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Delay Discounting Predicts Adolescent Substance Abuse Treatment Outcome

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Abstract

The purpose of the current study was to identify predictors of delay discounting among adolescents receiving treatment for marijuana abuse or dependence, and to test delay discounting as a predictor of treatment outcome. Participants for this study were 165 adolescents (88% male) between the ages of 12 and 18 (*M* =15.8; *SD* = 1.3) who enrolled in a clinical trial comparing three behavioral treatments for adolescent marijuana abuse or dependence. Participants completed a delay discounting task at treatment onset for $100 and $1,000 of hypothetical money and marijuana. Overall, smaller magnitude rewards were discounted more than larger magnitude rewards. Delay discounting rates were concurrently related to demographic variables (SES, race). Delay discounting of $1,000 of money predicted during treatment abstinence outcomes among adolescent marijuana abusers, over and above the effects of type of treatment received. Teens who show higher levels of discounting of the future may be an important subgroup to identify at treatment onset. Youth with a greater tendency to discount the future may require different intervention strategies that address their impulsivity (e.g., targeting executive function or inhibitory control) and/or different schedules of reinforcement to address their degree of preference for immediate rewards.

Keywords

delay discounting; adolescent substance abuse; marijuana

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The number of adolescents who were treated for primary marijuana abuse or dependence increased by over 300% from 1992 to 2007, and among adolescents admitted for substance abuse, the majority report marijuana as the primary drug of abuse (SAMHSA, 2009). An emerging literature indicates that adolescents in treatment for substance abuse have better outcomes than those not in treatment, and suggests that multiple types of individual and family based behavioral treatments hold promise (Waldron & Turner, 2008).

While research evaluating the efficacy of treatment programs for adolescent substance use has increased in recent years, fewer studies have explored predictors of differential response to these treatment programs. Decision-making is one factor relevant to all treatment programs, as drug use can be characterized as a choice between short-term consumption and long-term abstinence. Perhaps due to the under development of brain systems that are related to optimal decision making, adolescents may be particularly vulnerable to deficits in making decisions related to substance use (Casey, Jones, & Hare, 2008).

In delay discounting tasks, participants are asked to choose between a series of immediate and delayed rewards. Choices that favor immediate rewards over future rewards and choices that favor future rewards over immediate rewards can be used to calculate participants' delay discounting rate (Mazur, 1987). Delay discounting rates have shown discriminative validity across a wide range of substance use disorders, with individuals who use drugs being more likely to make choices that favor immediate rewards than non-users (e.g., Bickel, Odum, & Madden, 1999; Coffey, Gudleski, Saladin, & Brady, 2003; Kirby, Petry, & Bickel, 1999).

Few studies, however, have examined delay discounting in adults who use marijuana (Johnson et al., 2010) and none have examined delay discounting among adolescents who use marijuana. Prior studies have found that delay discounting rates are associated with level of tobacco use among adolescents. For example, adolescents with steeper rates of delay discounting exhibit higher rates of cigarette smoking than adolescents with shallow rates of delay discounting (Audrain-McGovern et al., 2004). Rates of delay discounting were higher for daily smokers compared to never-smokers (Reynolds, Patak, & Shroff, 2007). Furthermore, rates of delay discounting were not significantly different between adolescents who smoke infrequently and those who have never smoked (Reynolds, Karraker, Horn, & Richards, 2003).

Recent work has found that delay discounting rates are also predictive of treatment outcomes for tobacco cessation. Delay discounting rates predicted successful abstinence among pregnant women regardless of treatment condition (Yoon et al., 2007) and among highly dependent lower SES cigarette smokers (Sheffer, et al., in press). Among adolescent smokers, steeper rates of delay discounting were related to less success in a smoking cessation treatment program (Krishnan-Sarin et al., 2007). Thus, rates of delay discounting may predict treatment outcomes independent of assigned treatment condition.

Current Study

Many substance abusing adolescents fail to respond to even the best evidence based treatment (Dennis et al., 2004). Understanding differential response to treatment is critical. The primary purpose of the current study was to examine pre-treatment rates of delay discounting as predictors of abstinence from marijuana use during treatment, over and above the effects of treatment condition. Adolescents were enrolled in a behavioral treatment intervention for marijuana abuse or dependence that compared three 14-week behavioral treatment programs. This study also examined magnitude ($100 vs. $1,000) and commodity (money vs. marijuana) effects on delay discounting and concurrent relations between

measures of decision-making (i.e., delay discounting) and demographic and substance use variables at treatment onset.

Methods

Participants and Sample Selection

Participants for this study were 165 adolescents between the ages of 12 and 18 who enrolled in a randomized clinical trial comparing three behavioral treatments for adolescent marijuana abuse or dependence. As shown in Table 1, the adolescents were 88% male. Sixty-one percent of the adolescents identified as African-American or multiracial. Inclusion criteria included adolescents between the ages of 12 and 18 years who (1) had at least one parent or guardian who agreed to participate, (2) reported using marijuana during the previous 30 days or provided a marijuana-positive urine test on the day of their intake assessment, and (3) met DSM-IV (American Psychiatric Association, 1994) criteria for marijuana abuse or dependence.

Exclusion criteria included (1) current DSM-IV dependence on alcohol or other illicit drugs, (2) active psychosis, (3) severe medical or psychiatric illness that would limit participation, or (4) pregnancy. A total of 361 teens were assessed. One hundred and fifty participants were excluded; twenty did not complete the intake assessment; and 18 actively (reported that they were not interested) or passively (did not show up for the consent appointment) refused treatment. Of the 173 who enrolled, 165 (152 randomized and 13 pilot) completed one or more delay discounting tasks and are included in these analyses. The study was conducted in compliance with the Institutional Review Board of the University of Arkansas for Medical Sciences.

Procedures

All assessments and treatment were completed at our University-based outpatient clinic. Following an explanation of the study and written parent/guardian consent and assent from the adolescent, the adolescent was administered measures to assess frequency and psychosocial impact of their substance use and completed the delay discounting tasks. At their first treatment appointment, families signed a second consent and were assigned to a treatment condition.

Treatment Conditions

Participants received one of three 14 week treatments: (1) Cognitive Behavior Therapy (CBT) only (Sampl & Kadden, 2001; Webb, Scudder, Kaminer, & Kadden, 2002), (2) CBT + CM (clinic-based incentives and parent-based substance use monitoring contract), or (3) CBT + CM + a Family Management Curriculum (Dishion & Kavanagh, 2003). The CM schedule used escalating rewards for abstinence, with a reset procedure for substance use, with total potential earnings over 14 weeks of $590 (Stanger, Budney, Kamon, & Thostensen, 2009). These interventions are described in detail in Kamon et al. (2005) and Stanger et al. (2009).

Measures

Substance Use—At intake, diagnostic assessment of DSM-IV (American Psychiatric Association, 1994) marijuana abuse or dependence was performed by a trained bachelor's or master's level assistant using the Vermont Structured Diagnostic Interview (VSDI; Budney, Moore, Rocha, & Higgins, 2006; Hudziak, Copeland, Stanger, & Wadsworth, 2004; Stanger, et al., 2009). The VSDI is a brief diagnostic interview modeled after the KSADS (Kaufman et al., 1997), and has demonstrated good psychometric properties (Hudziak, et al., 2004).

At intake and twice weekly throughout treatment, substance use was also monitored using the Time-Line Follow-Back (Sobell & Sobell, 1992) with the adolescent. At intake, the Time-Line Follow-Back assessed number of days of marijuana use in the 30 days prior to intake.

Adolescents completed the Fagerstrom Test for Nicotine Dependence (FTND) (Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991). The FTND is a 6-item questionnaire, and responses were scored as 0, 1, 2, or 3, depending on the severity. Scores were summed and used as a continuous measure. Among the youth who reported any smoking (57% of the sample), total scores ranged from 0–7 (M = 2.0, SD = 1.9). In addition, non smoking youth were given a score of 0 on this measure. Analyses involving FTND excluded 4 participants with missing FTND scores.

Delay Discounting—Delay discounting tasks were administered at the intake assessment using a computerized choice program, whereby adolescents were asked to make choice decisions between smaller, immediate rewards and larger, delayed rewards (Baker, Johnson, & Bickel, 2003; Johnson & Bickel, 2002). Participants completed this task four times in a single session, twice for hypothetical monetary rewards as the reinforcer with magnitudes of $100 and $1,000; and twice for amounts of marijuana subjectively equivalent to $100 and $1,000 as the reinforcer. Youth always began with the money tasks, but magnitude was counterbalanced across participants. To determine the amount of marijuana that was equivalent to $100 and $1,000, adolescents were provided with the following instructions:

> I want you to imagine that you have a choice between receiving some money and receiving drugs. For the following statements, please fill in the amount of drugs that would make the two choices equally attractive to you. Please also circle your preferred grams or ounces.
>
> Receiving $100 right now would be just as attractive as receiving _____ grams/ounces of marijuana.
>
> Receiving $1,000 right now would be just as attractive as receiving ____ grams/ounces of marijuana.

Following this procedure, adolescents were presented with two choice buttons: a smaller immediate reward button on the left of the computer screen, which read “$ (money amount or marijuana amount equivalent to money) right now;” and a larger delayed reward button to the right of the computer screen, which read “$ (money amount or marijuana amount equivalent to money) in (delay).” The larger delayed reward was either $100 or $1,000 (or the amount of marijuana equivalent to these dollar amounts for delay discounting of marijuana). The smaller immediate reward was determined using an adjusting amount algorithm (Du, Green, & Myerson, 2002). Thus, the smaller immediate reward amount varied on each trial. The delay periods were 1 day, 1 week, 1 month, and 6 months. Delays were always presented in increasing order. At each delay, 6 trials were administered. The starting value of the smaller, sooner (adjusting) reward was always 50% of the larger, delayed reward. On subsequent trials, the smaller sooner reward adjusted up or down by 50% depending on the subject's choice (smaller, sooner choices resulted in decreases; larger, delayed choices resulted in increases).

Adolescents used the mouse to select the preferred outcome in each trial. Immediately following the mouse click, the adjusting outcome in the left command box changed according to the programmed algorithm. After a choice was made, both command boxes were highlighted for 1 second, during which mouse clicks had no programmed consequences.

Delay discounting was estimated using Mazur's (1987) equation: $V_d = V / (1 + kD)$, where V_d represents the discounted value at D delay in days, V is the undiscounted amount, and k is the estimated discounting parameter. High values of k indicate greater discounting (i.e., impulsive decisions) and low values of k indicate less discounting (i.e., reflective decisions). V_d was derived by calculating individuals' indifference point, which is the value of the immediate reward that is considered as attractive as the alternative delayed reward. Indifference points were calculated for each magnitude and commodity at each delay and fit to the hyperbolic model of delay discounting rate (k). Distributions of k tend to be highly positively skewed. Logarithm transformations of k substantially reduce the skewness. Hence we transformed all k estimates with the natural logarithm, ln$k$, and used these transformed values in subsequent analyses. All available discounting data were used in analyses.

Assessment of Marijuana Use—Observed urine collection and toxicology monitoring occurred twice a week, once at the weekly therapy session and once at a second scheduled time between sessions for 14 weeks. Specimens were screened with an on-site MGC 240 analyzer that uses an Enzyme Multiplied Immunoassay Technique to test for cannabinoids (Thermo Fisher Scientific). The cannabinoid cut-off level for a positive test was 50ng/ml. Adolescents with invalid urine drug screens were asked to provide a replacement sample within 4–24 hours. Urine specimens were considered invalid if the creatinine level was less than 30ng/ml. Failure to submit a valid, scheduled specimen was treated as a positive result.

Abstinence Outcomes—Adolescents with a negative urine drug test, and no parent- or self-report of marijuana use were considered to be abstinent during the interval since the last scheduled visit. Several abstinence variables were computed. The number of negative urine drug screens during treatment was summed and used as an outcome indicator. The longest period of continuous abstinence achieved during treatment in weeks was also calculated. This measure was selected because the CM schedule is designed to reinforce continuous abstinence (escalating rewards are provided for abstinence and rewards are reset to starting level if substance use detected). The longest period of continuous abstinence was also dichotomized to indicate whether ≥4 weeks or ≥8 weeks of continuous abstinence was achieved.

Data Analyses

Differences in delay discounting associated with the commodity (marijuana vs. money) and magnitude ($100 vs. $1,000) and their interaction were tested in a repeated measures two-factor analysis of variance (ANOVA). A general covariance structure was used for the within-individual correlations (the repeated-measures part of the model). The error degrees of freedom were estimated with the Kenward-Roger method. The model was fitted in the MIXED procedure of SAS® V9.2. From prior studies which included hypothetical future gains of $100 and $1,000 (Jones, Landes, Yi, & Bickel, 2009; Sheffer, et al., in press), power of .80 was estimated to detect a true mean d of 0.41 with .05 level paired t-tests. This detectable d of .41 is consistent with ds reported for tobacco smokers by Johnson et al. (2007).

Concurrent relations between demographic variables, days used marijuana at intake, and delay discounting were estimated using bivariate correlations and t tests. Selected variables were those commonly controlled in substance abuse treatment outcome research including age, gender, SES, race, and marijuana use frequency (Dennis, et al., 2004; Stanger, et al., 2009; Waldron & Turner, 2008). We also tested tobacco smoking as a correlate of discounting and treatment outcome because of its strong relations with delay discounting in prior research (Audrain-McGovern, et al., 2004; Bickel, et al., 1999). To examine delay discounting as a predictor of treatment outcome, bivariate correlations were computed

between each delay discounting score and marijuana use outcomes. For delay discounting measures and marijuana use outcomes showing significant bivariate relations, multivariate linear regression analyses for continuous outcomes and multivariate logistic regressions for dichotomous outcomes (achieving ≥4 and ≥8 weeks of continuous abstinence) were performed. The first set of models included treatment condition as a covariate and delay discounting rate. The second set of models included treatment condition, plus covariates showing significant bivariate relations with either discounting or treatment outcome. In terms of power for the least squares regressions, using an SD of 2.88 (Jones et al., 2009) and an *n* of 162, power of .80 was estimated to detect a slope that was about 7.5% the size of the SD of a normally-distributed outcome when using a .05 level two-sided test. However, calculations such as these must be interpreted with caution since small changes in assumed values can impact power substantially. Power calculations for the logistic regressions were not conducted because there were no available reliable a priori estimates of the percentage of adolescents who would achieve abstinence given the mean level of discounting.

Results

Descriptive Statistics

Adolescents reported using marijuana on an average of 10.7 days within the 30 days prior to intake and the mean of scores on the FTND was 1.11 with nonsmokers assigned a score of 0. The mean amount of marijuana reported as equivalent to $100 was 1.94 (SD=.29) ounces, and the amount equivalent to $1,000 was 19.21 (SD=13.4) ounces. Finally, the number of urine samples provided by adolescents ranged from 1–28 (M = 20.16, SD = 9.36).

Commodity and Magnitude Effects on Delay Discounting

In the repeated measures ANOVA examining the effects of commodity and magnitude, the smaller magnitudes were discounted more than larger magnitudes ($100 estimated mean ln($k$)= −3.81 vs. $1,000 estimated mean ln($k$)= −4.27; t(163)=3.58, p=.0005). The main effect of commodity was not significant (marijuana estimated mean ln(k)= −3.96 vs. money estimated mean ln(k)= −4.11; t(166)= 0.59, p=.56). There was no evidence that the magnitude effect differed between the two commodities (magnitude-commodity interaction: F(1, 162)=1.63, p=.20). The estimated delay discounting curves for each commodity are shown in Figure 1.

Relations Between Delay Discounting and Demographic and Substance Use Variables

Table 2 shows the Pearson correlations (for continuous variables) and the t-tests (for dichotomous variables) for the delay discounting scores and demographic and substance use variables assessed at treatment onset. Age and gender were not significantly related to any of the discounting measures. In addition, FTND scores and the number of days marijuana was used in the 30 days prior to intake were also not associated with any of the discounting measures. Socioeconomic status and race were related to all discounting measures except discounting of $100 of money, with low SES and non Caucasian youth having significantly higher discounting scores.

Effect of Delay Discounting at Treatment Intake on Abstinence During Treatment

In separate multivariate models for each substance use outcome and each delay discounting predictor, controlling for treatment condition, delay discounting of $1,000 money significantly predicted both the number of negative urine drug tests and the longest period of continuous abstinence (see Table 3). The number of samples submitted was not related to any intake discounting measure, and results are not shown in Table 3. These results suggest that as discounting $1,000 of money increased, marijuana abstinence decreased. Discounting

of $100 money also predicted the number of negative urine drug tests, over and above the effect of treatment condition. Delay discounting of $100 and $1,000 of marijuana, on the other hand, did not significantly predict the number of negative urine drug screens or the longest period of continuous abstinence, above and beyond the significant effects of treatment condition. All these effects were in the expected direction, but were not significant. When additional covariates related to either discounting or treatment outcome (i.e., gender, race, socioeconomic status, and days of recent marijuana use) were included (model 2), delay discounting of $100 and $1,000 money no longer accounted for unique variance in continuous abstinence or number of negative urine drug tests (see Table 3).

Delay discounting of $1,000 money also significantly predicted achieving both ≥4 and ≥8 weeks of abstinence, after controlling for treatment condition. These results suggest that for every unit increase in the ln*k* of $1,000 money (i.e., greater delay discounting), the odds of being abstinent for ≥4 weeks decreased by 0.87 and for ≥8 weeks decreased by 0.82. In addition, discounting of $1,000 of marijuana predicted achieving >4 weeks of abstinence. Delay discounting of $100 money and marijuana did not predict either brief (i.e., 4 weeks) or longer (i.e., 8 weeks) periods of abstinence, above the significant effects of treatment condition. When additional covariates (i.e., gender, race, socioeconomic status, and days of recent marijuana use) were included, discounting did not predict unique variance in dichotomized treatment outcome.

Discussion

Overall, the results showed that among adolescents in treatment for marijuana use, smaller magnitude rewards were discounted more than larger magnitude rewards. Delay discounting rates were concurrently related to socioeconomic status and race, but not to age, gender, tobacco use, or marijuana use days. Discounting of the larger ($1,000) amount of money was most strongly related to treatment outcome. Delay discounting of $1,000 of money predicted during treatment abstinence outcomes among adolescent marijuana abusers, over and above the effects of type of treatment received. Less consistent effects of discounting on outcome were also observed for $100 of money and $1,000 of marijuana. Overall, the results should be interpreted with caution, as multiple comparisons were made in these initial, exploratory analyses, and effect sizes are generally small.

Delay discounting among adolescents treated for marijuana abuse and dependence showed significant magnitude effects, with $100 being discounted more than $1,000. These effects are similar to magnitude effects found in delay discounting research with adults (Bickel, et al., 1999; Heil, Johnson, Higgins, & Bickel, 2006; Madden, Petry, Badger, & Bickel, 1997; Petry, 2001). However, there was no significant commodity effect, with the mean discount rate of marijuana being within 71% to 191% (95% confidence interval) of that for money. This is in contrast to adult research that has frequently reported that substance abusers discount substances of abuse more than money (e.g., Johnson, et al., 2010). It is not clear why these adolescent marijuana users did not discount their substance of abuse significantly more than money. This could reflect a developmental effect, or be related to teens having less experience purchasing marijuana or to their earlier stage of use. It could also reflect an order effect, since the marijuana discounting tasks were always completed after the money tasks. We are not aware of other studies in an adolescent (high school) population that tested commodity differences in discounting.

Delay discounting was concurrently related to demographic variables. SES and race were related to discounting of $100 and $1,000 of money and $1,000 of marijuana. These results are similar to those observed by others showing relations between SES and discounting (Evans & Rosenbaum, 2008) and between race and discounting (Romer, Duckworth,

Sznitman, & Park, 2010). FTND scores were not related to discounting and these relations between tobacco use and discounting of marijuana among marijuana users contrast with results of Johnson et al. (2010). This difference may be because although many of these youth were smokers, the mean FTND score in this adolescent sample was low, indicating low levels of tobacco use even among the smokers. Also of note, the age range was broad (12–18), and this study was not designed to test age differences in discounting. Thus, there may be important age differences in discounting not revealed by these data or analyses.

After controlling the effect of treatment condition, discounting of $1,000 of money predicted all measures of abstinence. Discounting of $100 of money and $1,000 of marijuana also predict some treatment outcomes, with similar magnitude effects across all outcomes. Discounting of $100 of marijuana is the weakest predictor of treatment outcomes. These results are similar to those obtained by Krishnan-Sarin et al. (2007) showing that performance on an experiential discounting task predicted end of treatment abstinence among treated adolescent tobacco smokers. Of note, the Krishnan-Sarin et al. (2007) analyses did not control demographic variables, and all youth were assigned to the same contingency management intervention. In addition, Audrain-McGovern et al. (2009) found that a questionnaire-based delay discounting measure predicted the development of early onset tobacco use in a longitudinal study of (initially) nonsmoking youth.

Some adult studies have failed to find significant relations between measures of discounting and treatment outcome (e.g., Passetti, Clark, Mehta, Joyce, & King, 2008). However, others have reported results consistent with these findings. For example, Mueller et al. (2009) reported that discounting of $10 and $1,000 of money and $1,000 (but not $100) worth of cigarettes predicted time to relapse to smoking in a laboratory study. In addition, Yoon et al. (2007) reported that discounting of $1,000 of money predicted smoking status at 24 weeks postpartum among women who discontinued smoking during pregnancy, after controlling age, educational level, and history of depressive symptoms. Two other studies reported a similar relation between delay discounting and relapse to tobacco smoking (MacKillop & Kahler, 2009; Sheffer, et al., in press).

Our results showed that discounting of larger amounts of money showed the strongest relations with treatment outcomes, and smaller amounts of marijuana showed the weakest. The implications of the variation in concurrent and predictive results across the discounting magnitudes and commodities are not clear. Many investigators have used different methods to assess discounting, not always generating a separate discounting score for different magnitudes or commodities. Results are also difficult to compare with published studies, as most studies have tested only discounting of money (and often a single magnitude) as a predictor of outcomes. It might be expected that discounting of the drug of choice would show the strongest relation to outcomes, which was not the case for these marijuana using youth. It is not clear if our results are unique to adolescent marijuana users or will generalize across age or other primary drugs of abuse. Further, our assessment of discounting, consistent with existing discounting research, assesses discounting of a single commodity over time. It may be of greater clinical interest to assess cross-commodity or relative discounting, allowing for the comparison of choices between immediate drug rewards and delayed health or money related rewards.

The significant relations found between discounting, race, and SES, and the failure of discounting to predict treatment outcome once these demographic variables (and frequency of marijuana use at intake) were controlled suggest complex relations between decision making and other variables that influence response to treatment. The results suggest that decision making shares variance in common with these variables, and that this shared

variance is related to treatment outcomes. Of note, among this set of variables related to treatment outcome, decision making is unique in that it is potentially modifiable.

It is also important to note that the one study comparing discounting across adult marijuana treatment seeking users and non users (Johnson, et al., 2010) suggested few differences between current, former, and non marijuana users with respect to discounting, a different pattern from what has been observed with other substance abusing populations. Our study was not designed to compare adolescent marijuana users to non users, thus it is unknown whether or not these adolescent marijuana users discounted money more than non users. However, whether or not marijuana using adolescents show greater discounting than non users, our results do indicate that the individual variability in discounting had predictive utility with respect to treatment outcome.

Conclusion

Delay discounting may be an important variable to assess as a treatment tailoring variable. There is evidence from laboratory studies suggesting that individuals with higher discounting scores may benefit from more frequent opportunities for reinforcement (Yi et al., 2008). It may also be important to identify biological determinants of reward preferences, including genetic factors (Anokhin, Golosheykin, Grant, & Heath, 2011) and neural processes (Bickel et al., 2007; Christakou, Brammer, & Rubia, 2011). Youth with a greater tendency to discount the future may require different intervention strategies that address their impulsivity possibly targeting executive function or inhibitory control via either cognitive training (e.g., Bickel, Yi, Landes, Hill, & Baxter, 2010), different schedules of reinforcement to address their preference for immediate rewards, or, potentially, medication or brain stimulation (Fecteau et al., 2007).

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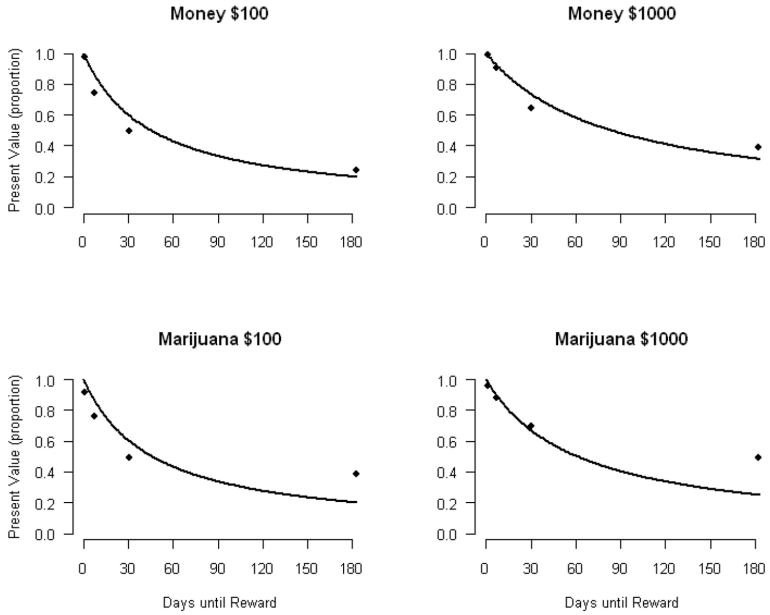

Figure 1.
Mean indifference points and estimated hyperbolic delay discounting curves with present value plotted as a function of delay interval. Mean indifference points are indicated by solid diamonds for the assessed delays of 1, 7, 30, and 180 days.

Table 1

Demographics, substance use, and delay discounting

N=165	**M (SD) or % (N)**
Age	15.77 (1.34)
Male	87.9% (145)
Race	
Caucasian	38% (62)
African American	59% (98)
Multiracial	2% (4)
Native American	<1% (1)
SES (9 step scale)[a]	5.10 (2.41)
Marital status of primary parent	
Currently Married	42% (70)
Single/Separated/Divorced/Widowed	58% (95)
Days of MJ use[b]	10.71 (9.57)
Fagerstrom[c]	1.11 (1.73)
no. of Urine Specimens Provided	20.16 (9.36)

	ln*k*	***k***
$100 Money	−3.86 (2.50)[d]	0.87(8.21)
$1,000 Money	−4.45 (2.36)[d]	0.15(0.90)
$100 Marijuana	−3.78 (3.58)[e]	7.38(26.86)
$1,000 Marijuana	−4.08 (3.91)[e]	9.00(28.57)

Note. There were no significant differences between conditions on any variable.

M=Mean; SD=Standard Deviation; SES = socioeconomic status.

[a] A score of 5 on the Hollingshead (1975) scale represents the following types of occupations: bank teller, dental assistant, and billing clerk.

[b] Days of MJ use is the number of days used marijuana in the 30 days prior to intake.

[c] N=159 for Fagerstrom with four teens not completing the measure.

[d] N = 164 for $100 and $1,000 money with one teen failing to complete the tasks;

[e] N = 163 for $100 and $1,000 marijuana with two teens failing to complete the tasks.

Table 2

Relations between demographic and pretreatment substance use variables and delay discounting

	$100 Money	$1,000 Money	$100 Marijuana	$1,000 Marijuana
	r	*r*	*r*	*r*
Age	.08	−.08	−.09	−.04
SES	−.16*	−.26**	−.14	−.23**
Fagerstrom	.09	.10	−.04	.10
Days used MJ	−.02	.05	−.09	−.05

	M (SD)	*t*	M (SD)	*t*	M (SD)	*t*	M (SD)	*t*
Gender								
Male	−3.78(2.51)	−1.14	−4.32(2.35)	−1.87	−3.94(3.43)	1.57	−4.22(3.80)	1.45
Female	−4.46(2.35)		−5.36(2.25)		−2.61(4.44)		−2.87(4.53)	
Race								
Caucasian	−4.37(2.04)	2.03*	−5.38(1.86)	4.09**	−4.34(3.06)	1.55	−5.09(3.31)	2.66**
Non Caucasian	−3.56(2.70)		−3.89(2.46)		−3.44(3.83)		−3.43(3.31)	

Note. SES= socioeconomic status;

Days used MJ is the number of days used marijuana in the 30 days prior to intake;

* $p < 0.05$.

** $p < 0.01$.

Table 3

Effect of Delay Discounting on Abstinence Outcomes

	Abstinence									
	Number of Negative Urine Drug Screens			Continuous Abstinence			4 Weeks Abstinence		8 Weeks Abstinence	
Predictor	***B***	***s.e.***	**β**	***B***	***s.e.***	**β**	**OR**	**95% CI**	**OR**	**95% CI**
Model 1:										
$100 money	−0.69	0.35	−0.15*	−0.26	0.16	−0.12	0.90	[0.79, 1.02]	0.88	[0.77, 1.01]
$1,000 money	−0.95	0.36	−0.20*	−0.43	0.17	−0.20*	0.87	[0.75, 0.99]*	0.82	[0.71, 0.95]*
$100 marijuana	−0.08	0.25	−0.03	−0.00	0.12	−0.00	0.97	[0.89, 1.06]	0.96	[0.87, 1.06]
$1,000 marijuana	−0.35	0.23	−0.12	−0.13	0.11	−0.09	0.91	[0.84, 0.99]*	0.93	[0.85, 1.02]
Model 2:										
$100 money	−0.39	0.31	−0.09							
$1,000 money	−0.24	0.34	−0.05	−0.13	0.16	−0.06	0.97	[0.83, 1.14]	0.88	[0.74, 1.04]
$1,000 marijuana							0.93	[0.85, 1.03]		

Note. Model 1 controls for treatment condition only. Model 2 controls for treatment condition, gender, race, socioeconomic status, and number of days of marijuana use in the 30 days prior to intake.

B=unstandardized parameter estimate; s.e.=standard error; β=standardized parameter estimate; OR = odds ratio; CI = confidence interval.

Number of negative urine drug screens is out of a possible 28 samples. Continuous Abstinence is out of a possible 14 weeks.

* $p < 0.05$.