LSU Master's Theses   Graduate School

2005

Relationships among performance on simulated tasks of decision-making, positive outcome expectancies for MDMA, and age of first MDMA use

Scott Michael Patterson
Louisiana State University and Agricultural and Mechanical College, spatte3@lsu.edu

Follow this and additional works at: https://digitalcommons.lsu.edu/gradschool_theses

Part of the Psychology Commons

RELATIONSHIPS AMONG PERFORMANCE ON SIMULATED TASKS OF
DECISION-MAKING, POSITIVE OUTCOME EXPECTANCIES FOR MDMA, AND
AGE OF FIRST MDMA USE

A Thesis

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Master of Arts

in

The Department of Psychology

by
Scott Michael Patterson
B.A., Louisiana State University, 2002
May, 2005

Table of Contents

Abstract

The purpose of this study was to examine relationships among 3,4-methylendioxymethamphetamine (MDMA) use patterns and beliefs, the Gambling Task, the delay discounting task, and the Adult Self-Report (ASR). Sixty-eight college students completed measures of substance use, social desirability, the MDMA Beliefs Questionnaire (MDMA-BQ), the Gambling Task, the delay discounting task, and the ASR. Contrary to predictions, participants who had used MDMA at least once did not vary from those who had never used MDMA on the Gambling Task, the delay discounting task, or the ASR. As predicted, MDMA users' outcome expectancies for MDMA significantly differed from non-users. MDMA-BQ scales and age of first MDMA use were not correlated with Gambling Task, delay discounting task, or ASR scores. No relationships were found among Gambling Task, delay discounting task, and ASR scores.

Introduction

Three, 4-Methylendioxymethamphetamine (MDMA) is a selective serotonergic (5-HT) neurotoxin that is a popular drug of abuse (Morgan, 2000; Tasker, Raw, & McNeil, 1999). As many as one in nine high school seniors have tried MDMA (National Institute on Drug Abuse; NIDA, 2001). As MDMA use increases, research into the subjective, physical, and social effects of MDMA has become more prevalent.

Recent studies have revealed that the use of MDMA can have many harmful effects. Side effects of MDMA consumption can include hyperthermia, sudden death, and cardiovascular collapse (Bedford, Schwartz, & Dawling, 1992; McCann, Slate, & Ricaurte, 1996). Functional neuroimaging studies have suggested that repeated exposure to MDMA may result in permanent depletion of 5-HT, which has been linked with various effects such as depressed mood and memory deficits (Reneman, Booij, Schmand, Brink, & Gunning, 2000; Semple, Ebmeier, Glabus, O'Carroll, & Johnstone, 1999; Verheyden, Hadfield, Calin, & Curran, 2002). Behavioral and environmental factors commonly associated with MDMA use (e.g., increased and continuous physical activity, such as dancing at clubs for extended periods of time) may exacerbate these adverse effects (Gross, Barrett, Shestowsky, & Pihl, 2002). Despite this body of research, the reasons for MDMA initiation are still relatively unexplored.

Previous research has examined the relationship between impulsive decision-making and nicotine, alcohol, and polydrug use (e.g., Ball, Carroll, & Rounsaville, 1994). Similar to nicotine, alcohol, and polydrug use, regular MDMA use has been associated with depressed mood, anxiety, and impulsive behavior (Morgan, 1998; Morgan, 2000; Parrott, Sisk, & Turner 2000). In addition, long-term users of MDMA have reported beliefs that MDMA's effects are not harmful, and that it poses few, if any, health related risks (NIDA, 2001). Current and long-

term substance users have been shown to be less concerned with damaging effects of substances than non-users (Fabricius, Nagoshi, & MacKinnon, 1993).

<u>Impulsive Decision-Making and Substance Use</u>

Impulsive decision-making has long been examined as a precursor or simple correlate to substance use and abuse, social deviance, and deviant sexual behavior (Ball et al., 1994; Harpur, 1994; Kalichman, Hechman, & Kelly, 1996). Impulsive decision-making is defined as the likelihood to ignore greater long-term rewards while risking loss in order to achieve immediate, if not lesser, short-term gain (Hinson, Jameson, & Whitney, 2003). In other words, impulsive decision-makers tend to act quickly, are more likely to seek new experiences, and are hypothesized to not consider the consequences of their actions as often as less impulsive individuals. Behaviorally, impulsive individuals have been shown to be more likely to take physical and social risks than less impulsive individuals (Zuckerman, 1979). Impulsive decision-making is sometimes used as a behavioral interpretation of trait impulsivity, a personality trait defined by Gerbing, Ahadi, and Patton (1987) as the tendency to respond to a given stimulus quickly, without real evaluation of consequences and risks.

Impulsive decision-making has been positively correlated with substance abuse in college students (Galizio, Rosenthal, & Stein, 1983; Segal, Huba, & Singer, 1980; Zuckerman, Bone, Neary, Mangelsdorff, & Brustman, 1972), drug and alcohol use by teenagers (Bates, White, & Labouvie, 1994; Earleywine & Finn, 1991; Forsyth & Hundleby, 1987; Newcomb & McGee, 1989; Teichman, Barnea, & Ravav, 1989), and substance abuse among those in treatment settings (Galizio & Stein, 1983; Kosten, Ball, & Rounsaville, 1994; Luthar, Anton, Merikangas, & Rounsaville, 1992; Sutker, Archer, & Allain, 1978). In a study of public health campaigns,

Donohew (1990) found that up to 80% of adolescent substance users exhibited more impulsive behaviors, such as substance use and sexual behaviors, than non-users.

The role of impulsive decision-making in the transformation from infrequent user to active substance user has also been studied. Adolescent and adult participants with high scores on impulsive decision-making measures have been shown to be more likely to have tried smoking and progressed to smoking a second cigarette (Hirschman, Leventhal, & Glynn, 1984). In addition, longitudinal studies of individuals who were likely to ignore risks associated with drug use show they are significantly more likely to transition from infrequent to regular use of cigarettes, when compared to control groups (Collins et al., 1987). Number and variety of drugs used have been positively correlated with impulsive decision-making scores on sensation seeking scales (Spotts & Shontz, 1984). Spotts and Shontz (1984) suggested that this data points toward a tendency to experiment with a variety of substances and experiences in search of stimulation.

Various explanations and criticisms of the relationship between impulsive decision-making behaviors and substance abuse have been proposed (Curran, White, & Hansell, 2000). Studies have examined how measures of impulsive behavior, risk-taking, and general novelty seeking relate to each other (Lejuez et al., 2002). Lejuez et al. (2002) found that these measures produce similar correlations when measuring substance use and often have overlapping questionnaire items, suggesting a common factor may be affecting each construct. The directionality of the relationship between substance use and impulsive behaviors has also been questioned. It is unclear whether impulsive decision-making behaviors lead to substance abuse, substance abuse increases the likelihood of impulsive decision-making behaviors, or there is an underlying common factor (Curran et al., 2000).

Mechanisms of Impulsive Decision-Making

Several mechanisms have been proposed to explain impulsive decision-making. The optimal level of arousal theory was used to support impulsive decision-making research (Zuckerman, 1969; Zuckerman, Kolin, Price, & Zoob, 1964). This theory stated that more impulsive individuals, those more likely to seek stimulation in risky situations, engage in impulsive behavior in order to achieve a higher level of psychological arousal. Specifically, individuals with impulsive decision-making tendencies were expected to have either a higher threshold for arousing events or a greater need for arousal than others. According to the theory of optimal arousal, impulsive decision-making occurred because of an exaggerated need for stimulation and a willingness to risk social or physical damage.

The optimal level of arousal theory was revised and currently incorporates a psychobiological approach. Zuckerman (1984) developed the theory of optimal level of catecholaminergic activity. This theory has also been revised as recent research connects impulsive behavior (specifically novelty seeking, the likelihood to seek new situations in a search for stimulation or arousal) to the D4 dopamine receptor gene (D4DR; Benjamin et al., 1996; Cloninger, Adolfsson, & Svrakic, 1996; Ebstein et al., 1996). The dopamine receptor theory states that impulsive or risk-taking behavior elicits pleasure through neurological release of dopamine, a process similar to the effects of drugs of abuse.

Ebstein et al. (1996) examined the role of D4DR with regards to novelty seeking behavior. Prior to the genetic testing of D4DR, evidence that impulsive behavior was related to dopamine came from individuals with Parkinson's disease (a medical condition involving dopamine deficiency) and differences in observed behavior between dopamine agonists, such as amphetamines and cocaine, when compared to dopamine blockers. Ebstein et al. (1996)

identified individuals with varying D4DR genotypes and administered a novelty seeking

questionnaire. They found that the D4DR gene was significantly associated with novelty seeking

test scores (including impulsive decision-making behaviors). This finding was independent of

ethnicity, sex, and age.

In order to test heritability, Benjamin et al. (1996) replicated these findings using

different personality measures with a population of siblings. The authors found that the presence

of long alleles on D4DR exon III (an area responsible for mRNA production) was positively

correlated with impulsive behavior. Subjects with short alleles on D4DR exon III showed

opposite behaviors (i.e., caution and consideration of future consequences). Benjamin et al.

(1996) found that D4DR accounts for 10% of the heritability of impulsive behavior, with

implications that other similar genes may also exist. It has been hypothesized that substance

abuse or drug-seeking behavior may share a similar neurological system with impulsive

behavior, and that high arousal situations (such as sports and mountain climbing) may be used as

substitutes for drug-seeking behaviors (Bardo & Mueller, 1991; Bardo et al., 1996).

Behavioral Measures of Impulsive Decision-Making

Self-report questionnaires are the most widely used form of measurement in the study of

impulsive decision-making and substance abuse. Self-report questionnaires have been seen as a

quick and inexpensive way to identify those at high risk of experimentation with substances

(Scourfield, Stevens, & Merikangas, 1996). While many general personality inventories assess

impulsive behavior, they frequently assess it as a part of a larger construct (Barratt, 1985;

Eysenck, Pearson, Easting, & Allsopp, 1985; Zuckerman, Eysenck, & Eysenck, 1978). Specific

measures of impulsive behavior are less common. As general criticisms of the viability of self-

report have increased, behavioral measures have been developed (Lejuez et al., 2002). Two

proposed behavioral measures of impulsive decision-making are the delay discounting task and the Gambling Task (Bechara, Damasio, Damasio, & Anderson, 1994).

The choice of a smaller but immediate reward over a larger but delayed reward has been proposed as a possible behavioral definition of impulsive decision-making (Rachlin & Green, 1972). Delay discounting tasks involve the presentation of a hypothetical reward, generally money, that is available to the participant immediately or after various time intervals. Initially, the immediate reward is a large dollar amount and is gradually decreased until the participant begins to select more delayed interval rewards. Using a delay discounting task, Petry (2001) found that heavy alcohol users were more impulsive than light alcohol users and non-users. In this study, heavy drinkers were significantly more likely to accept lesser immediate rewards (rewards presented were money or alcohol) over greater delayed rewards. Light alcohol users and non-users were less likely to accept immediate rewards and were more likely to plan for future consequences and greater eventual rewards.

Similar to delay discounting tasks, the Gambling Task (Bechara et al., 1994) adds a risk component into impulsive decision-making, while still requiring individuals to choose between immediate or delayed reward. The Gambling Task measures whether individuals will risk loss of rewards or incur negative gain for the possibility of greater reward. Unlike delay discounting, rewards are offered but not guaranteed; loss is an integral component of risk-taking. While a delayed reward is still present, lesser rewards must be accepted over time to reveal increased overall gain. Through this process, likelihood to risk loss and inability to plan for future consequences can be studied.

Recently, the Gambling Task (Bechara et al., 1994) has been used in the measurement of impulsive decision-making. Using the Gambling Task, Petry, Bickel, & Arnett (1998) showed

that heroin users were more likely to choose cards related to immediate gain with negative consequences than non-users. Bechara et al. (2001) found similar results with alcohol, cocaine, and amphetamine users. Additionally, Businelle, Kendzor, Patterson, Rash, and Copeland (under review) showed that heavy smokers consistently demonstrate decision-making deficits on the Gambling Task.

Similar to delay discounting tasks, substance users tested with the Gambling Task show a marked pattern of behaviors in which they take great risks for greater immediate gain, even if risk of less gain or possible loss is evident. Further evidence of similarities between delay discounting and the Gambling Task was found by Monterosso, Ehrman, Napier, O'Brien, and Childress (2001). Monterosso et al. administered both a delay discounting task and the Gambling Task to cocaine abusers to test the similarity of the mutual construct. The authors found that cocaine abusers had similar on each measure and showed insensitivity to future consequences on both the delay discounting task and the Gambling Task.

MDMA: Demographics and Impulsive Decision-Making

Severe alcohol, nicotine, and polydrug dependence among patients in clinical settings and "gateway" drug (substances said to lead to polydrug use) studies among adolescents have formed the basis for existing research associating impulsive behavior and substance use (Ball et al., 1994). However, the relationship between MDMA use and impulsive behavior has not been extensively studied. With the rising popularity of MDMA use among adolescent (NIDA, 2001) and adult populations (Klitzman, Pope, & Hudson, 2000; Morgan, 2000; Tasker et al., 1999), more research about MDMA use is appropriate. In a study of gay and bisexual men, Klitzman et al. (2000) found that MDMA was the second prevalent illicit substance of use (marijuana was the most prevalent).

An increasing trend of MDMA use has been found among adolescents and students in college settings (NIDA, 2001). A NIDA (2001) study on MDMA use reports several reasons for the initiation of MDMA use. These reasons range from curiosity and peer influence to positive beliefs of the drug's physical and social effects. According to this study, MDMA users view MDMA as a benign drug, similar to any other recreationally used drug in tablet form (NIDA, 2001). Businelle, Patterson, Loupe, and Copeland (under review) found that MDMA users were less likely than non-users to report beliefs that MDMA use had associated health risks. NIDA (2001) suggested that the lack of MDMA education and lack of availability of information about other related substances might be reasons for perceptions that MDMA does not have harmful effects.

Age of initiation of MDMA use continues to vary (NIDA, 2001). NIDA found increasing MDMA use among adolescents in the 8th, 10th, and 12th grades. For the second consecutive year, students in grades 10 and 12 reported increases in MDMA use, with 12th grade students showing a lifetime MDMA use of 11%. This indicates that one in nine adolescents have tried MDMA by 12th grade. Eighth grade students showed significant levels of MDMA use for the first time. Contemporary studies have not thoroughly investigated the relationship between impulsive behavior and age of first drug use with any substances. Considering research indicating a genetic component to impulsive decision-making (Benjamin et al., 1996; Cloninger et al., 1996; Ebstein et al., 1996), impulsive decision-making may contribute to situations where individuals first use MDMA.

<u>Expectancy Theory Applied to Drug Use</u>

Several theories of drug use and drug use initiation have been developed, including outcome expectancies (i.e. beliefs about the possible relationship between behaviors in a

situation). Desirability impacts behavior by increasing the probability of expected behaviors with positive expected outcomes and decreasing the probability of behaviors with negative outcomes. Subjective expected utility (SEU; Edwards, 1954) is the likelihood of an outcome to occur weighted by its importance or desirability. Eiser (1983) views smoking initiation as the effect of SEU on an assessment of short-term gains and long term consequences. Specifically, an individual's positive expectations of the short-term gains associated with smoking initiation (e.g., social appearance) must outweigh the negative opinions associated with the long-term consequences (such as health hazards). An individual's assessment of gains and consequences is hypothesized to determine if an individual will decide to initiate smoking or not. In order to begin smoking, Eiser (1983) suggests that an individual must modify outcome expectancies and choose to concentrate on short-term gains and ignore possible risks associated with smoking. In a similar vein, outcome expectancies have been associated with alcohol use patterns (Bauman, Fiser, Bryan, & Chenoweth, 1985; Christiansen, Roehling, Smith & Goldman, 1989).

After initiation of use, positive outcome expectancies reinforce drug use behaviors and lead to continued drug use. Outcome expectancies have been shown to be highly correlated with alcohol use and maintenance (Brown, Goldman, Inn, & Anderson, 1980; Fromme, Stroot, & Kaplan, 1993) and drug use (Schafer & Brown, 1991). Young adults with strong positive outcome expectancies for drug use are more likely to drink, use illicit drugs, and to continue using drugs (Benthin, Slovic, & Severson, 1993). Businelle, Patterson, et al. (under review) reported findings that the subjective effects of substance use (i.e., outcome expectancies), including MDMA, account for a significant amount of variance in substance use behavior.

Outcome expectancies have also been shown to correlate with physiologically-based responses that are related to risk-taking behavior, such as impulsive decision-making (Kalichman

et al., 1996; Katz, Fromme, & D'Amico, 2000). Galizio et al. (1983) found that impulsive

decision-makers reported more psychologically arousing situations when asked what situations

would be more likely to reinforce drug use behaviors. In addition, outcome expectancies have

been shown to partially mediate the association between self-reported alcohol use and impulsive

behavior (Henderson, Goldman, Coovert, & Carnevalla, 1994; Webb, Baer, Francis, & Caid,

1993). In these studies, impulsive decision-makers had more positive outcome expectancies

about the effects of alcohol and reported significantly higher levels of alcohol use than non-

impulsive users.

Statement of Problem and Hypotheses

Past research with nicotine, alcohol, and cocaine, has shown a positive correlation

between impulsive behavior and substance use (Bates et al., 1994; Galizio et al., 1983; Segal et

al., 1980; Teichman et al., 1989; Zuckerman et al., 1972). The Gambling Task (Bechara et al.,

1994) has been suggested as a measure of impulsive decision-making behaviors and has been

correlated with presence of substance abuse (Bechara et al., 1994). Similarly, the delay

discounting task has been proposed as a behavioral measure of impulsive decision-making

(Rachlin et al., 1972). The purpose of this study was to examine the relationship between

patterns of MDMA use and impulsive decision-making, as measured by the Gambling Task, the

delay discounting task, and the impulsivity subscale of the Adult Self-Report for Ages 18-59

(ASR).

The following hypotheses were proposed for this study:

1) Based on past research, it was hypothesized that those who have used MDMA at least
   once would receive higher scores on the Gambling Task, the delay discounting task,
   and the ASR impulsivity subscale than those who have never used MDMA.

2) Those who have used MDMA at least once would obtain higher positive outcome expectancies and lower negative outcome expectancies for MDMA than those who have never used MDMA, as measured by the MDMA Beliefs Questionnaire.

3) A positive correlation would exist between positive MDMA outcome expectancies and scores on the Gambling Task, positive MDMA outcome expectancies and scores on the delay discounting task, and positive MDMA outcome expectancies and scores on the impulsivity subscale of the ASR. Negative MDMA outcome expectancies would be negatively correlated with scores on the Gambling Task, with scores on the delay discounting task, and with scores on the impulsivity subscale of the ASR.

4) Age of first MDMA use, for those who have used MDMA at least once, would be negatively correlated with scores on the Gambling Task, with scores on the delay discounting task, and with scores on the impulsivity subscale of the ASR.

5) A positive correlation would exist among scores on the ASR impulsivity subscale and the Gambling Task, the ASR impulsivity subscale and the delay discounting task, and the Gambling Task and the delay discounting task.

Method

Power Analysis

Previous research has indicated medium effect sizes in studies of impulsive decision-making and its effects on substance use. In order to control for Type I Error, alpha was set at 0.05. Power was set at 0.80 to control for Type II error. Using Cohen's (1988) estimate of a medium effect size (0.5), it was estimated that a sample of 68 individuals (34 individuals that had used MDMA at least once and 34 individuals that had never used MDMA) were needed in order to detect the expected differences between participants and achieve a power of 0.80.

Participants

Participants were recruited through the Louisiana State University Psychology Department research participant pool. They read and signed an informed consent form approved by the Institutional Review Board for Louisiana State University. Compensation received for participation was extra credit for undergraduate psychology classes.

Materials

Drug History and Demographics Interview. This interview was adapted from the Addiction Severity Index (McLellan, Kushner, & Metzger, 1992). It assesses demographics, age of first use, route of administration, and quantity of MDMA and other substances used by participants. Only substances used in a recreational or non-medically pertinent manner are recorded.

MDMA Beliefs Questionnaire (MDMA-BQ; Businelle, Patterson, et al., under review). The Beliefs about Drugs Questionnaires were developed to assess beliefs of the possible effects of five substances of abuse (MDMA, rohypnol, ketamine, GHB, methamphetamine). Each measure consists of questions with participant answers recorded on a ten point Likert scale

ranging from unlikely to likely. Only the MDMA scale, the MDMA-BQ, was used in the present study. The MDMA scale consists of 23 questions and 5 scales: Global Positive Effects, Safety, Health Risks, Psychological Consequences, and Dose/Mixing. In a previous study (Businelle, Patterson, et al., under review) users were significantly more likely than non-users to endorse positive beliefs on the Global Positive Effects and Safety scales. Non-users were more likely than users to endorse negative beliefs on the Health Risks, Psychological Consequences, and Dose/Mixing scales. Coefficient alpha reliabilities for the scales are: Global Positive Effects .95, Safety .59, Health Risks .65, Psychological Consequences .66, Dose/Mixing .38.

Marlowe-Crowne Social Desirability Scale (MCS; Crowne & Marlowe, 1960). The MCS is a forced choice questionnaire containing items describing culturally acceptable behaviors that are unlikely to occur. The MCS is a measure of a participant's tendency to respond to test items in a socially or culturally desirable way or in a way that they believe is expected by the experimental situation.

Drug Abuse Screening Test (DAST; Skinner, 1982). The DAST is a 28-item self-report questionnaire measuring general substance abuse history. It significantly discriminates substance abusers from nonabusers. The DAST has an internal consistency reliability estimate of .92 (Skinner, 1982).

Gambling Task (Bechara, Tranel, & Damasio, 2000). A computerized version of Bechara's Gambling Task was used as a potential measure of impulsive decision-making. During presentation, a screen reveals four decks of cards visually labeled A, B, C, and D. Each deck consists of 30 black cards and 30 red cards. The color of the cards does not affect whether the participant wins or loses money on a draw from that deck. The participant selects one card from a deck of their choice. After selection is made, the computer makes an audible sound and

inform the participant of the results of their choice. All choices are recorded into an electronic text form. Established procedure (Bechara et al., 2001) states that participants will choose 100 cards with a six second interval between draws. The card presentation is divided into five 20-card blocks. Participant scores comprise the number of cards chosen from decks A and B for each 20-card block and the number of cards chosen from decks C and D for each 20-card block.

To help measure decision-making and planning, the Gambling Task presents two "Bad" decks (A and B) that provide greater average payoffs with an overall lose of money and two "Good" decks (C and D) that provide lower average payoffs with an overall monetary gain. Decks A and B pay $100 on average while Decks C and D pay $50 on average. Decks A and B will merit a net loss of $250 for the first 10-card block, increasing by $150 for each 10 cards after that. At the sixth 10-card block, the net loss will remain steady at $1000. Decks C and D will show a net gain of $250 for the first 10 card choices and will increase by $50 for each 10 cards after that. At the sixth 10-card block, the net gain will remain steady at $375. Decks A and B differ only that deck A has an increasing frequency of punishment and a constant magnitude of punishment. Deck B has an increasing magnitude of punishment and a constant frequency of punishment. A similar pattern exists in decks C and D, with deck C having an increasing frequency of punishment and constant magnitude of punishment. Deck D has an increasing magnitude of punishment and constant frequency of punishment. See Appendix for the Gambling Task instructions.

Delay Discounting. A hand-administered card task, the delay discounting task, was used as another measure of impulsive decision-making. Two conditions were presented with hypothetical delayed rewards of $1000 and $10000. Participants were asked to select between two monetary amounts, one they could have now and one they could have later after a time

14

delay. Three index card stacks were presented: the available money now, the available money later, and the time delay. As each "Now" amount was chosen, the monetary amount was decreased. When the participant selected the "Later" amount, which remained stable at $1000 or $10000, the "Now" amount not chosen was recorded. After this point, the time delay was increased and the process was repeated.

The "Now" rewards available for the $1000 condition were $1000, $990, $980, $960, $940, $920, $900, $850, $800, $750, $700, $650, $600, $550, $500, $450, $400, $350, $300, $250, $200, $150, $100, $80, $60, $40, $20, $10, $5, and $1. The "Now" rewards available for the $10000 condition were ten times greater than the "Now" rewards. During each condition, eight time delays were used. As such, sixteen data points are recorded for each participant (eight for the $1000 condition, eight for the $10000 condition). Time delay intervals were 1 week, 1 month, 6 months, 1 year, 3 years, 5 years, 10 years, and 25 years.

Adult Self-Report for Ages 18-59 (ASR; Achenbach & Rescorla, 2003). The ASR is a normed problem behavior and clinical diagnosis self-report questionnaire used primarily to assess Attention-Deficit/Hyperactivity Disorder in adults aged 18 to 59. The computer derived impulsivity subscale derived will be used as a possible measure of impulsive decision-making.

Procedure

Participants signed up for testing sessions using the Louisiana State University web page. Participants met the experimenter at the Psychological Services Center in Johnston Hall. When they arrived at the meeting, the study components and criteria were explained and informed consent was obtained. Two groups were formed, one consisting of 34 individuals who had used MDMA at least once, and one consisting of 34 individuals who had never used MDMA. An interview consisting of demographics and drug history was used by trained experimenters to

15

assess substance use. As non-MDMA users were more prevalent, once 34 participants who had

never used MDMA completed the drug history and demographics interview, no more non-users

were accepted into the control group. After this point, any others registered were assessed for

MDMA use with the drug history and demographics interview. Additional non-users were

released after interview. The first 34 MDMA users formed the experimental group. The two

groups then completed the MDMA Beliefs Questionnaire, Marlowe-Crowne Social Desirability

Scale (MCS), Drug Abuse Screening Test (DAST), a computerized version of the Gambling

Task, Adult Self-Report for Ages 18-59, and the delay discounting task. To control for order

effects, the questionnaires and tasks were presented in a random order to each participant.

Afterwards, extra credit was given for participation in the study.

Results

<u>Participant Characteristics</u>

A total of 180 individuals registered for this experiment through LSU Internet accounts. Each participant completed the drug history and demographics interview. The first 34 participants who had ever used MDMA and the first 34 participants who had never used MDMA (34 MDMA users, 34 non-users) completed the full assessment battery, consisting of the MCS, DAST, MDMA-BQ, the Gambling Task, the delay discounting task, and the ASR. The first 34 qualifying participants with no MDMA use history formed the control group. Additional non-users were released after initial interview. Of those who completed the drug history and demographics interview, 18.8% reported using MDMA at least once during their lifetime. These participants formed the experimental group. The MDMA group had used MDMA a mean of 14.62 ($\underline{SD}$ = 24.47) times. The mean number of occasions where MDMA was used over the last 30 days was .29 ($\underline{SD}$ = .836). The mean age of first use of MDMA was 18.29 (SD = 2.03). The characteristics of participants are listed in Table 1.

A chi-square with ethnicity (Caucasian, African-American, Asian, Hispanic, and Other) and group (MDMA users vs. non-users) as the factors revealed that the groups did not differ in ethnicity, $\underline{X}^2$(4, $\underline{N}$ = 68) = .080, <u>ns</u>. A chi-square with sex (male vs. female) and group (MDMA users vs. non-users) as the factors revealed that the groups did not differ in sex, $\underline{X}^2$(1, $\underline{N}$ = 68) = .794, <u>ns</u>.

A chi-square with ethnicity (Caucasian, African-American, Asian, Hispanic, and Other) and group (MDMA users vs. non-users) as the factors revealed that the groups did not differ in ethnicity, $\underline{X}^2$(4, $\underline{N}$ = 68) = .080, <u>ns</u>. A chi-square with sex (male vs. female) and group (MDMA

17

Table 1

Participant Characteristics

	Overall	MDMA Users	Non-Users	p
	N=68	n=34	n=34	
Age (SD)	21.10 (2.98)	22.21 (3.73)	20.00 (1.28)	$p < .005$
Sex				
Male	30.9%	29.4%	32.4%	ns
Female	69.1%	70.6%	67.6%	ns
Ethnicity				
Caucasian	86.8%	94.1%	79.4%	ns
African-American	7.4%	2.9%	11.8%	ns
Asian	2.9%		5.9%	ns
Hispanic	1.5%	2.9%		ns
Other	1.5%		2.9%	ns
DAST (SD)	4.71 (3.63)	6.74 (3.66)	2.68 (2.20)	$p < .001$
MCS (SD)	14.10 (5.29)	13.59 (5.04)	14.62 (5.55)	ns

users vs. non-users) as the factors revealed that the groups did not differ in sex, $\underline{X}^2(1, \underline{N} = 68) =$ .794, ns.

One-way analyses of variance (ANOVAs) were conducted with group as the independent variable and the continuous baseline variables as the dependent variables. Groups did not differ in MCS scores, $\underline{F}(1,66) = .426$, ns. However, groups did differ significantly in DAST scores, $\underline{F}(1,66) = 30.701$, $p < .001$ and age, $\underline{F}(1,66) = 10.631$, $p < .005$. MDMA users received higher scores on the DAST and were older than controls.

A series of chi-squares were run with history of recreational drug use and group (MDMA users vs. non-users) as the factors. The MDMA group was found to be significantly more likely to have used alcohol until intoxication, $X^2(1, N = 68) = 3.981$, $p < .05$, heroin, $X^2(1, N = 68) = 4.250$, $p < .05$, opiates, $X^2(1, N = 68) = 29.386$, $p < .001$, barbiturates, $X^2(1, N = 68) = 4.250$, $p < .05$, sedatives, $X^2(1, N = 68) = 21.254$, $p < .001$, cocaine, $X^2(1, N = 68) = 24.480$, $p < .001$, amphetamines, $X^2(1, N = 68) = 19.059$, $p < .001$, cannabis, $X^2(1, N = 68) = 19.911$, $p < .001$, hallucinogens, $X^2(1, N = 68) = 19.911$, $p < .001$, inhalants, $X^2(1, N = 68) = 8.995$, $p < .005$, multiple substances in a day, $X^2(1, N = 68) = 17.752$, $p < .001$, and cigarettes, $X^2(1, N = 68) = 9.49$, $p < .005$. Recreational drug history characteristics are listed in Table 2.

Hypothesis 1:   Adult Self-Report for Ages 18-59

The ASR, a clinical measure of Attention-Deficit/Hyperactivity Disorder, contains an impulsivity subscale. Computer scoring was used to derive this subscale. It was predicted that MDMA users would receive elevated scores on the ASR impulsivity subscale, significantly greater than controls. A one-way analysis of variance (ANOVA) was conducted with group (MDMA users vs. non-users) as the independent variable and ASR impulsivity subscale scores as the dependent variable. MDMA users did not score significantly higher on the ASR impulsivity subscale, $F(1,67) = .077$, ns.

Delay Discounting Task. Median k-values, indicators of the strength of the hyperbolic delay discounting function, were derived with the formula $V=A/(1+kD)$, where V equals the amount in the "now" category that was not chosen, A equals the amount of the "later" category, and D equals the time delay in weeks. Two median k-values were recorded for each participant, one for the $1000 condition and one for the $10000 condition. Established procedure states that median k-values are used

Table 2: Recreational Drug Use History

	Overall	MDMA Users	Non-Users	p
	N=68	n=34	n=34	
Alcohol	97.1%	100%	94.1%	ns
Alcohol until intoxication	89.7%	97.1%	82.4%	$p < .05$
Heroin	5.9%	11.8%		$p < .05$
Opiates	41.2%	73.5%	8.8%	$p < .001$
Barbiturates	5.9%	11.8%		$p < .05$
Sedatives	48.5%	76.5%	20.6%	$p < .001$
Cocaine	26.5%	52.9%		$p < .001$
Amphetamines	50.0%	76.5%	23.5%	$p < .001$
Cannabis	69.1%	94.1%	44.1%	$p < .001$
Hallucinogens	30.9%	55.9%	5.9%	$p < .001$
Inhalants	20.6%	35.3%	5.9%	$p < .005$
Cigarettes	75.0%	91.2%	58.8%	$p < .001$
Multiple substances in one day	60.3%	85.3%	35.3%	$p < .001$

to retain the hyperbolic shape of the delay discounting task (Bickel & Marsch, 2001; Hinson et al., 2003; Petry, 2001).

It was predicted that MDMA users would receive higher scores than non-users on the both delay discounting task conditions. Two one-way analyses of variance (ANOVA) were conducted with group (MDMA users vs. non-users) as the independent variable and delay

discounting task condition ($1000 and $10000) as the dependent variables. MDMA users did not score significantly higher on the delay discounting task $1000 condition, $\underline{F}(1,67) = 1.997$, $\underline{ns}$, or the $10000 condition, $\underline{F}(1,67) = .966$, $\underline{ns}$.

Gambling Task. Procedure set by Bechara et al. (2001) derives Gambling Task scores by summing total number of "bad" cards (cards with greater overall loss) drawn from decks drawn from decks C and D in each 20-card block. That is, each participant received five Gambling Task scores, block 1 (cards 1 through 20), block 2 (cards 21 through 40), block 3 (cards 41 through 60), block 4 (cards 61 through 80), and block 5 (cards 81 through 100). This method is typical for deriving Gambling Task scores.

Monterosso et al. (2001) demonstrated that the last 50 trials on the Gambling Task are a more reliable and accurate measure of performance than the 5-block set. This strategy only takes into account participant scores after the reward and punishment strategies have been integrated. As such, it has been demonstrated to be a better measure of learning in the Gambling Task than using 5-block sets. Accordingly, the last 50 trials of the Gambling Task were included in analyses.

It was predicted that MDMA users would receive elevated scores on the Gambling Task, significantly greater than controls. To test this, a one-way analysis of covariance (ANCOVA) was conducted with group (MDMA users vs. non-users) as the independent variable and last 50 Gambling Task scores as the dependent variable. History of heroin, barbiturate, and inhalant use were entered as covariates as they correlated with the dependent variable. MDMA users did not score significantly higher on the Gambling Task, $\underline{F}(1,67) = 2.560$, $\underline{ns}$.

A repeated measures ANCOVA was conducted with group (MDMA users vs. non-users) as the between subjects factor, block (5 levels) as the within subjects factor, and number of cards

chosen from the "bad decks" as the dependent variable. Age, history of heroin, barbiturate, hallucinogen, and inhalant use were entered as covariates as they correlated with Gambling Task block scores. There was no block by group interaction, $F(4,67) = .900$, ns. There was a significant block by age interaction, $F(4,67) = 3.103$, $p < .05$. This indicates that younger participants performed significantly poorer than older participants on the Gambling Task. The main effect for block approached significance, $F(4,67) = 2.464$, $p < .06$. See Table 3 for block means.

Table 3. Block Means for the Number of "Bad Cards" Picked

	M
Block 1	11.99
Block 2	8.93
Block 3	8.47
Block 4	7.46
Block 5	8.15

Hypothesis 2

It was predicted that MDMA users would have higher positive outcome expectancies for MDMA use, as measured by the Global Positive Effects and Safety scales of the MDMA-BQ, than non-users. To test the Global Positive Effects scale, a one-way ANCOVA was conducted with group (MDMA users vs. non-users) as the independent variable and Global Positive Effects scale scores as the dependent variable. A similar ANCOVA was done with Safety as the dependent variable. Age was entered as a covariate on the Global Positive Effects analysis as it was significantly correlated with Global Positive Effects scores. MDMA users were more likely to endorse higher scores on the Global Positive Effects scale, $F(1,67) = 4.733$, $p<.01$, but they

were not more likely to endorse higher scores on the Safety scale, $\underline{F}(1,67) = .680$, $\underline{ns}$, than non-users.

In contrast, it was predicted that MDMA users would have lower negative outcome expectancies for MDMA use, as measured by the Health Risks, Psychological Consequences, and Dose/Mixing scales of the MDMA-BQ, than non-users. To test the Health Risks scale, a one-way analysis of covariance (ANCOVA) was conducted with group (MDMA users vs. non-users) as the independent variable and Health Risks scale scores as the dependent variable. Two similar ANCOVAs were conducted with Psychological Consequences and Dose/Mixing as the dependent variables. Histories of sedative and cocaine use were entered as covariates for the Health Risks ANCOVA while histories of opiate and hallucinogen use were entered as covariates for the Psychological Consequences ANCOVA as they significantly correlated with the dependent variables. MDMA users were not more likely to endorse lower scores on the Health Risks scale, $\underline{F}(1,67) = 1.78$, $\underline{ns}$. Similarly, MDMA users were not more likely to endorse higher scores on the Dose/Mixing scale, $\underline{F}(1,67) = .084$, $\underline{ns}$. MDMA users were significantly more likely to endorse lower scores on the Psychological Consequences scale, $\underline{F}(1,67) = 2.422$, $\underline{p}<.05$.

Hypothesis 3

It was predicted that positive MDMA outcome expectancies would be positively correlated with the Gambling Task, the delay discounting task, and the ASR impulsivity subscale. To test this, a bivariate correlation comparing ASR impulsivity subscale scores, median k-values for the two delay discounting conditions, and the last 50 items of the Gambling Task with the two scales of the MDMA-BQ associated with positive expectancies for MDMA, Global Positive Effects and Safety. See Table 4 for correlations.

Table 4. Correlations for Decision-Making Measures and Positive MDMA-BQ Scales

	Global Positive Effects	Safety
ASR	-.019, ns	.029, ns
Delay discounting $1000	.093, ns	-.183, ns
Delay discounting $10000	.123, ns	-.157, ns
Last 50 Gambling Task items	.113, ns	.040, ns

It was also predicted that a negative correlation would exist between negative MDMA outcome expectancies and Gambling Task scores, negative MDMA outcome expectancies and delay discounting task scores, and negative MDMA outcome expectancies and ASR impulsivity subscale scores. To test this, a similar bivariate correlation was conducted to compare Gambling Task, delay discounting task, and ASR impulsivity subscale scores and the three scales of the MDMA-BQ associated with negative expectancies for MDMA, Health Risks, Psychological Consequences, and Dose/Mixing. See Table 5 for correlations.

Hypothesis 4

Pearson product-moment correlations were use to determine whether age of first MDMA use and ASR impulsivity subscale scores, median k-values for the two delay discounting conditions, and the last 50 items of the Gambling Task were correlated. Age of first MDMA use did not significantly correlate with the last 50 items of the Gambling Task, r = .095, ns, with the median k-values for the $1000 delay discounting condition, r = -.229, ns, with the median k-values for the $10000 delay discounting condition, r = -.200, ns, or with the ASR impulsivity subscale scores, r = .155, ns.

Table 5. Correlations for Decision-Making Measures and Negative MDMA-BQ Scales

	Health Risks	Psychological Consequences	Dose/Mixing
ASR	.074, ns	.147, ns	.146, ns
Delay discounting $1000	.154, ns	.179, ns	-.101, ns
Delay discounting $10000	.156, ns	.067, ns	.057, ns
Last 50 Gambling Task items	-.146, ns	-.163, ns	-.038, ns

Hypothesis 5

It was predicted that a positive correlation would exist among the ASR impulsivity subscale and the Gambling Task, the ASR impulsivity subscale and the delay discounting task, and the Gambling Task and the delay discounting task. To test this, a bivariate correlation comparing ASR impulsivity subscale scores, median k-values for the two delay discounting conditions, and scores received on the last 50 items of the Gambling Task was conducted to derive Pearson product-moment correlations. The last 50 items of the Gambling Task were not correlated with median k-values for the $1000 delay discounting condition, $r = .107$, ns, the median k-values for the $10000 delay discounting condition, $r = .042$, ns, or ASR impulsivity subscale scores, $r = .186$, ns. Median k-values for the $1000 delay discounting condition were correlated positively with median k-values for the $10000 delay discounting condition, $r = .902$, $p<.001$. However, median k-values for the $1000 delay discounting condition were not correlated with ASR impulsivity subscale scores, $r = .05$, ns. Similarly, median k-values for the $10000 delay discounting condition were not correlated with ASR impulsivity subscale scores, $r = .099$, ns.

Discussion

This study was designed to examine differences in Gambling Task, delay discounting task, and ASR impulsivity subscale scores between individuals who have used MDMA and those who have not. Past research has established a relationship between impulsive behavior and various substance use histories (Ball et al., 1994; Bechara et al., 2001; Galizio et al., 1983; Petry et al., 1998; Segal et al., 1980; Zuckerman et al., 1972), but not MDMA. Also, the relationships among MDMA expectancies and impulsive behaviors have not been examined. To study these relationships, participants completed a measure of MDMA outcome expectancies, the ASR, the Gambling Task, and the delay discounting task. Examiners were trained in presentation of tasks and measures, and able to answer questions related to task instructions. Participants completed all items on tasks and measures; no data was missing. Pilot testing revealed no potential problems with measures or established procedures.

Scores on the ASR impulsivity subscale, the Gambling Task, and the delay discounting task were compared between those who had used MDMA at least once and those who had never used MDMA. Results show that there were no significant differences between MDMA users and non-users on any of the measures. Presence of MDMA use history did not affect performance on the Gambling Task, the delay discounting task, or the ASR. Results show that older participants tended to perform better on the Gambling Task. This effect may be a product of education, as better educated students might be expected to fare better on more difficult tasks. However, education level was not evaluated in this study. Similar to predictions, a block main effect approached significance, indicating an improvement in performance on the Gambling Task as learning strategies were developed.

As established by Businelle, Patterson, et al. (2003), scale scores on the MDMA-BQ were predicted to vary between MDMA users and non-users. Specifically, MDMA users were expected to obtain higher scores on the positive scales, Global Positive Effects and Safety, and lower scores on the negative scales, Health Risks, Psychological Consequences, and Dose/Mixing. MDMA users were found to be more likely to obtain higher scores on the Global Positive Effects scale than non-users, but there was no difference in the Safety scale. Also, MDMA users were more likely to obtain lower scores on the Psychological Consequences scale than non-users, but there was no difference in the Health Risks or Dose/Mixing scales. The lack of differences here may be a product of substance use in the control group, a limitation of the study discussed below.

Positive scale scores of the MDMA-BQ were also predicted to positively correlate with the Gambling Task, with the delay discounting task, and with the ASR impulsivity subscale. No significant correlations were found between the positive scales of the MDMA-BQ, Global Positive Effects and Safety, and the Gambling Task, the delay discounting task, or the ASR impulsivity subscale. Similarly, negative scale scores of the MDMA-BQ were predicted to negatively correlate with the Gambling Task, with the delay discounting task, and with the ASR impulsivity subscale. No significant correlations were found between the negative scales, Health Risks, Psychological Consequences, and Dose/Mixing, and the Gambling Task, the delay discounting task, or the ASR impulsivity subscale. While studies relate substance use expectancies to substance initiation and continued use (Brown et al. 1980; Fromme et al., 1993; Shafer & Brown, 1991) and impulsive behaviors to substance use (Ball et al., 1994; Bechara et al., 2001; Galizio et al., 1983; Petry et al., 1998; Segal et al., 1980; Zuckerman et al., 1972), substance use expectancies did not correlate directly with Gambling Task, delay discounting

task, or ASR impulsivity subscale scores. This may be an effect of restricted range of the population. Many studies (e.g., Petry, 2001) have compared substance abusers in treatment settings and the general population. MDMA users that have advanced to college level studies may be less representative of the average MDMA using population, and more similar to controls.

Correlations were examined to test the relationship between age of first MDMA use and the Gambling Task, age of first MDMA use and the delay discounting task, and age of first MDMA use and the ASR impulsivity subscale. No relationship was found between the age of first MDMA use and scores on the Gambling Task, the delay discounting task, or the impulsivity subscale of the ASR. No studies have looked at the stability of the Gambling Task or delay discounting task scores over time. As such, Gambling Task, delayed discounting task, and ASR impulsivity subscale scores at age of first MDMA use may not be similar current scores. Future studies should examine change in scores over time.

The possibility that different constructs are being measured by the Gambling Task, the delay discounting task, and the ASR impulsivity subscale exists. A positive correlation was predicted among scores on the Gambling Task and delay discounting task, the Gambling Task and the ASR impulsivity subscale, and the delay discounting task and the ASR impulsivity subscale. No significant correlations were found among the different measures. Only the two delay discounting conditions positively correlated among the measures. This may indicate a variation in construct between measures. The ASR impulsivity subscale is a clinical measure of impulsive behavior related to Attention-Deficit/Hyperactivity Disorder. This scale may not be adequate to measure decision-making in substance use. The Gambling Task and the delay discounting task vary as well. The Gambling Task presents participants with losses for bad choices, while the delay discounting task offers no consequences for decisions. These

differences may account for the variation in scores. Monterosso et al. (2001) found differences between Gambling Task and delay discounting scores as well. The authors found that Gambling Task scores correlated better with general intelligence measures than with the delay discounting task and other impulsivity questionnaires. Therefore, the Gambling Task may be affected by general intelligence in addition to impulsive behavior. Also, Monterosso et al. (2001) found that Gambling Task and delay discounting task scores did not correlate with various self-report measures of impulsive decision-making.

A limitation of this study is the presence of substance use among participants in the non-user control group. This study did not examine whether substance use (other than MDMA) among the control group varied from the general population. As general substance use has been correlated with Gambling Task and delay discounting task scores (Bechara et al, 2001; Petry et al, 1998), extensive drug use may have minimized differences between the control and experimental groups. Future studies should consider drug naïve or low substance use control groups. In this study, there was no drug naïve group to compare the control group data with to examine differences in substances used. Also, the experimental MDMA group required that participants have used MDMA once in their lifetime. It was not required that participants be multiple time users or consistent MDMA abusers. This difference may be important in detecting variability in scores on the Gambling Task, the delay discounting task, and the ASR impulsivity subscale among those who use MDMA and those who do not.

References

Achenbach, T. M., & Rescorla, L. A. (2003). Manual for the ASEBA Adult Forms & Profiles. Burlington, VT: University of Vermont, Research Center for Children, Youth, and Families.

Ball, S. A., Carroll, K. M., & Rounsaville, B. J. (1994). Sensation seeking, substance abuse, and psychopathology in treatment-seeking and community cocaine abusers. Journal of Consulting and Clinical Psychology, 62. 1053-1057.

Bardo, M. T., Donohew, R. L., & Harrington, N. G. (1996). Psychobiology of novelty seeking and drug seeking behavior. Behavioural Brain Research, 77, 23-43.

Bardo, M. T. & Mueller, C. W. (1991). Sensation seeking and drug abuse prevention from a biological perspective. In. Donohew, L., Sypher, H.E., and Bukoski, W.J. (Eds.), Persuasive communication and drug abuse prevention (pp. 195-207). Hillsdale, NJ: Lawrence Erlbaum.

Barratt, E. S. (1985). Impulsiveness subtraits: Arousal and information processing. In Spense, J. T. & Itard, C. E. (Eds.), Motivation, Emotion, and Personality (pp. 137-146). Amsterdam: Elsevier.

Bates, M. E., White, H. R., & Labouvie, E. (1994). Changes in sensation seeking needs and drug use. In. Venturelli, P.J. (Ed.), Drug use in America: Social, cultural and political perspectives (pp. 67-75). Sudbury, MA: Jones & Bartlett.

Bauman, K. E., Fisher, L. A., Bryan, E. S., & Chenoweth, R. L. (1985). Relationship between subjective expected utility and behavior: A longitudinal study of adolescent drinking behavior. Journal of Studies on Alcohol, 46, 32-38.

Bechara, A. Damasio, A. R., Damasio, H., & Anderson, S. W. (1994). Insensitivity to future consequences following damage to human prefrontal cortex. Cognition, 50, 7-15.

Bechara, A., Dolan, S., Denburg, N., Hindes, A., Anderson, S. W., & Nathan, P. E. (2001). Decision-making deficits, linked to a dysfunctional ventromedial prefrontal cortex, revealed in alcohol and stimulant abusers. Neuropsychologia, 39, 376-389.

Bechara, A., Tranel, D., & Damasio, H. (2000). Characterization of the decision-making deficit of patients with ventromedial prefrontal cortex lesions. Brain, 123, 2189-2202.

Bedford, R, Schwartz, R. H., & Dawling, S. (1992). Accidental ingestion of 'ecstasy' (3, 4-methylenediomethamphetamine). Archives of Disease in Childhood, 67, 1114-1115.

Benthin, A., Slovic, P., & Severson, H. (1993). A psychometric study of adolescent risk perception. Journal of Adolescence, 16, 153-168.

Benjamin, J., Li, L., Patterson, C., Greenberg, B. D., Murphy, D. L., & Hamer, D. H. (1996). Population and familial association between the D4 dopamine receptor gene and measures of novelty seeking. Nature Genetics, 12, 81-84.

Bickel, W. K., & Marsch, L. A. (2001). Toward a behavioral economic understanding of drug dependence: delay discounting processes. Addiction, 96, 73.86.

Brown, S. A., Goldman, M. A., Inn, A., & Anderson, L. R. (1980). Expectations of reinforcement from alcohol: Their domain and relation to drinking patterns. Journal of Consulting and Clinical Psychology, 48, 419-426.

Businelle, M. S., Kendzor, D. E., Patterson, S. M., Rash, C. J., & Copeland, A. L. (under review). Heavy smokers choose large, immediate rewards with large penalties on a simulated task of gambling. Manuscript submitted for publication.

Businelle, M. S., Patterson, S. M., Loupe, V. A., & Copeland, A. L. (under review). The development and validation of the Beliefs about Drugs Questionnaires. Manuscript submitted for publication.

Christiansen, B. A., Roehling, P. V., Smith, G. T., & Goldman, M. S. (1989). Using alcohol expectancies to predict adolescent drinking behavior after one year. Journal of Consulting and Clinical Psychology, 57, 93-99.

Cloninger, C. R., Adolfsson, R., & Svrakic, N. M. (1996). Mapping genes for human personality. Nature Genetics, 12, 3-4.

Cohen, J. (1988). Statistical Power Analysis for the Behavioral Sciences (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum.

Collins, L. M., Sussman, S., Rauch, J. M., Dent, C. W., Johnson, A., Hansen, W. B., & Flay, B. R. (1987). Psychosocial predictors of young adolescent cigarette smoking: A sixteen month, three-wave longitudinal study. Journal of Applied Social Psychology, 17, 554-573.

Crowne, D. P. & Marlowe, D. (1960). A new scale of social desirability independent of psychopathology. Journal of Consulting and Clinical Psychology, 24, 349-354.

Curran, G. M., White, H. R., Hansell, S. (2000). Personality, environment, and problem drug use. Journal of Drug Issues, 30, 375-406.

Donohew, L., Helm, D. M., Lawrence, P., & Shatzer, M. J. (1990). Sensation seeking, marijuana use, and responses to prevention messages: Implications for public health campaigns. In.

Watson, R.R. (Ed.), <u>Drug and Alcohol Abuse Prevention</u> (pp. 73-93). Totowa, NJ: Humana Press.

Earleywine, M., & Finn, P. R. (1991). Sensation seeking explains the relation between behavioral disinhibition and alcohol consumption. <u>Addictive Behaviors, 16,</u> 123-128.

Ebstein, R. P., Novick, O., Umansky, R., Priel, B., Osher, Y., Blaine, D., Bennett, E. R., Nemanov, L., Katz, M., & Belmaker, R. H. (1996). Dopamine D4 receptor (D4DR) exon III polymorphism associated with the human personality trait of novelty seeking. <u>Nature Genetics, 12</u>, 78-80.

Eiser, J. R. (1983). Smoking, addiction and decision-making. <u>International Review of Applied Psychology, 32</u>, 11-28.

Eysenck, S. B., Pearson, P. R., Easting, G., & Allsopp, J. F. (1985). Age norms for impulsiveness, venturesomeness, and empathy in adults. <u>Personality and Individual Differences, 6,</u> 613-619.

Fabricius, W. V., Nagoshi, C. T., & MacKinnon, D. P. (1993). Beliefs about the harmfulness of drug use in adults who use different drugs. <u>Psychology of Addictive Behaviors, 7,</u> 52-65.

Forsyth, G., & Hundleby, J. D. (1987). Personality and situation as determinants of desire to drink in young adults. <u>International Journal of Addictions, 22</u>, 653-669.

Fromme, K., Stroot, E., & Kaplan, D. (1993). The comprehensive effects of alcohol questionnaire: Development and psychometric evaluation of a new expectancy questionnaire. <u>Psychological Assessment, 5</u>, 19-26.

Galizio, M., Rosenthal, D., & Stein, F. A. (1983). Sensation seeking, reinforcement, and student drug use. <u>Addictive Behaviors</u>, 8, 243-252.

Galizio, M., & Stein, F. A. (1983). Sensation seeking and drug choice. <u>International Journal of Addictions, 18,</u> 1039-1048.

Gerbing, D. W., Ahadi, S. A., & Patton, J. H. (1987). Toward a conceptualization of impulsivity: Components across the behavioral and self-report domains. <u>Multivariate Behavioral Research, 22,</u> 357-379.

Gross, S. R., Barrett, S. P., Shestowsky, J. S., & Pihl, R. O. (2002). Ecstasy and drug consumption patterns: A Canadian rave population study. Canadian Journal of Psychiatry, 47, 546-551.

Harpur, T. J. (1994). Assessment of psychopathy as a function of age. <u>Journal of Abnormal Psychology, 103</u>, 604-609.

Henderson, M. J., Goldman, M. S., Coovert, M. D., & Carnevalla, N. (1994). Covariance structure models of expectancy. <u>Journal of Studies on Alcohol, 55,</u> 315-326.

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

Hirschman, R. S., Leventhal, H., & Glynn, K. (1984). The development of smoking behaviour: Conceptualization and supportive cross-sectional survey data. <u>Journal of Applied Social Psychology</u>, 14, 184-204.

Kalichman, S., Heckman, T., & Kelly, J. (1996). Sensation seeking as an explanation for the association between substance use and HIV-related risky sexual behavior. <u>Archives of Sexual Behavior, 25,</u> 141-154.

Katz, E. C., Fromme, K., & D'Amico, E. J. (2000). Effects of outcome expectancies and personality on young adults' illicit drug use, heavy drinking, and risky sexual behavior. <u>Cognitive Therapy & Research</u>, 24, 1-22.

Klitzman, R. L., Pope Jr., H. G., Hudson, J. I. (2000). MDMA ("ecstasy") abuse and high-risk sexual behaviors among 169 gay and bisexual men. <u>American Journal of Psychiatry, 157</u>, 1162-1164.

Kosten, T. A., Ball, S. A., & Rounsaville, B. J. (1994). A sibling study of sensation seeking and opiate addiction. <u>Journal of Nervous and Mental Disease, 182,</u> 284-289.

Lejuez, C. W., Read, J. P., Kahler, C. W., Richards, J. B., Ramsey, S. E., Stuart, G. L., Strong, D. R., & Brown, R. A. (2002). Evaluation of a behavioral measure of risk taking: The Balloon Analogue Risk Task (BART). <u>Journal of Experimental Psychology: Applied, 8,</u> 75-84.

Luthar, S. S., Anton, S. F., Merikangas, K. R., & Rounsaville, B. J. (1992). Vulnerability to drug abuse among opioid addicts' siblings: individual, familial, and peer influences. <u>Comprehensive Psychiatry, 33,</u> 190-196.

McCann, U., Slate, S. O., & Ricaurte, G. A. (1996). Adverse reactions with 3-4-methylendioxymethamphetamine (MDMA; "ecstasy'). <u>Drug Safety, 15,</u> 107-115.

McLellan, A., Kushner, H., Metzger, D. (1992). The fifth edition of the Addiction Severity Index. <u>Journal of Substance Abuse Treatment, 9</u>, 199-213.

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

Morgan, M. J. (1998). Recreational use of Ecstasy (MDMA) is associated with elevated impulsivity. Neuropsychopharmacology, 19, 252-264.

Morgan, M. J. (2000). Ecstasy (MDMA): A review of its possible persistent psychological effects. Psychopharmacology, 152, 230-248.

National Institute on Drug Abuse (2001). Ecstasy: What we know and don't know about MDMA. Retrieved December 20, 2003, from http://www.drugabuse.gov/Meetings/MDMA/MDMAExSummary.html

Newcomb, M. D., & McGee, L. (1989). Adolescent alcohol use and other delinquent behaviors: A one-year longitudinal analysis controlling for sensation seeking. Criminal Justice and Behavior, 16, 345-369.

Parrott, A. C., Sisk, E., & Turner, J. J. (2000). Psychobiological problems in heavy "Ecstasy" (MDMA) polydrug users. Drug and Alcohol Dependence, 60, 105-110.

Petry, N. M. (2001). Delay discounting of money and alcohol in actively using alcoholics, currently abstinent alcoholics, and controls. Psychopharmacology, 154, 243-250.

Petry, N. M., Bickel, W., & Arnett, M. (1998). Shortened time horizons and insensitivity to future consequences in heroin addicts. Addiction, 93, 729-738.

Rachlin, H., & Green, L. (1972). Commitment, choice, and self-control. Journal of Experimental Analysis of Behavior, 17, 15-22.

Reneman, L., Booij, J., Schmand, B., Brink, W., Gunning, B. (2000). Memory disturbances in "Ecstasy" users are correlated with an altered serotonin neurotransmission. Psychopharmacology, 148, 322-324.

Schafer, J., & Brown, S. A. (1992). Marijuana and cocaine effect expectancies and drug use patterns. Journal of Consulting and Clinical Psychology, 59, 558-565.

Scourfield, J., Stevens, D. E., & Merikangas, K. R. (1996). Substance abuse, comorbidity, and sensation seeking: Gender differences. Comprehensive Psychiatry, 37, 384-392.

Segal, B., Huba, G. J., & Singer, J. L. (1980). Drugs Daydreaming, and Personality: A Study of College Youth. Hillsdale, NJ: Lawrence Erlbaum.

Semple, D. M., Ebmeier, K. P., Glabus, M. F., O'Carroll, R. E., Johnstone, E. C. (1999). Reduced in vivo binding to the serotonin transporter in the cerebral cortex of MDMA ('ecstasy') users. British Journal of Psychiatry, 175, 63-69.

Skinner, H. A. (1982). The drug abuse screening test. Addictive Behaviors, 7, 363-371.

Spotts, J. V., & Shontz, F. C. (1984). Correlates of sensation seeking by heavy, chronic drug users. Perceptual and Motor Skills, 58, 427-435.

Sutker, P. B., Archer, R. P., & Allain, A. N. (1978). Drug abuse patterns, personality characteristics, and relationships with sex, race, and sensation seeking. Journal of Consulting and Clinical Psychology, 46, 97-100.

Tasker, T., Raw, M., & McNeil, A. (1999). Drug Realities: A Summary of the Results of the 1996 National Drugs Campaign Survey. London: Health Education Authority.

Teichman, M., Barnea, Z., & Ravav, G. (1989). Personality and substance use among adolescents: A longitudinal study. British Journal of Addiction, 84, 181-190.

Verheyden, S. L., Hadfield, J., Calin, T., Curran, H. V. (2002). Sub-acute effects of MDMA (3,4-methylenedioxymethamphetamine, "ecstasy") on mood: evidence of gender differences. Psychopharmacology, 161, 23-31.

Webb, J. A., Baer, P. E., Francis, D. J., & Caid, C. D. (1993). Relationship among social and intrapersonal risk, alcohol expectancies, and alcohol usage among early adolescents. Addictive Behaviors, 18, 127-134.

Zuckerman, M. (1969). Theoretical formulations. In J.P. Zubek (Ed.), Sensory deprivation: Fifteen years of research (pp. 407-432). New York, NY: Appleton Century Crofts.

Zuckerman, M. (1979). Sensations seeking: Beyond the optimal level of arousal. Hillsdale, NJ: Lawrence Erlbaum.

Zuckerman, M. (1984). Sensation seeking: A comparative approach to a human trait. Behavioral and Brain Sciences, 7, 413-471.

Zuckerman, M., Eysenck, S., & Eysenck, H. J. (1978). Sensation seeking in England and America: Cross-cultural, age, and sex comparisons. Journal of Consulting and Clinical Psychology, 46, 139-149.

Zuckerman, M., Bone, R. N., Neary, R., Mangelsdorff, D., & Brustman, B. (1972). What is the sensation seeker? Personality trait and experience correlates of the sensation seeking scales. Journal of Consulting and Clinical Psychology, 39, 308-321.

Zuckerman, M., Kolin, E. A., Price, L., & Zoob, I. (1964). Development of a sensation-seeking scale. Journal of Consulting and Clinical Psychology, 28, 477-482.

Appendix

Instructions for the Computer Gambling Task

1. In front of you on the screen, there are 4 decks of cards A', B' C' and D'.

2. I want you to select one card at a time, by clicking on the card, from any deck you choose.

3. Each time you select a card, the computer will tell you that you won some money. I don't know how much money you will win. You will find out as we go along. Every time you win, the green bar gets bigger.

4. Every so often, however, when you click on a card, the computer tells you that you won some money, but then it says that you lost some money too. I don't know when you will lose, or how much you will lose. You will find out as we go along. Every time you lose, the green bar gets smaller.

5. You are absolutely free to switch from one deck to another at any time, and as often as you wish.

6. The goal of the game is to win as much money as possible and if you can't win, avoid losing money as much as possible.

7. You won't know when the game will end. You must keep on playing until the computer stops.

8. I am going to give you this $2000 credit, the green bar, to start the game. The red bar here is a reminder of how much money you borrowed to play the game, and how much money you have to pay back before we see how much you won or lost.

9. It is important to know that just like in a real card game; the computer does not change the order of the cards after the game starts. You may not be able to figure out exactly when you will lose money, but the game is fair. The computer does not make you lose at random, or make you lose money based on the last card you picked. Also, each deck contains an equal number of cards of each color, so the color of the cards does not tell you which decks are better in this game. So you must not try to figure out what the computer is doing. All I can say is that some decks are worse than the 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.

Vita

Scott Michael Patterson was born in Baton Rouge, Louisiana. Scott attended Louisiana State University and received a Bachelor of Arts 2002. He is currently enrolled in the clinical psychology doctoral program at Louisiana State University, working under Dr. Amy L. Copeland. His research and clinical area of interest are illicit substance use and cognitive belief systems.