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Decision-Making and Risk Aversion among Depressive Adults

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Abstract

Depression is associated with behavioral avoidance of potentially rewarding environmental contexts. The present study examined the performance of depressive individuals and controls on a neuropsychological measure of decision-making that favors risk avoidance. Depressive ($n = 41$) and control ($n = 44$) participants were administered the Iowa Gambling Task, which measures the ability of participants to maximize earnings by choosing low-risk, low-reward responses over high-risk, high-reward responses. Results provided partial support for the hypothesis that depressive participants would learn to avoid risky responses faster than control participants. Depressive participants demonstrated better performance than controls, scoring higher than controls overall and showing a trend towards earning more money overall. However, the lack of an interaction between depressive status and time does not support the specific hypothesis of more rapid learning. Findings suggested enhanced feedback-based decision making and risk aversion among depressive individuals.

Keywords

Depression; reward; decision-making; Iowa Gambling Task

1. Introduction

Clinical observation and empirical research point to abnormal responses to both positive and negative stimuli among individuals with unipolar depression. Significant loss of interest or pleasure in daily activities is a diagnostic feature of depression (APA, 1994), while negative cognitive schemas or biased information processing also are evident among depressed individuals (Beck, Rush, Shaw, & Emery, 1979; Bower, 1981). A greater understanding of responsivity to valenced stimuli in depression has the potential to inform effective treatments, and vice versa. For example, treatments that address a depressed patient's behavioral responses to positive and negative stimuli have been found to be effective in reducing depressive symptoms (Dimidjian et al., 2006; Jacobson et al., 1996). Behavioral activation treatments for

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unipolar depression are theorized to work by encouraging patients to approach and engage in rewarding activities and contexts, and to inhibit the behavioral withdrawal often characteristic of depression (Jacobson, Martell, & Dimidjian, 2001). Though behavioral withdrawal may help patients protect themselves from potentially aversive situations (e.g., spending less time with a loved one to avoid rejection or staying home from work to avoid negative feedback from an employer), persistent avoidance also reduces the availability of potentially rewarding stimuli.

In line with treatment outcome studies examining behavioral activation, laboratory-based studies have demonstrated a processing bias toward increased engagement with negative stimuli in depressed individuals when compared to non-depressed controls. For example, depressed individuals have been shown to label mildly happy facial expressions as sad or neutral (Surguladze et al., 2004). Compared to non-depressed controls, depressed individuals responded faster to stimuli cued by a negative word (Mathews, Ridgeway, & Williamson, 1996; Mogg, Bradley, & Williams, 1995) or sad face (Gotlib, Krasnoperova, Yue, & Joormann, 2004). In conjunction with a processing bias away from positive stimuli and toward negative stimuli, individuals with unipolar depression may react differently to reward and punishment than their non-depressed counterparts. On a task involving recognition of previously learned stimuli, non-depressed controls modified their response criteria to maximize monetary rewards and minimize punishments, while depressed individuals did not change their style of responding (Henriques & Davidson, 2000). Risk taking, which has been defined as behavior that has the potential for rewards as well as negative consequences (Jessor, 1998; Lejuez, Aklin, & Jones, 2003), also may be affected by negative mood or depression. Depressed individuals score higher on self-report measures of harm avoidance, including increased responsiveness to signals of aversive stimuli (Bock, 2004; Joffe, Bagby, Levitt, Regan, & Parker, 1993); however, behavioral correlates of self-reported harm avoidance among depressed individuals have not been reported in the literature. Among healthy controls, individuals who have been induced to a negative mood indicated less risk-taking on a self-report measure (Yuen & Lee, 2003), compared to responses before the induction. Other studies using non-clinical samples, however, have indicated no effect of induced negative mood or of naturally occurring low moods on risk taking (Clark, Iversen, & Goodwin, 2001; Hockey, Maule, Clough, & Bdzola, 2000). Given the relative lack of behavioral data on risk taking in depressed individuals as well as inconsistencies in findings among analogue samples, further research is necessary to determine the effects of depression and depressive symptoms on risk taking behavior in the laboratory.

One behavioral laboratory task that frequently has been used to examine risk taking is the Iowa Gambling Task (IGT; Bechara, Damasio, Damasio, & Anderson, 1994; Bechara, Damasio, Tranel, & Damasio, 1997; Damasio, 1994). In this task, participants are presented with four decks of cards. Each time a participant chooses a card, he or she receives a monetary reward, and may receive a monetary penalty. Some of the card decks involve very high rewards and similarly high penalties (the “risky” decks), with an unfavorable reward-to-punishment ratio; other decks involve lower rewards and penalties, but a favorable reward-to-punishment ratio. Task success requires the participant to decide, through trial and error, to choose non-risky decks rather than risky decks. Accordingly, the IGT task can be thought of as a test of one's ability to discern the relative benefit of avoiding punishment over pursuing reward and to choose the most beneficial response. Several clinical groups have demonstrated poor performance on the IGT (relative to control groups), by choosing predominantly from risky decks, perhaps indicating problems with risk aversion in these groups. Such groups include individuals with damage to the ventromedial prefrontal cortex (Bechara, Damasio, & Damasio, 2000), individuals with a history of suicidality (though not those with a history of affective disorder; Jollant et al., 2005), and persons with sociopathic traits (Mitchell, Colledge, Leonard, & Blair, 2002) or chronic pain (Apkarian et al., 2004). We are not aware of any studies

investigating risk aversion using the IGT with individuals experiencing current depressive symptoms.

The primary purpose of the present study was to examine the hypothesis that depression is associated with *higher* responsivity to negative feedback (i.e., punishment) relative to reward. In line with theoretical accounts of risk-taking (Jessor, 1998; Lejuez, Aklin, & Jones, 2003), we used the IGT to measure decision-making associated with positive and negative feedback. We hypothesized that depressive individuals would demonstrate higher responsivity to negative feedback, through a pattern of initially sampling from all card decks, followed by a sharp decrease in the number of cards chosen from risky decks toward the latter trials of the task. In contrast, we hypothesized that control individuals would demonstrate a similar pattern, but with a less pronounced decrease in choices from risky decks toward the latter trials of the task. Given that the design of the task favors harm avoidance over pursuit of reward, the greater attention to negative stimuli and harm avoidance in the depressive group is hypothesized to drive faster learning. The control group is hypothesized to demonstrate relatively less rapid learning due to greater motivation to pursue the high rewards of the risky decks.

2. Method

2.1 Participants

A total of 85 participants (44 controls, 41 depressive individuals) were recruited for the study. The study protocol was approved by the Institutional Review Board of the Duke University Health System. This study was part of a joint recruitment effort for several concurrent studies of emotion regulation and psychopathology. Participants were recruited via local newspaper and web site advertisements, as well as via flyers posted in campus and medical center locations. Advertisements for individuals with psychopathology targeted symptoms of depression, emotional lability, interpersonal problems, and/or self-injury, while advertisements for controls targeted “healthy” individuals interested in a study of “emotions.” Interested participants were screened and referred to all studies for which they met inclusion criteria. Inclusion criteria for the current study included: (a) age between 22 and 55 years, and (b) Modified Hamilton Rating Scale for Depression (HAM-D) score of less than 7 (controls) or greater than 13 (depressive individuals). Participants were excluded if they were currently manic or had a history of psychosis. Participants reported no history of neurological disorders. As anticipated, the mean HAM-D score for the control group ($M = 3.3$, $SD = 3.2$) was significantly lower than the mean for the depressive group ($M = 17.4$, $SD = 4.0$), $t(83) = 17.95$, $p < .001$. The control group ($M = 36.7$ years, $SD = 10.3$) did not significantly differ from the patient group ($M = 37.9$ years, $SD = 8.7$) in terms of age, $t(83) = 0.57$, $p = .57$. The ethnic distribution of the sample was as follows: 70% Caucasian, 20% African American, 4% Asian or Asian American, and 5% Hispanic, with one participant declining to indicate race/ethnicity. The two participant groups did not differ in racial/ethnic composition, $\chi^2(4) = 4.19$, $p = .38$. The sample was 75% female, with no significant gender differences between groups, $\chi^2(1) = .19$, $p = .66$. The majority of the sample had either a college (43%) or advanced (24%) degree, with an additional 21% completing some college, 11% completing high school or a GED, and 1% with a grade school education. The two participant groups differed in terms of highest education level, $\chi^2(4) = 9.85$, $p = .04$, with a greater percent of the control group holding an advanced degree (18% vs. 6%), and a greater percentage of the depressed group holding a college (24% vs. 18%) or high school (9% vs. 5%) degree. For the 82 participants willing to provide information on income, there was no significant group difference in annual income category, $t(80) = 1.58$, $p = .11$, with the sample household income averaging between \$20,000 - \$40,000. The proportion of participants using antidepressant medications was significantly higher in the depressive group (46%) than in the control group (25%), $\chi^2(1) = 4.62$, $p < .05$. The relatively high rate of medication use among controls is likely due to the presence of ads

recruiting control participants at hospital and clinic locations, and likely reflects previously depressed individuals who responded well to their medications.

2.2 Measures

2.2.1 Demographic Information—A brief self-report questionnaire was administered to obtain information on age, gender, race, marital status, and total household income.

2.2.2 Mania and Psychosis Screening—Mania and psychosis items from Section A and the B/C Screener of the Structured Clinical Interview for DSM-IV Disorders (SCID-I; First, Spitzer, Gibbon, & Williams, 1995) were administered over the phone to screen out potential participants who endorsed the presence of manic and/or psychotic symptoms.

2.2.3 Hamilton Depression Rating Scale (Hamilton, 1960)—The HAM-D is one of the most widely used instruments for assessing symptoms of unipolar depression. We used a 17-item version of the HAM-D interview, which has demonstrated high reliability and validity (Miller, Bishop, Norman, & Maddever, 1985). Cutoff values of less than 7 for the control group and greater than 13 for the depressive group were used (Frank et al., 1991).

2.2.4 Iowa Gambling Task (IGT) (Bechara, Damasio, Damasio, & Anderson, 1994)—As described in the introduction above, participants were presented with four decks of cards, including two high-risk decks and two low-risk decks. A total of 100 card-selection trials were administered. Each time participants chose a card from one of the decks, they received a monetary reward and may have received monetary punishment. Reward amounts ranged from \$40 to \$80 for low-risk decks and \$80 to \$170 in high-risk decks. Losses ranged from \$25 to \$375 for the low-risk decks and \$150 to \$2500 for the high-risk decks. On average, choosing exclusively from high-risk decks led to losses of \$250 every 10 trials; in contrast, choosing exclusively from low-risk decks led to gains of \$250 every 10 trials.

2.3 Procedure

HAM-D and mania/psychosis rule-out items were administered over the phone prior to the in-person study appointment by trained research assistants, under the supervision of the first three authors. An IRB-approved verbal consent procedure was used to collect prescreening data. On the day of the experiment, participants provided written informed consent to participate in the study and were seated in a cushioned chair in front of a computer. A practice “Mouse Aerobics” exercise was used to ensure that participants were comfortable with using a computer mouse. Participants were compensated \$30 for completing both the IGT and other experimental procedures associated with another study with overlapping inclusion criteria. For the IGT task, participants were read a set of standard instructions by the experimenter. Participants were instructed to choose cards one at a time from any of the four decks, and were told they were free to switch from one deck to another at any time, as often as they would like. They were informed that all cards would win them money, but that some cards would simultaneously lose them money and that they might lose more than they won in any given hand. They also were told 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.” They were informed that they would not actually receive the money they “won,” but should treat the task as if they were using their own money. (The use of virtual versus actual monetary reinforcers as motivators on the IGT has not been found to significantly alter performance; Bowman & Turnbull, 2003). The experimenter remained in the room with participants for the first few trials to ensure that they did not have questions about the task, and then left the room for the remainder of the task. Participants were told how to signal the experimenter if they experienced problems or had additional questions.

3. Results

3.1 Data screening and transformations

The distribution characteristics were examined, and Kolmogorov-Smirnov tests were used to examine whether the dependent variables of interest were normally distributed. The number of cards from risky decks and net money earned were normally distributed and there were no outliers; therefore, no data transformations were performed.

3.2 Depression and Response to Negative feedback

The primary hypotheses were as follows: (a) both controls and depressed participants would initially sample randomly from the decks, but would then develop an aversion to the risky decks, and (b) compared with controls, depressed individuals would develop a stronger aversion to the risky decks as evidenced by a larger decrease in choices from risky decks as the task progressed. We conducted a 2 (control versus depressed) $\times$ 5 (blocks of 20 trials) mixed-model ANOVA. The dependent variable was an index of IGT performance calculated as the sum of cards from non-risky decks minus the sum of cards from risky decks (i.e., $(C + D) - (A + B)$). Positive values on this variable indicate that a majority of choices were from non-risky decks, while negative values indicate a majority of risky choices. Consistent with these hypotheses, the ANOVA revealed a main effect for block, $F(4, 332) = 9.60, p < .001, \eta_p^2 = .12$, with all participants choosing fewer risky cards (i.e., being more effective in their choices) over time. There was also a main effect for Group, $F(1, 83) = 4.03, p < .05, \eta_p^2 = .05$, indicating that depressed individuals chose fewer cards from risky decks than non-depressed participants across all trials of the task. The Group $\times$ Block interaction was non-significant, $F(4, 332) = 0.96, p = .43, \eta_p^2 = .01$ (see Figure 1)¹. There was a trend for depressive participants to win more money than controls overall, $t(83) = 1.71, p = .09$.

4. Discussion

Consistent with previous studies, all participants learned to avoid the risky decks over the course of the task, with significant declines in the number of risky cards selected over time. Depressive participants chose fewer risky cards across the entire task compared to control participants and showed a trend toward winning more money overall. This result only partially supports our hypotheses, in that the depressive group showed better performance across the entire task on average, rather than showing a faster rate of learning than controls (as would be indicated by an interaction of group and block). Consistent with the study hypotheses, by the end of the task, depressive participants were more “successful” than controls at making decisions that avoided negative feedback (i.e., higher risk), winning an average of \$140 compared to the average loss of \$375 by controls in the final task block.

It is somewhat difficult to interpret a finding of better performance overall by the depressive group, as opposed to an interaction between trial block and group. An interaction would strongly suggest a learning effect, with both groups starting at the same level of performance but diverging by the end of the task. A main effect suggests that the depressive participants were less likely to choose risky decks throughout the task, but does not support the hypothesis of faster learning. We therefore interpret our finding as indicating that depressive subjects are more risk averse than controls, but that this effect is not necessarily manifested in faster learning of contingencies.

¹Given that the groups differed in education level, education was entered as a covariate in a separate analysis. Though education was a significant predictor of IGT score, $F(1, 79) = 5.58, p < .05$, as was the Education $\times$ Block interaction, $F(4, 316) = 4.30, p < .05$, depressive group remained a significant predictor of IGT score, $F(1, 79) = 6.49, p < .05$, and the Group $\times$ Block interaction remained nonsignificant, $F(4, 316) = 1.66, p > .10$.

The structure of the IGT task places greater value on negative feedback than positive feedback, requiring participants to forego high-reward cards for less risky but less rewarding choices. The finding of differential IGT performance in depressive participants suggests that depressed individuals may have a heightened sensitivity to aversive contingencies. This is consistent with a bias towards negative stimuli or self-evaluation in depression, as well as the construct of harm avoidance. Other correlates of harm avoidance such as anxiety (Schmitt, Brinkley, & Newman, 1999) and the personality trait of neuroticism (Carter & Smith Pasqualini, 2004) also have been linked to enhanced IGT performance, though clinically significant anxiety can be associated with impaired performance (e.g., OCD; Cavedini et al., 2002). It may be that depressed individuals behave as if negative or punishing consequences are more likely to occur than positive or rewarding consequences. For example, Elliott and colleagues found that depressed individuals did not change their behavior under conditions of absent versus negative feedback. In contrast, non-depressed controls did not demonstrate different behavior under conditions of absent versus *positive* feedback (Elliott, Sahakian, Michael, Paykel, & Dolan, 1998). They conclude that in the absence of feedback, “normal subjects behave as if they are expecting success while depressed patients behave as if they are expecting failure.” Our results are consistent with this conclusion.

Results from the present study also are consistent with Damasio's (1994) somatic marker hypothesis, which attempts to explain how individuals make decisions between alternative courses of action characterized by varying potentials for positive and negative feedback. According to this hypothesis, a process of trial-and-error learning leads individuals to develop non-conscious learned associations between emotional states (called “somatic markers”) and particular courses of action. Over time, these emotional states (both negative and positive) begin to function as guides in effective decision-making. Essentially, when individuals are faced with different options, negative somatic markers will guide them away from unfavorable options, and positive somatic markers will guide them toward favorable options.

In support of the somatic marker hypothesis, several studies have found that individuals with frontal lobe damage (particularly, ventromedial prefrontal cortex damage), who do not experience anticipatory physiological reactions when facing decisions, also perform poorly on the IGT (Anderson, Bechara, Damasio, Tranel, & Damasio, 1999; Bechara, Damasio, & Damasio, 2000). Likewise, a lack of anticipatory response to potentially punishing situations has been linked to sociopathy; however, there has been mixed support for the presence of impaired IGT performance in individuals with sociopathic traits (Blair & Cipolotti, 2000; Blair, Colledge, Murray, & Mitchell, 2001; Lösel & Schmucker, 2004; Mitchell, Colledge, Leonard, & Blair, 2002). Enhanced performance by depressive participants on the IGT may reflect either stronger or more rapid acquisition of somatic markers in response to negative feedback, potentially as a result of a processing bias toward negative information in general. Likewise, depressed individuals may have weaker positive somatic markers, and as a result, demonstrate less appetitive, reward-seeking behaviors. These empirical questions should be addressed in future studies examining decision making and risk taking in depression.

The findings in this study are consistent with depressed individuals' tendency toward enhanced attention and responsivity to negative feedback, relative to positive feedback. It is rare to find a neuropsychological task in which psychopathology is associated with *positive* performance. Indeed, our findings speak to the potentially adaptive nature of adopting a low-risk low-reward strategy when faced with a clearly differentiable high-risk high-reward alternative. Similar to the concept of depressive realism (e.g., Alloy & Abramson, 1979), it may be that individuals with high depressive symptoms are more accurate at discriminating punishment from reward, and, accordingly, are differentially protected from punishment in the environment. However, when chronically used in a rigid or context insensitive manner, such a strategy likely reduces the probability of being exposed to rewarding environments, which, in turn, may exacerbate

depressive symptoms. Such strategies may keep you from losing, but won't necessarily help you win.

It is important to note that it is uncommon in the natural environment to find punishment and reward as closely tied (hence the risk) as in the IGT. Thus, in the natural environment, unlike the IGT, avoiding risk often will lead to missed opportunities for rewards. There is value in the depressive style of minimizing losses; however, the flexibility to maximize rewards as well may be one of the keys to emotional health and overcoming depression. Along these lines, engaging in an increasing number of rewarding experiences has been shown to be sufficient in improving depression (Hopko, Lejuez, LePage, Hopko, & McNeil, 2003; Jacobson et al., 1996; Lejuez, Hopko, LePage, Hopko, & McNeil, 2001). Thus, if generalized, this risk-averse strategy may be an important factor in the maintenance of depressive experiences (Chapman et al., 2007), and successful treatments for unipolar depression may operate, at one level of analysis, by blocking avoidance of risk for punishment and providing opportunities for new learning to occur.

Several limitations should be considered when interpreting the findings of this study. First, depressive symptoms were assessed by a screening interview (HAM-D) as opposed to formal diagnostic testing. Although the modified HAM-D interview used in the study has strong validity and reliability (Miller et al., 1985), formal diagnostic testing would help provide a more precise picture of the effects of depression on learning from feedback. Based on established cutoffs on the 17-item HAM-D (Miller et al., 1985), our sample may be best characterized as mildly to moderately symptomatic. In addition, future studies should include an assessment of emotional state and task motivation on the day of testing to examine these factors as potential covariates of IGT performance. Another challenge is that our data are cross-sectional data cannot be used to discern whether these effects are related to state or trait characteristics. However, previous findings of no differences between individuals with a history of affective disorders and a lifetime-free control group (Jollant et al., 2005) would suggest that our findings may be driven primarily by state effects. As mentioned earlier in this section, the lack of an interaction effect makes interpretation of the current results less clear. An additional concern is that the design of the present study makes it difficult to discern whether IGT performance among depressive individuals was superior due to a heightened response to punishment, a decreased response to reward, or both. This study represents a first demonstration of relative risk avoidance/lack of reward pursuit among depressive individuals in a well-validated task. Future studies are planned to use modified IGT tasks to measure the behavior of depressed individuals when feedback is neutral (i.e., risk equals reward) or weighted towards the positive (i.e., reward outweighs risk).

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Figure 1. Changes in the number of risky cards chosen by depressed and control participants over the course of 100 IGT trials. Each block represents 20 trials.