

Note. Significance levels appear below correlations (*p*'s < .10 are in bold).

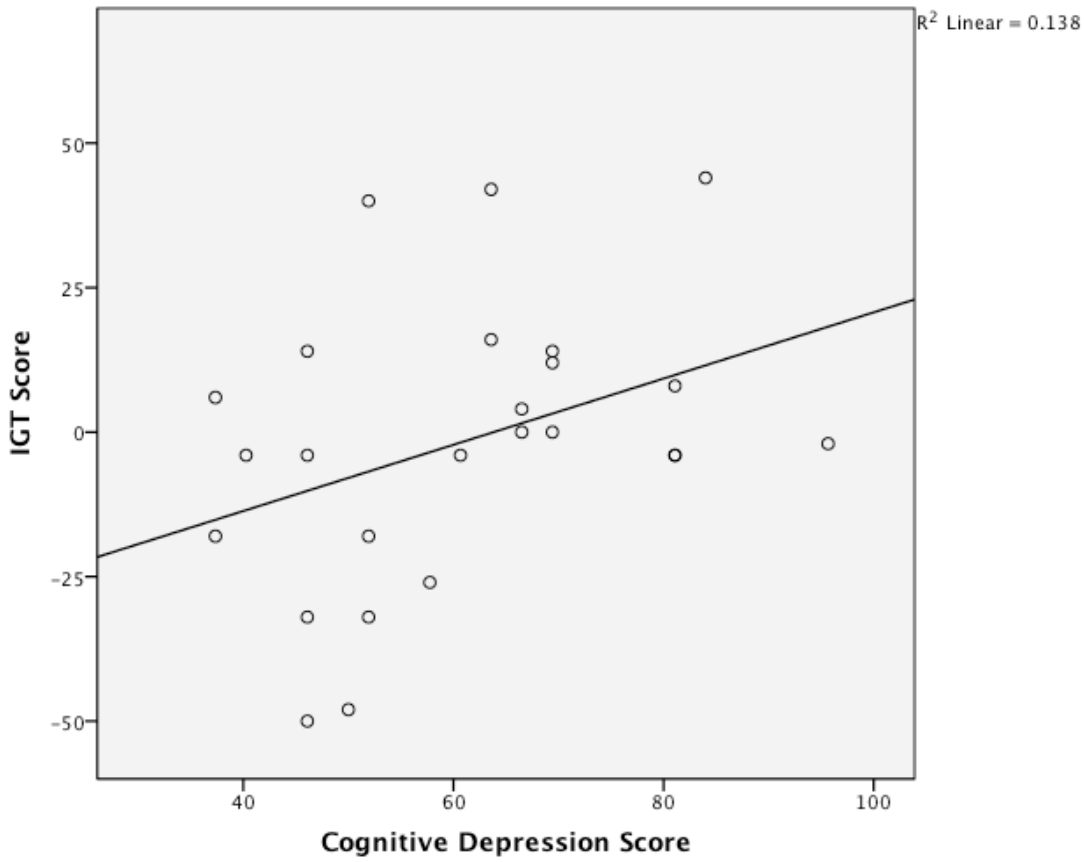

Figure 2. Relationship between IGT and cognitive depression scores.

The results of a stepwise linear regression for predicting IGT score from PAI subscales were in line with the correlations (see Table 4). IGT score could be predicted from cognitive and affective depression score, resulting in the equation IGT = -20.94 + 1.27*DEPC - .85*DEPA (full model: $F(2, 22) = 4.10$, $MSE = 476$, $p = .031$). The relationship between predicted IGT score and observed IGT is shown in Figure 3.

Table 4
Stepwise Linear Regression for Predicting IGT Score from PAI Subscales

	Coefficients				
	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	-20.939	19.215		-1.09	0.288
TDEPC	1.269	0.446	0.822	2.844	0.009
TDEPA	-0.849	0.423	-0.58	-2.008	0.057

Note: Dependent measure is IGT.

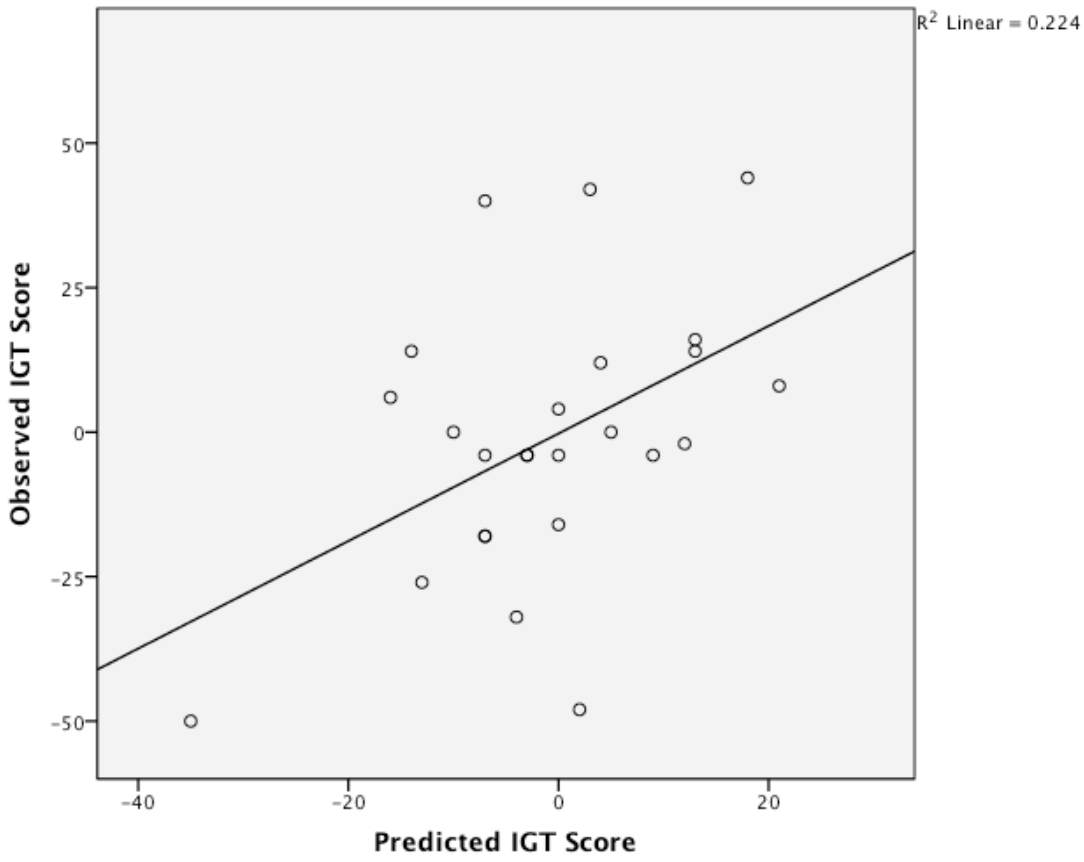

Figure 3. Relationship between predicted IGT score, based on PAI subscales, and observed IGT score.

For ease of illustration of the central finding, we also did median splits on cognitive depression (Mdn = 54.84) and on affective depression (Mdn = 64.92).

Figure 4 depicts mean IGT scores for individuals in each of the four resulting groups. As is illustrated in Figure 4, high cognitive depression is associated with better performance, and individuals with affective but not cognitive depression perform the most poorly on the task.

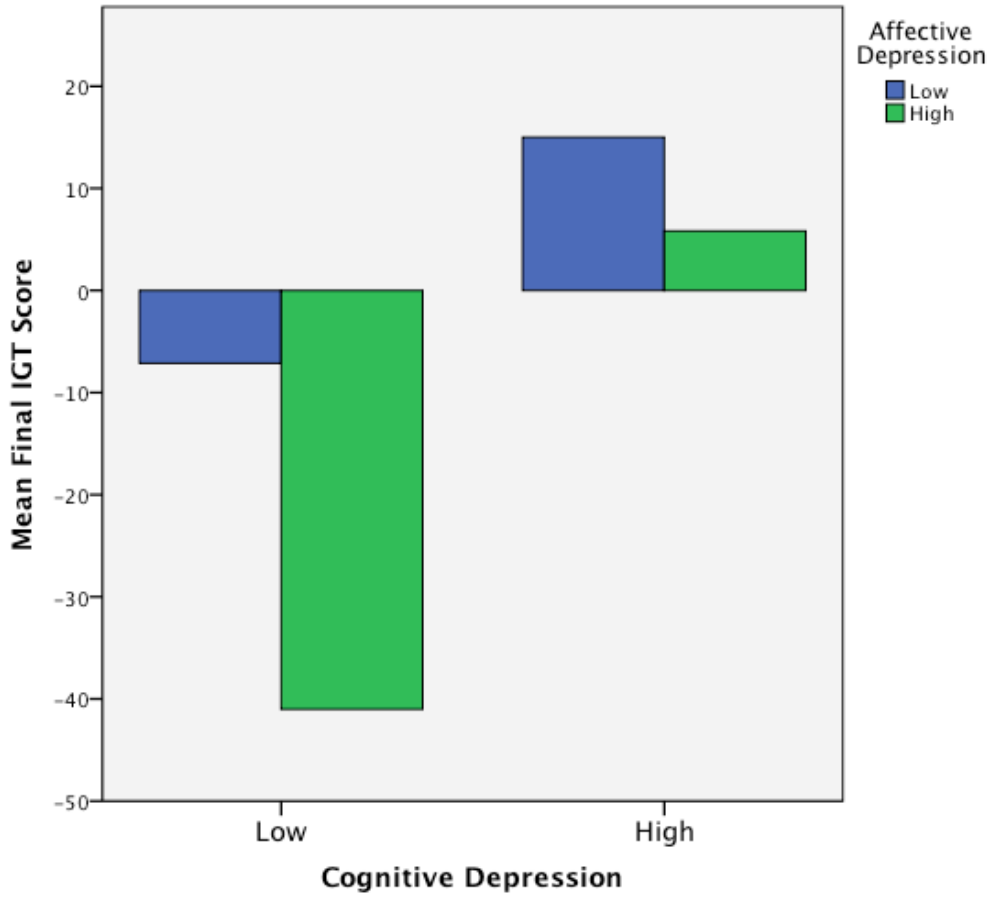

Figure 4. Mean IGT score of individuals high and low in cognitive and affective depression.

We next considered IGT as a function of cognitive and affective depression on a block-by-block basis, and again used the median splits for ease of exposition. It can be seen in Figure 5 that participants low in both types of depression were not high

performers in the task, though they did improve across trials. Participants with low affective depression but high cognitive depression had the highest scores, showing some improvement across trials. The lowest performers were those high in affective depression but low in cognitive depression; these individuals consistently selected from the high-risk desks and did not improve over time. Finally, individuals with high affective and high cognitive depression performed at about the same level as the non-depressed individuals, neither drawn to the high risk desks nor showing significant improvement over time.

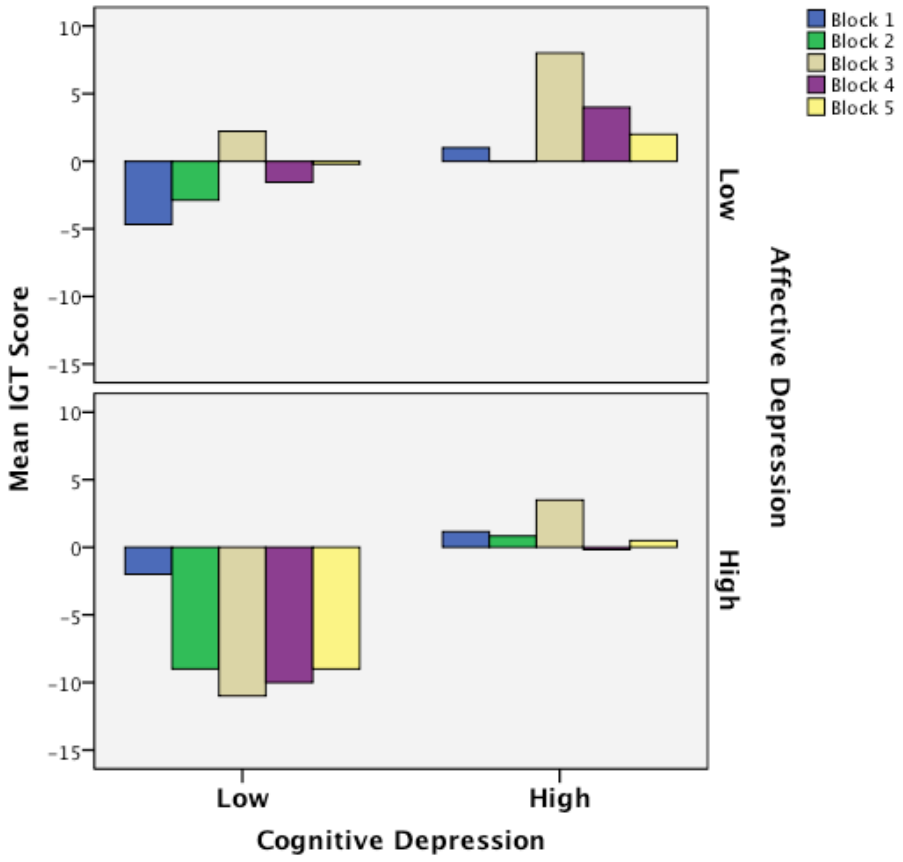

Figure 5. IGT score per block for individuals high and low in cognitive and affective depression.

We conducted a repeated measures ANOVA with levels of cognitive and affective depression as between subjects factors, and found that again, there was a main effect of cognitive depression ($F(1, 21) = 8.53$, $MSE = 93.26$, $p = .008$) and a marginally significant effect of affective depression ($F(1, 21) = 3.33$, $MSE = 93.26$, $p = .082$). There was no main effect of blocks and there was no interaction between blocks and either cognitive or affective depression (p's $> .10$).

Finally, we considered the IGT surveys, which the participants filled out after completing the task. The survey consisted of 4 questions: (1) How did you decide which decks to choose? Did you have a strategy of any kind? Did your behavior change over time? (2) Which decks were better and worse? Explain your response if you can. (3) When playing the game, what information did you most pay attention to? (4) If there is anything else you would like to tell us, please do so here. There were a range of strategies that seem to have been employed on the task; some participants stated that they chose from the decks randomly and some reported that they tested each deck out in order. Such responses included, "[My] strategy was not working so I went for safe bets, then I got greedy and then I lost it all then I just picked any card because I realized it was just luck," and "I started with the pattern ABCD. Once one (i.e. 'B') would take away money, I would eliminate it from the pattern." Ten participants were able to discern that Decks A and/or B were disadvantageous decks. However, even with this recognition, many participants noted that they would take the risk of picking from Decks A and B, in the hopes of earning more money.

Summary of results

We found that IGT performance is positively related to cognitive depression and, once cognitive depression has been controlled for, negatively related to affective depression. Overall, individuals in our study did poorly on the IGT, and the only individuals who performed well overall were those who scored high on cognitive but not affective depression. The latter individuals learned to choose from the advantageous decks during the study. Individuals who scored most poorly on the IGT were those who were high on affective depression and low on cognitive depression; these individuals went for the disadvantageous decks throughout the task and did not show improvement in performance over time. IGT performance was not related to other components of the PAI. With this research we have found that, although participants suffering from generalized anxiety, borderline personality, and traumatic stress all may have impaired performance on the Iowa Gambling Task, it was only the depressive symptoms that were reliably related to behavior.

Discussion

While past research did not consider the distinction between cognitive and affective depression in relation to IGT, the present work suggests that this is an important distinction. Some elaboration of these components is now warranted. Cognitive depression refers to negative thought patterns revealed by statements such as "I feel that I've let everyone down," "Sometimes I think I'm worthless," and "I can't seem to concentrate very well." Cognitive depression focuses on thoughts of worthlessness, personal failure, hopelessness, and rumination on these thoughts. Suffering from cognitive depression as defined by the PAI also suggests

indecisiveness and problems with concentration (Morey, 2003). In contrast, the questions regarding affective depression are more focused on feelings of sadness and anhedonia, with statements such as "Much of the time I'm sad for no real reason," "I've forgotten what it's like to feel happy," and "I have no interest in life." It has been shown that depressive affect is preceded by depressive cognitions, which suggests that cognitive depression often arises in patients before affective depression (Beck & Alford, 2009). Even though the cognitive aspects of depression are the first to arise, patients' cognitive symptoms are also more likely to be the first to improve during a depressive episode, before the affective symptoms (Beck & Alford, 2009).

In past work, individuals with very high scores on dimensions of affect dysregulation have frequently performed more poorly than controls on the IGT. This has raised the question of whether there is one versus multiple different sources of poor performance across clinical disorders. In some ways, this question has not been resolved with the present work in that the major finding is that cognitive depression predicts improved rather than impaired performance. On the other hand, there is also evidence that, after controlling for cognitive depression, affective depression – characterized by sad feeling and lack of motivation – is the best predictor of poor performance. Affectively depressed individuals were not simply unmotivated to do the task or unable to learn the task (either of these typically results in a score around 0). Rather, they consistently picked from the decks with high risks and rewards.

This finding is important because it suggests that affective depression, or sad and hopeless mood, may be what is most closely related to poor IGT performance across individuals with challenges to affect regulation. Given that depressive symptoms and

borderline personality, posttraumatic stress, and anxiety co-occur with frequency, it would not be implausible that affective depression drives IGT performance across situations. Affective depression symptoms are the most severe symptoms of depression and so this measure could be a stand-in for level of severity of one's mental health. It also may be, to go back to Damásio's (1994) somatic markers hypothesis, that strong feelings of sadness interfere with the formation of somatic markers in response to large losses.

A lack or impairment of somatic markers could actively lead to poor performance on the IGT because a participant would not be receiving the physiological signals to warn them that a particular deck is disadvantageous. Without receiving these emotional cues, or with extreme emotions overriding these cues, participants may not be able to make accurate decisions. It is possible that affective depression's control over a participant's emotion interferes with rational decision making. Another attribute of affective depression that may contribute to underperformance on the IGT is the anhedonia and apathy often felt by those with affective depression. This attitude may impair IGT performance due to a lack of motivation to succeed on the task and a tendency to ignore the internal emotional cues that could better direct decision making. Since score on the IS is highly correlated with affective depression, impulsivity on the task may play a role in impairment on IGT performance; the emotional cues may be present in individuals with affective depression, but their impulsivity may override any directed decision making.

Perhaps more surprising in the present study is that the higher one scores on cognitive depression, the better one performs on the IGT. This is the case even at

clinically significant levels cognitive depression. This finding suggests that cognitive processes associated with depression may actually benefit performance on the IGT. We hypothesize two explanations for the improved performance amongst those with high cognitive depression. One explanation centers on ruminative thinking styles, a thinking style commonly seen among depressed patients. A second explanation for improved performance amongst those with high cognitive depression is risk aversion, another behavior commonly seen among depressed patients.

Rumination

Rumination, a key cognitive depression symptom, is defined by the tendency to focus on and think repeatedly about the negative consequences of an event (Disner, Beevers, Haigh, & Beck, 2011). In regards to decision making, rumination causes a person to have less confidence in her decisions, regret decisions more frequently, and have a harder time committing to decisions. Ruminative thoughts are characterized by high self-focus and abstractness (Randenborgh. de Jong-Meyer & Hüffmeier, 2010). This prolonged and repetitive thinking process, usually associated with negative cognitions, is a hallmark of depression (Koster, De Lissnyder, Derakshan & De Raedt, 2011). It is the functional response to the incompletion of established goals, and occurs when an individual does not make adequate progress towards the goal, and needs to reevaluate her strategies, reevaluate how desirable the goal is, or reinterpret her behaviors as whether it is progressive towards the goals. Rumination leads to a depressive thought pattern, which can lead to impaired decision making and problem solving abilities (Paivandy, Bullock, Reardon & Kelly, 2008). However, the findings by Paivandy et al. imply that for the purposes of the IGT, those with a

ruminative thinking style, or a high score on the cognitive depression (DEPC) scale, may have an advantage during the task.

Rumination may lead to someone being more focused on the goal of gaining money; when one picks from a bad deck and loses money, she feels the effects of this loss more strongly than someone who doesn't have a ruminative thinking style. Several dysfunctional thinking schemas characteristic of depression have been developed. One of these logical errors of thinking is termed "emotional reasoning" (Power, 2004). A statement that expresses this emotional reasoning would be "I feel bad therefore I must have done something wrong." This type of feedback could prove beneficial to a person suffering from cognitive depression when performing on the IGT; the patient is aware of the consequence of her choices and may have the ability to correct them by picking from an advantageous deck. The individual is responding to emotional feedback and that will improve her performance on the task.

A number of studies have looked at the relationship between rumination and attention. In one example of such a study, children were shown a sad video. Those who dealt with the sad emotion via rumination remembered more details about the sad clip (free recall) than those who dealt with the emotion regulation via the distraction method (Davis, 2009). Adults who ruminate could achieve better IGT scores because the participants are aware of the consequences of their actions, and are still feeling the emotion from the previous loss. Many have found that ruminators have trouble keeping certain unimportant facts out of their working memory, which could benefit IGT performance because the participant is constantly aware of her previous choice and its consequences (Whitmer, 2009). This could improve learning

on the task.

A distinction is often made between passive and active rumination. Passive rumination can be compared to brooding, and active rumination can be compared to pondering (Kashdan, Young & McKnight, 2012). If rumination is active, goal-oriented, and error correcting, it can be beneficial (Kashdan, Young & McKnight, 2012). This goal-oriented type of rumination has also been thought of as a self-focused motivation process (Smith & Alloy, 2009). These thinking patterns associated with cognitive depression can create a goal-oriented cognitive processing pattern that may facilitate performance on the IGT. These participants could be more impacted by the monetary loss during the IGT and may be better able to focus on the task because they are more affected by the loss.

Risk aversion

An alternate hypothesis is that risk aversion mediates the relationship between cognitive depression and IGT performance. In general, it has been found that people are often risk aversive for gains and risk seeking for losses; this observation has been found in hypothetical and real-life decision making situations (Kliger & Levy, 2003). In addition, it has been found that people experience loss aversion; they are more sensitive to losses than to gains. For example, losing $100 "hurts" more than gaining $100 feels rewarding. Researchers posit that risk aversion may be partially due to loss aversion (Dreher, 2007). A few researchers have examined the relationship between mood and risk aversion, with findings indicating that those with an induced negative mood avoid more risks (Chapman et al., 2007; Smoski et al., 2008).

Our findings support the findings of Must et al. (2007) and Smoski et al. (2008), who found that patients with depression outperformed controls on the IGT. Smoski et al. (2008) attributed this behavior to the risk aversion commonly found amongst depressed individuals. A naturalistic study also found that depressed individuals were less willing to make risky financial choices for their stock portfolio than non-depressed individuals, demonstrating that this risk-aversive behavior does have implications for real-life decision making (Kramer & Weber, 2012). Our results are consistent with these findings. However, our results are in contradiction to previous studies that suggested that trait anxiety was the underlying factor in risk-avoidant decision making. However, such studies did not focus specifically on the IGT (Maner et al., 2007).

The concept of depressive realism may also play into risk aversion among depressed individuals. Depressive realism is a tendency for people who are depressed to make more realistic probability judgments than non-depressed people (Stone, Dodrill & Johnson, 2001). It may be that depressed individuals do not possess an illusion of control and are more accurate in their predictions (Msetfi, Murphy & Simpson, 2007). Depressive realism has been found to be moderated by the severity of one's depression, which aligns with our finding that a higher score on the DEPC PAI subscale is correlated with better performance on the IGT (McKendree-Smith & Scogin, 2000). This could provide an explanation for why those with high cognitive depression scored better on the IGT than those who scored low on cognitive depression.

Limitations and future directions

There are several limitations of the present work. The primary limitation is that of those who responded to our advertisements, there were no participants with scores in a non-elevated range across all PAI subscales. In some ways, this is not surprising in that it reflects the population of the community sampled, and the fact that we did try to oversample individuals with affect dysregulation. A related limitation is that typical performance on the IGT was surprisingly low. To the extent that our goal was to assess the relationship between PAI subscales and IGT, it was valuable to have individuals with an elevated score on at least one subscale, and there were many participants with a clinically elevated score on only one subscale. However, the interpretation of such poor performance can be challenging (e.g., what has to do with lack of motivation or memory impairment versus a true preference for a disadvantageous deck). One goal of future work is to develop new decision tasks that might be able to tease apart different explanations for poor decision making performance. A second goal is to replicate the study with a different population, such as with college students. A third goal is to introduce skin conductance as an additional dependent measure to look at anticipatory responses as they relate to affective and cognitive depression.

Conclusions

Previous studies have focused on individual clinical disorders of affect regulation, for example, comparing individuals with anxiety disorders to healthy controls, and generally finding poorer IGT performance for those with clinical disorders. No studies have looked at multiple symptoms of affect dysregulation in the context of a

single study. From this study we have observed that it is the subscales of depression that predict IGT score. Because depression is highly correlated with anxiety, borderline personality, and posttraumatic stress, it may be depression that underlies poor performance in studies that have solely focused on any one of these disorders.

Through this investigation we have two important findings related to better understanding impaired decision making skills in those with affective dysregulation. First, we have found that depressive symptoms predict performance on the IGT, and that depressive symptoms might underlie performance differences across a wide array of co-occurring clinical disorders. Second, we have found that is it the affective depression that is negatively associated with IGT performance; in contrast, cognitive depression is positively correlated with performance on the IGT. Cognitive depressive symptoms, which often precede affective ones, can have severe negative consequences broadly speaking, but appear to be related to good performance on decision making tasks. We have demonstrated the detrimental effects that affective depression can have on decision making, and hopefully our findings will lead to better understanding of how to ameliorate the decision making abilities of those afflicted with affect dysregulation, so that the real-life negative consequences of poor decision making skills can be mitigated.

In conclusion, our research has shown that depression is not always damaging to decision making capabilities. In fact, it seems as though the cognitive aspect of depression can aide in making optimal decisions, and it is the affective aspect of depression that can be harmful to making decisions. This finding is an important basis for understanding how depression interferes with real-life decision making

situations, and could lead to further research that could determine the most effective means to improve the lives of those suffering from affective dysregulation.

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Appendix A: Sample Affect Regulation Items from PAI Scales

DEPC
I don't feel like trying anymore.
I think good things will happen to me in the future.

DEPA
Much of the time I'm sad for no real reason.
I've forgotten what it's like to feel happy.

DEPP
I hardly have any energy.
I have little interest in sex.

ANXA
I am so tense in certain situations that I have great difficulty getting by.
I can't do some things well because of nervousness.

ANXC
I often have trouble concentrating because I'm nervous.
It's often hard for me to enjoy myself because I am worrying about things.

ANXP
I often feel jittery.
I worry so much that at times I feel like I am going to faint.

BORA
My mood can shift quite suddenly.
My moods get quite intense.

BORI
My attitude about myself changes a lot.
Sometimes I feel terribly empty inside.

BORN
My relationships have been stormy.
I want to let certain people know how much they've hurt me.

BORS
I sometimes do things so impulsively that I get into trouble.
When I'm upset, I typically do something to hurt myself.

ARDT
I've been troubled by memories of a bad experience for a long time.
Since I had a very bad experience, I am no longer interested in some things that I used to enjoy.

Appendix B: Iowa Gambling Task Instructions

Welcome to this card game. In this game, you are starting out with no money and your goal is to try to earn as much money as possible. If you do well, you will receive a small bonus at the end of today's session. How will you make money? You will pick cards, one at a time, from the four decks that appear on the screen. When you pick a card from a deck, you will see how much you've gained, how much you've lost, and how much you have in your winnings. For example, the first card you pick might give you $50 but take away from you $20, resulting in your having $30 in your winnings. Pick cards in any way you like from whichever decks you like until the computer tells you that it is time to stop. If you have questions, ask the experimenter now. When you are ready to go on to the game, click anywhere on this screen with the mouse button to begin.

Appendix C: Iowa Gambling Task Gain-Loss Structure

On every trial, Deck A provided a gain of $100. Trials 3, 18, 28, 37, 43, 53, 68, 78, 87, and 93, also had a loss of $150. Trials 7, 15, 26, 32, 47, 57, 65, 76, 82, and 97 also had a loss of $200. Trials 9, 14, 27, 33, 49, 59, 64, 77, 83, and 99 also had a loss of $250. Trials 5, 17, 22, 38, 45, 55, 67, 72, 88, and 95 also had a loss of $300. Trials 10, 12, 24, 31, 50, 60, 62, 74, 81, and 100 also had a loss of $350. All other trials did not have a loss.

Deck B also provided a gain of $100 on every trial. Trials 9, 14, 21, 32, 49, 59, 64, 71, 82, and 99 also had a loss of $1250. All other trials did not have a loss.

Deck C provided a gain of $50 on every trial. Trials 12, 17, 25, 34, 35, 62, 67, 75, 84, and 85 also had a loss of $25. Trials 3, 5, 7, 9, 10, 20, 24, 26, 30, 39, 43, 45, 47, 49, 50, 53, 55, 57, 59, 60, 70, 74, 76, 80, 89, 93, 95, 97, 99, and 100 also had a loss of $50. Trials 13, 18, 29, 37, 40, 63, 68, 79, 87, and 90 also had a loss of $75. All other trials did not have a loss.

Deck D provided a gain of $50 on every trial. Trials 10, 20, 29, 35, 50, 60, 70, 79, 85, and 100 also had a loss of $250. All other trials did not have a loss.