



Published in final edited form as:

Addict Behav. 2011 ; 36(1-2): 125–128. doi:10.1016/j.addbeh.2010.08.014.

A Money Management-Based Substance Use Treatment Increases Valuation of Future Rewards

Anne C. Black, Ph.D.^{a,1} and Marc I. Rosen, M.D.^{a,b}

^a Yale University, School of Medicine; 950 Campbell Avenue; West Haven, CT 06516

^b VA Connecticut Healthcare System; 950 Campbell Avenue, 116-A; West Haven, CT 06516

Abstract

Objective—A positive association between delay discounting and substance use has been documented; substance users tend to discount future rewards more than non-users. However, studies detailing the responsiveness of delay discounting to interventions are lacking, and few have examined how any behavioral intervention affects delay discounting and whether these effects moderate changes in substance abuse. This study assesses the effectiveness of a money management intervention, Advisor-Teller Money Manager (ATM), in reducing delay discounting over time and the relationship of these effects to changes in cocaine use.

Method—Ninety psychiatric patients with histories of cocaine and/or alcohol use were randomly assigned to 36-weeks of ATM treatment or to a minimal-attention control condition. Delay discounting and cocaine use were measured throughout the intervention with a 52-week follow up measure of cocaine use. Analyses were conducted of (a) the effect of ATM on slopes of delay discounting and cocaine abstinence and (b) the relationship between change in delay discounting and change in cocaine abstinence.

Results—The ATM intervention was associated with significantly less delay discounting and less cocaine use over time relative to controls. Increases in delay discounting were associated with decreased abstinence from cocaine.

Conclusions—ATM treatment decreased delay discounting rates and these effects extended to cocaine use. Concrete conceptualizations of future events, as occur in financial planning, with higher perceived probability may account for higher valuation of future rewards in counseled patients.

Keywords

Delay Discounting; Substance Use; Money Management; Psychiatric; HLM

1. Introduction

Drug dependence has been conceptualized as a manifestation of delay discounting, the propensity to de-value future rewards and prefer smaller, more immediate rewards. Substance-dependent individuals select the immediate and temporary benefits of drug use over, and often

¹Corresponding author. Anne C. Black, Yale University School of Medicine; VA Connecticut Healthcare Center, Bldg 1, 9-160; West Haven, CT, 06516; anne.black@yale.edu; Phone: (203) 932-5711 ext. 2575.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

at the expense of, delayed but more sustainable rewards such as social relationships, employment, and health.

Studies have demonstrated that substance-using individuals have a greater tendency to discount delayed monetary rewards than controls with less or no substances use (e.g., Bickel, Odum, & Madden, 1999; Coffey, Gudleski, Saladin, & Brady, 2003; Field, Christiansen, Cole, & Goudie, 2007; Kirby & Petry, 2004; Petry, 2001). Empirical studies also have determined that substance users are disproportionately likely to discount future, hypothetical *non-monetary* rewards including drugs of abuse (e.g., Bickel et al., 1999; Coffey et al., 2003; Field et al., 2007; Petry, 2001), health, and freedom (Petry, 2003) in favor of immediately-available, but less valuable alternatives.

The direction of association between delay discounting and substance use is not yet well understood; delay discounting may affect the likelihood of substance use, the reverse may be true, or a third variable may explain their association (deWit, 2009; Perry & Carroll, 2008). Importantly, short-term abstinence from cocaine has been shown to have no effect on discounting (Kirby & Petry, 2004).

Few studies have assessed the stability of monetary delay discounting within individuals over time. One-week retesting in healthy participants showed good score reliability (Baker, Johnson, & Bickel, 2003; Simpson & Vuchinich, 2000), moderate reliability was demonstrated after six weeks (Beck & Triplett, 2009) and weak correlations were noted across quarters (Kirby et al., 2002). None of the reliability studies reviewed assessed stability of delay discounting in individuals with severe mental illness.

A small number of studies have assessed whether delay discounting can be changed by intervention, and only one involved substance users (Christensen, Landes, & Bickel, 2009). Participants who responded to a multi-modal substance use treatment reduced their delay discounting more than non-responders. Although in many substance abuse treatments, patients are asked to consider future rewards that may be gained by resisting the immediate temptations of substance use, *no study has described an intervention that significantly impacts delay discounting.*

In a randomized clinical trial, ATM, a money management-based substance use intervention, was effective in reducing cocaine use in patients with a history of cocaine and/or alcohol abuse (Rosen, Rounsaville, Ablondi, Black, & Rosenheck, 2010) In the current analysis, repeated assessments of delay discounting and cocaine use from the same clinical trial were modeled to address the following: (1) the effect of ATM on delay discounting over time (2) the effect of ATM on cocaine use over time (3) the relationship between change in delay discounting and change in cocaine use and (4) the psychometric properties of the delay discounting measure in a dually-diagnosed sample.

2. Method

2.1. Participants

Participants were 90 adult patients with histories of cocaine and/or alcohol use receiving outpatient psychiatric treatment at a state-operated mental health clinic. Half the participants were female, and 49% were African American. Forty-eight percent of participants reported using cocaine in the 90 days prior to treatment, and 24% of participants' pre-treatment toxicology screens were positive for cocaine. The majority of participants were supported by Social Security Administration disability benefits.

2.2. Study Conditions

After completing baseline assessments, patients were randomly assigned to ATM or the control condition.

2.2.1 Advisor-Teller Money Manager (ATM) Intervention—ATM, a multi-component treatment package, addresses substance abuse in the context of discussions of other money management concerns. Patients were encouraged to make monthly budgets reflecting long-term goals, broken down into shorter-term spending plans. Individualized instruction in planning and monitoring budget adherence was provided. Weekly urine toxicology tests and breathalyzers were collected and patients reviewed the circumstances around their drug use. Participants were given the option of depositing their funds into an account accessible only to the ATM money manager, and/or having checkbooks and ATM cards stored by the money manager.

2.2.2 Control Condition—Patients in the control condition did not receive individualized feedback about their spending or substance use, but were given a workbook to make monthly budgets, and were encouraged to meet with the counselor weekly to review their progress in completing budgets.

All participants attended bi-weekly data collection sessions with a research assistant, completing a battery of assessments related to substance use, psychiatric symptoms, and money management, among other topics. Urine toxicology and breathalyzer tests also were conducted (Rosen et al., 2010).

2.3 Materials

2.3.1. Measurement of Delay Discounting—To assess delay discounting over time, the Monetary-Choice Questionnaire (Kirby, Petry, & Bickel, 1999) was administered at 0, 8, 20, and 32 weeks after randomization. This instrument comprises 27 items presenting the option of a smaller, immediate monetary reward or a larger, delayed reward. Each item in the questionnaire is characterized by a value, k , representing the amount of discounting of the later reward that renders it equal to the smaller reward. A single k estimate (“discounting-rate parameter”, Kirby et al., 1999), the geometric mean of all item-level k values, represents the overall rate of discounting. Discounting-rate parameters can range from 0 (selection of the delayed reward option for all items, or no discounting) to .25 (selection of the immediate reward option for all items, or always discounting).

To encourage thoughtful responding to items, all participants were given a 1 in 6 chance to receive the reward chosen on one of the items, with random selection of the rewarded item (Kirby and Petry, 2004).

2.3.2 Toxicology Screening—Abstinence from cocaine use was determined by bi-weekly toxicology screens for cocaine metabolite. Screening results were coded 1 or 0 to indicate positive or negative results, respectively.

2.4 Data Analysis

2.4.1 Reliability of Monetary Choice Questionnaire Scores—To determine the reliability of scores, the internal consistency of dichotomous item responses on the Monetary Choice Questionnaire at each time point was assessed by KR-20. Discounting score consistency was assessed as the proportion of the 27 items accurately represented by the overall k value.

Test-retest reliability of overall k values was estimated by the intraclass correlation coefficient (ICC), a measure of stability for multiple repeated measures (Vangeneugden, Laenen, Geys, Renard, & Molenberghs, 2004).

2.4.2 Hierarchical Linear Models—We used hierarchical linear and generalized linear modeling to estimate individual growth trajectories of delay discounting and abstinence, respectively. The natural log of the discounting rate parameter ($n\log k$) was used to provide a more normal distribution of scores. To estimate the unconditional effect of time on delay discounting, a model containing only week of assessment was specified (Time Model). In the second model we assessed the influence of established covariates by adding age, years of education, and monthly income to the Time model (Covariate Model). Finally, to determine the effect of ATM treatment on delay discounting, group assignment was added to the Time model as a predictor of the intercept and time slope coefficient (ATM Model).

Three cocaine abstinence models were specified: (1) A time-only model to estimate the average trajectory of abstinence (Time Model), (2) an ATM model assessing the effect of group assignment on the intercept and time slope coefficient (ATM Model), and (3) the K-slope model in which the additional effect of k slope on the slope of abstinence was assessed by including k slope as predictor of the time slope coefficient, along with the group assignment indicator (K-slope Model).

3. Results

3.1 Monetary Choice Questionnaire

3.1.1. Reliability—Scores on the Monetary Choice Questionnaire had good reliability. KR-20 estimates ranged from .94 to .96 across testing occasions. Interitem tetrachoric correlations averaged $r = .623$. The consistency of respondents' discounting rates across items ranged in proportion from .90 to .93. The ICC estimate was .56, indicating moderately correlated scores across lags of 8 and 12 weeks.

3.1.2. Distribution of Discounting Rate Parameters—Discounting-rate parameters ranged from .00016 to .25 for all test occasions. The majority of k -values represented people who discounted very little but in approximately 22% of questionnaires, participants *always* chose the immediate reward.

3.1.3. Linear Change in Delay Discounting Over Time—As participants did not differ significantly on initial values of discounting by age, income, or education, these covariates were not retained in the models.

At week 0, participants averaged a discount rate of $k = .015$ and rates of discounting increased over time ($p = .065$), with the effect of time varying significantly across participants ($p = .003$). Group assignment was unrelated to baseline rates of discounting ($p = .978$) but moderated the effect of time; ATM participants discounted less over time than control participants ($p = .052$) (Figure 1).

3.2. Drug Abstinence over Time

On average, abstinence remained stable over time but the effect of time varied significantly across participants ($p < .001$). Treatment assignment was positively related to the time slope coefficient ($p = .046$); ATM participants had significantly more positive abstinence slopes than controls. Controlling for the effect of group assignment, the slope of k values had a negative effect on abstinence ($p = .091$) (Figure 2). Participants who increased their delay discounting

over time correspondingly decreased their abstinence from cocaine. Both treatment and k slope accounted uniquely for the between-person variability in abstinence slopes.

4. Discussion

This study provides evidence that a money management-based intervention for cocaine users effectively modified relative valuation of future monetary rewards, and that this change was accompanied by decisions about cocaine use. Individuals who received specific instruction in financial planning and budgeting reported a greater preference for future rewards than individuals who did not receive this instruction.

Bickel and Marsch (2001) described “loss of control” as the tendency for individuals to reverse preference for rewards from delayed to immediate options as the availability of the sooner reward becomes more proximal in time. This phenomenon may be interpreted by temporal construal theory (Trope & Liberman, 2000, 2003), positing that distant future events are conceptualized less concretely than more proximal ones and are judged less likely to occur. Respondents to a delay discounting questionnaire reported factoring the perceived uncertainty of future rewards into their discount decision-making, even though no difference in reward probability was presented (Patak & Reynolds, 2007). The mere delay in reward availability caused future rewards to be assessed as less probable, and therefore less valuable.

However, regular review of future rewards (i.e., budget planning) may increase their salience, perhaps by changing how clearly they are conceptualized. Bilgin and Brenner (2008) showed that the judgment of probability of future events depended on how concretely the future events were described. Future events described in more detail were evaluated as more likely to occur.

Results of the current study may reflect the effect of the systematic and repeated review of future rewards in concrete terms on participants’ conceptualization of those rewards, their judgment of future reward probability, and ultimately their valuation of future rewards. The clinical truism that substance users often have poorly conceived future goals and uncertainty about the future has been demonstrated by studies noting a negative relationship between future orientation and substance use (Peters et al., 2005; Robbins & Bryan, 2004). Having clearly identified plans for the future has been associated with lower rates of recent and lifetime substance use.

A secondary goal of this study was to determine the quality of measurement of the delay discounting measure for this dually-diagnosed sample. Delay discounting scores were highly consistent within testing occasion and moderately reliable across 8- and 12-week lags.

5. Limitations

Because ATM is a bundled intervention that targets both cocaine use and impulsive spending, we cannot be certain that ATM independently impacted these two outcomes, or that greater abstinence from cocaine in the ATM group did not cause the relatively low delay discounting among ATM participants.

6. Summary

The study provides evidence for the efficacy of a behavioral intervention to increase valuation of future rewards and decrease rates of cocaine use among psychiatric patients with co-morbid cocaine use. It suggests the utility of discounting scores from the Monetary Choice Questionnaire for this population, and demonstrates statistically the applicability of a model whereby changes in delay discounting moderate the slope of cocaine abstinence.

Acknowledgments

The authors acknowledge Aryeh Herman, Kristin Serowik, and Elina Stefanovics for their individual and valuable contributions to this paper.

References

- Baker F, Johnson MW, Bickel WK. Delay discounting in current and never-before cigarette smokers: Similarities and differences across commodity, sign, and magnitude. *J Abnorm Psychol* 2003;112:382–392. [PubMed: 12943017]
- Beck RC, Triplett MF. Test-retest reliability of a group-administered paper-pencil measure of delay discounting. *Exp Clin Psychopharmacol* 2009;17:345–355. [PubMed: 19803634]
- Bickel WK, Odum AL, Madden GJ. Impulsivity and cigarette smoking: Delay discounting in current, never, and ex-smokers. *Psychopharmacology* 1999;146:447–454. [PubMed: 10550495]
- Bickel WK, Marsch LA. Toward a behavioral economic understanding of drug dependence: Delay discounting processes. *Addiction* 2001;96:73–86. [PubMed: 11177521]
- Bilgin B, Brenner L. Temporal distance moderates description dependence of subjective probability. *J Exp Soc Psychol* 2008;44:890–895.
- Christensen, DR.; Landes, RD.; Bickel, WK. The effects of multimodal treatment on delay discounting in opioid-dependent individuals. Poster presented at 71st annual meeting of College on Problems of Drug Dependence; Reno/Sparks, NV. 2009 Jun.
- Coffey SF, Gudleski GD, Saladin ME, Brady KT. Impulsivity and rapid discounting of delayed hypothetical rewards in cocaine-dependent individuals. *Exp Clin Psychopharmacol* 2003;11:18–25. [PubMed: 12622340]
- de Wit H. Impulsivity as a determinant and consequence of drug use: A review of underlying processes. *Addict Biol* 2009;14:22–31. [PubMed: 18855805]
- Field M, Christiansen P, Cole J, Goudie A. Delay discounting and the alcohol Stroop in heavy drinking adolescents. *Addiction* 2007;102:579–586. [PubMed: 17309540]
- Kirby KN, Godoy R, Reyes-Garcia V, Byron E, Apaza L, Leonard W, ... Wilkie D. Correlates of delay-discount rates: Evidence from Tsimane' Amerindians of the Bolivian rain forest. *J Econ Psychol* 2002;23:291–316.
- Kirby KN, Petry NM. Heroin and cocaine abusers have higher discount rates for delayed rewards than alcoholics or non-drug-using controls. *Addiction* 2004;99:461–471. [PubMed: 15049746]
- Kirby KN, Petry NM, Bickel WK. Heroin addicts have higher discount rates for delayed rewards than non-drug-using controls. *J Exp Psychol Gen* 1999;128:78–87. [PubMed: 10100392]
- Patak M, Reynolds B. Question-based assessments of delay discounting: Do respondents spontaneously incorporate uncertainty into their valuations for delayed rewards? *Addict Behav* 2007;32:351–357. [PubMed: 16647214]
- Perry JL, Carroll ME. The role of impulsive behavior in drug abuse. *Psychopharmacology* 2008;200:1–26. [PubMed: 18600315]
- Peters RJ, Tortolero SR, Johnson RJ, Addy RC, Markham CM, Escobar-Chavez L, ... Yacoubian GS. The relationship between future orientation and street substance use among Texas alternative school students. *Am J Addict* 2005;14:478–485. [PubMed: 16257885]
- Petry NM. Delay discounting of money and alcohol in actively using alcoholics, currently abstinent alcoholics, and controls. *Psychopharmacology* 2001;154:243–250. [PubMed: 11351931]
- Petry NM. Discounting of money, health, and freedom in substance abusers and controls. *Drug Alcohol Depend* 2003;71:133–141. [PubMed: 12927651]
- Robbins RN, Bryan A. Relationships between future orientation, sensation seeking, and risk behavior among adjudicated adolescents. *J Adolesc Res* 2004;19:428–445. [PubMed: 16429605]
- Rosen MI, Rounsaville BJ, Ablondi K, Black AC, Rosenheck RA. Advisor-Teller Money Manager (ATM) Therapy for Substance Abuse. *Psychiatr Serv* 2010;61:707–713. [PubMed: 20592006]
- Simpson CA, Vuchinich RE. Reliability of a measure of temporal discounting. *Psychol Rec* 2000;50:3–16.

- Trope Y, Liberman M. Temporal construal and time-dependent changes in preference. *J Pers Soc Psychol* 2000;79:876–889. [PubMed: 11138758]
- Trope Y, Liberman M. Temporal construal. *Psychol Rev* 2003;110:403–421. [PubMed: 12885109]
- Vangeneugden T, Laenen A, Geys H, Renard D, Molenberghs G. Applying linear mixed models to estimate reliability in clinical trial data with repeated measurements. *Controlled Clinical Trials* 2004;25:13–30. [PubMed: 14980746]

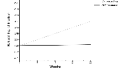


Figure 1.
Group X Time Interaction for Natural Log of k Values

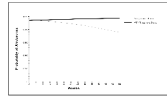


Figure 2.
Group X Time Interaction for Probability of Abstinence.