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The association between parental history and delay discounting among individuals in recovery from addiction

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Abstract

Background—Family history of addiction is a risk factor for substance use disorders. Delay discounting (DD) is associated with the risk of substance use and dependence, and is predictive of the likelihood of successful abstinence and treatment outcomes; thus, we investigated the extent to which having parents with addiction (parental history of addiction) and number of addicted parents affect DD among individuals in recovery from addiction.

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Contributors

Athamneh analyzed and interpreted the data, and wrote the manuscript; Stein provided expertise in the analysis and interpretation of findings and edited the manuscript; Quisenberry contributed to the data collection and edited the manuscript; Pope contributed to the interpretation of findings and edited the manuscript; Bickel conceptualized the study, provided expertise in the analysis and interpretation of findings and edited the manuscript. All authors have read and approved of the final version of the manuscript before submission to the journal.

Conflict of Interest

Dr. Bickel is a principal in HealthSim, LLC
None of the other authors have any conflict of interest.

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Methods—Data from 177 individuals in recovery from addiction from The International Quit and Recovery Registry (IQRR), an ongoing online data collection program that aims to understand addiction and how people succeed in recovery, were included in the analysis. Participants with no, one, or two parents with addiction were compared on measures of DD using an adjusting-amount task.

Results—Parental history of addiction was significantly associated with delay discounting. After controlling for age and gender, which were significantly different between groups, participants reporting two biological parents with addiction had significantly higher DD rates compared to those reporting one or no parents with addiction.

Conclusions—Participants with two parents with addiction had significantly higher rates of discounting compared to those with no or only one parent with addiction. This information can serve as a foundation to better identify and target important subgroups that need additional or non-traditional intervention strategies to address their larger degree of impulsivity and help maintain abstinence or achieve better treatment outcomes.

Keywords

Addiction; Delay Discounting; Parental History; Recovery from Addiction

1.0 Introduction

Substance dependence is a major public health concern (National Institute on Drug Abuse 2005; Nutt et al., 2006) involving harmful effects for the dependent individuals, their families, communities, and society as a whole (National Institute on Drug Abuse 2011; Nutt et al., 2007). Substance use disorders are among the most common psychiatric disorders starting in young adulthood (National Research Council and Institute of Medicine 2010) that co-occur with other mental and physical health problems, and show a strong familial pattern (Kessler et al., 2005; Sher et al., 2005). Because drug addiction is, in part, a choice between short-term reinforcement from substance use and long-term reinforcement from abstinence, the processes underlying decision-making are important to the success of treatment programs. Behavioral economics, combining psychological and economic principles, has been extensively used to understand the decision-making process in individuals with addiction (Bickel et al., 2014a; Heather and Vuchinich 2003). Delay discounting, one of the most widely studied behavioral economic measures, refers to the subjective change in the value of a reward based on the delay to its receipt (Madden and Bickel 2010).

Individuals with addiction have significantly higher rates of delay discounting compared to healthy controls (Amlung et al., 2016; Bickel et al., 2014b; MacKillop et al., 2011). This finding is robust in most drugs of abuse, including opiates (Madden et al., 1999), alcohol (Mitchell et al., 2005), cocaine (Coffey et al., 2003), and nicotine (Baker et al., 2003). In addition, delay discounting rates are positively associated with the risk of substance use with greater discounting rates reported among individuals exhibiting greater drug consumption and dependence (Fernie et al., 2013; Khurana et al., 2013; MacKillop et al., 2011), and negatively associated with the likelihood of successful abstinence from addiction (Krishnan-

Sarin et al., 2007; MacKillop and Kahler 2009; C. Sheffer et al., 2012, 2014; Washio et al., 2011; Yoon et al., 2007).

Several previous studies compared discounting rates in current, ex-, and never substance-dependent individuals. Bickel et al. (1999) compared rates of discounting among current, never, and ex-smokers (reported abstinence from cigarettes for at least one year, and had smoked at least 20 cigarettes daily for at least 5 years prior to quitting) and indicated higher rates of discounting among current smokers but no significant difference between never and ex-smokers (Bickel et al., 1999). Former heroin and amphetamine users (reported that they had previously been a long-term misusers of either amphetamine or heroin) discounted delayed money less than current drug users but more than non-users (Bretteville-Jensen 1999). No significant difference in discounting was found between currently abstinent (reported no cocaine use in the past 30 days) and currently using cocaine-dependent outpatients (Heil et al., 2006). Moreover, rates of discounting by ex-alcohol dependent individuals (reported a lifetime history of alcohol dependence but were not drunk to intoxication for more than 30 days) and ex-smokers (reported abstinence from cigarettes for at least one year, and had smoked at least 20 cigarettes daily for at least 5 years prior to quitting) are intermediate to that of current users and never-users in alcohol dependence (Petry 2001) and cigarette smoking, (Odum et al., 2002) respectively. Interestingly, in individuals with substance dependence, high delay discounting rates may persist even after years of abstinence (Mitchell et al., 2005), suggesting a possible irreversible effect of substance abuse and/or a pre-existing genetic risk (MacKillop 2013; Meyer-Lindenberg et al., 2006; Bickel 2015).

Addiction is heritable such that relatives of addicted individuals are eight times more susceptible to developing an addiction compared to the general population (Merikangas et al., 1998). Recent data indicates that delay discounting is also highly heritable (Anokhin et al., 2011, 2015; Mitchell 2011; Wilhelm and Mitchell 2009). A substantially higher correlation between immediate or delayed choices was found within monozygotic twin pairs compared to dizygotic twin pairs, suggesting the presence of a genetic contribution (Anokhin et al., 2011). In addition, rates of discounting among mothers with nicotine dependence and their children were significantly higher than mothers without nicotine dependence and their children (Reynolds et al., 2009). Few studies, however, have examined the association between delay discounting and family history of addiction. Those that have reported mixed results, with some reporting a positive association (Dougherty et al., 2014; Smith et al., 2015; VanderBroek et al., 2016), some reporting a positive association among women but not men (Petry et al., 2002) and some indicating no association (Herting et al., 2010; Sanchez-Roige et al., 2016). Importantly, these studies compared groups of participants with and without a family or parental history of addiction but did not investigate or report the effect of number of parents with addiction in the family on rates of discounting. Hence, the extent to which delay discounting is affected by the number of parents with a history of addiction remains unknown.

The purpose of the present study is to compare delay discounting rates from individuals who are registered in the International Quit and Recovery Registry (IQRR), an ongoing online registry seeking to understand the phenotype of recovery, as a function of the number of

parental figures who suffer from addiction. We hypothesize that higher rates of discounting will be a graded function of the number of parents with addiction. Given the predictive relation between discounting and successful attempts at drug abstinence reviewed above (Krishnan-Sarin et al., 2007; MacKillop and Kahler 2009; Sheffer et al., 2012, 2014; Washio et al., 2011; Yoon et al., 2007), understanding the effect of parental history and number of parents with addiction on delay discounting rates might better identify those individuals in recovery who may be at greater risk of relapse.

2.0 Methodology

2.1 Participants

Participants were recruited from the IQRR, an online community and registry that was launched in September 2011 and is available internationally through the IQRR website (<https://quitandrecover.org>) to adults who are in self-reported recovery from one or more substance or behavioral addictions. The goals of the IQRR include understanding what allows people to succeed in overcoming addiction, tapping the insights of experiences of people who are in recovery, and understanding associations between addiction and decision-making processes. The IQRR also aims to better understand the phenotype of recovery through administration of monthly research assessments. Interested individuals who are in recovery may become IQRR members, called “Recovery Heroes,” by completing a registration process that includes providing general contact information and completing a detailed initial questionnaire concerning socioeconomic demographics, and personal and family history of behavioral addictions and/or substance use. Once registered, IQRR members are encouraged to create a website profile, which allows them to complete any available monthly research assessments.

For each monthly research assessment released, participants earn a badge available on their profile and 100 points which is exchangeable for \$1.00. The present study concerns data from 224 participants who completed one of the IQRR assessments. Inclusion criteria for the present study required that participants be between the ages of 18 and 68 years (Green et al., 1994, 1999) and self-report recovery from one or more substances. Individuals were excluded (n=41) if they: 1) did not complete the delay discounting task (n=3), 2) did not complete the parental history of addiction questions (n=14), 3) provided nonsystematic delay discounting data (n=18; Johnson and Bickel 2008), and 4) reported a non-substance related primary addiction (e.g., gambling, shopping, viewing pornography, or other; n=5). These and other inclusion and exclusion criteria were determined by specific responses to the parental history questions and delay discounting items as described in detail below. Figure 1 diagrams that of the 218 participants who were eligible and completed the assessment, 41 were excluded for the present study; thus, the final sample consisted of 177 participants. This study was conducted in compliance with the Institutional Review Board of Virginia Polytechnic Institute and State University.

2.2 Study Measures

To determine the primary addiction of each participant, we used the standard IQRR question, “What was your primary addiction?” with the following choices: a) tranquilizers/

depressants; b) prescription pain relievers; c) nicotine; d) cannabis products; e) cocaine; f) stimulants; g) opioids; h) alcohol; i) overeating; j) gambling; k) viewing pornography; l) shopping; or m) other. Examples were provided for each addiction.

To identify parental history of addiction, we used the standard IQRR question from the initial IQRR registrant questionnaire, in which respondents were asked “Do either of your biological parents have any addiction?” with five choices to choose from: “Father, Mother, Neither, both, prefer not to answer”.

Delay discounting was measured using an adjusting-amount task (Du et al., 2002), which presents participants with multiple choices (here, hypothetical monetary rewards) between a relatively larger-delayed reward and a relatively smaller, immediate reward, the magnitude of which is adjusted until the two choices are deemed approximately equal (e.g., an indifference point is reached). Participants in this study were presented with repeated hypothetical choices between \$1000 delivered after five discrete delays (1 day, 1 week, 1 month, 6 months, 1 year) or a \$500 reward delivered now. Depending on the choice, the amount of the smaller reward was either increased or decreased until reaching an indifference point. Plotting the indifference points at each delay yielded a delay discounting curve that is modeled using this commonly employed hyperbolic discounting function,

$$V = \frac{A}{1+kD}, \quad \text{Equation 1}$$

where V refers to the value of the delayed reward, A represents the amount of the delayed reward, D is the delay, and k is the estimated index of discounting (Mazur 1987). Larger k values represent higher discounting (i.e., more impulsivity). To reduce the positive skew of the data, which is typical among DD data, estimates of k were transformed using the natural logarithm, $\ln(k)$ to perform statistical analyses on rates of delay discounting.

2.3 Statistical Analysis

SPSS was used to perform all the statistical analysis ($P = 0.05$). One participant had a discounting rate that was identified as an outlier using the “outlier labeling rule” (Hoaglin and Iglewicz 1987), which is based on multiplying the interquartile range (IQR) by a factor of 2.2; hence, this value was removed from all further analysis in this study. Descriptive statistics and chi-square analyses were used to determine the frequencies and associations of sample characteristics with the delay discounting rates and parental history of addiction. As no significant difference in any of the demographics or outcome measures were found between those who answered “Father” or “Mother” to the parental history of addiction question (data not shown), the four groups (both, father, mother, neither) were reclassified into three groups (i.e., both parents, one parent, neither) to ease the analysis and interpretation of the results.

For demographic characteristics (e.g., gender, income, education, marital status, and age), a one-way ANOVA and Pearson chi-square analyses were conducted to compare means and

frequencies among the parental history of addiction groups. An analysis of covariance was then conducted to compare mean delay discounting rates among the parental history groups, with those demographic factors that differed significantly between groups modeled as covariates (here, participant gender and age). When appropriate, post hoc comparisons were conducted using the Sidak pairwise correction.

3.0 Results

Figure 1 diagrams that of the 224 participants who completed the assessment, 47 were excluded; thus, 177 participants were included in the final analysis. In this final sample, 59 participants (33.3%) did not report a parental history of addiction, 88 (49.7%) reported one addicted parent (62 father, 26 mother), and 30 (16.9%) reported two addicted parents. The mean age (SD) of participants was 47.29 (11.84) for the three groups together (no parental history 49.5 (11.13); one-parent 47.5 (12.13); two parents 41.9 (11.00)). The ANOVAs and Pearson chi-square analyses of the continuous and categorical demographic variables, respectively, indicated a significant difference in age [$F(2,176) = 4.282, p=0.015$] and gender [$X^2(2, N=177) = 6.205, p=0.045$] among the three parental history groups. Hence, we controlled for these two variables in our final ANCOVA analysis. No other significant differences were found in the sociodemographic variables. Table 1 provides the distributions of the sample characteristics.

The mean (M) rates of delay discounting (lnk) for participants with two addicted parents (M = -5.02, SD = 1.47) was significantly higher ($p=0.014$) than the neither parents with addiction (M = -6.41, SD = 2.01) and the one parent with addiction (M = -6.25, SD = 2.04) groups (see Figure 2). The indifference point at each delay is presented in Figure 3.

Analysis of variance (ANOVA) showed a main effect of parental history on rates of delay discounting ($F(2,176) = 5.593, p = 0.004$). Due to differences in age and gender between groups, an ANCOVA with a between-subjects factor of parental history of addiction (i.e., both parents, one parent, neither parent) and covariates of age and gender was conducted and revealed a main effect of parental history on delay discounting rates [$F(2, 171) = 3.820, p=0.024$], and age, [$F(1, 171) = 6.780, p=0.010$], but not gender [$F(1, 171) = 0.020, p=0.886$]. Pairwise comparisons using the Sidak test indicated that participants who had two parents with addiction had significantly higher discounting rates compared to those who had one parent with addiction ($p=0.036$) or neither parent with addiction ($p=0.032$) groups after controlling for age and gender.

4.0 Discussion

To our knowledge, this study is the first to investigate the differences in delay discounting rates as a function of number of addicted parents (i.e., neither, one parent, two parents) among individuals in recovery from addiction. We report greater delay discounting in those with two addicted parents, compared to one or none. Other demographic variables such as smoking status, income, marital status, and education did not significantly contribute to differences in rates of discounting; and above all, when the influence of gender and age were controlled, the parental history of addiction continued to predict discounting rates. In

contrast with our hypothesis no significant difference in discounting rates were observed between those who have one addicted parent compared to those who have no addicted parents. Below, we discuss two main points related to these findings.

First, as rates of delay discounting are higher across individuals with many developmental and psychiatric disorders (Barkley et al., 2001; Rounds et al., 2007; Scheres et al., 2010; Wilson et al., 2010; Yoon et al., 2007), our findings of significant effect of parental addiction on rates of discounting among individuals in recovery from addiction are consistent with previous studies examining the effect of family/parental addiction on the risk of many negative outcomes among offspring, including emotional, social, and behavioral problems (Lander et al., 2013) in addition to abnormal cognitive functioning such as shorter attention span, hyperactivity (Steinhausen et al., 1984), higher impulsiveness, aggressiveness (Stanger et al., 1999), and Attention Deficit Hyperactivity Disorder (ADHD) (Sundquist et al., 2014) with findings indicating higher risk among individuals with family/parental history compared to controls (Wilens 1994).

Second, our results are consistent with findings from studies examining the effect of number of parents with addiction and the negative outcomes on offspring which indicated stronger association among those who have two addicted parents compared to one or none (Earls et al., 1988; Yoon et al., 2013). For example, greater risk for social competence deficits in children from families with two alcohol-dependent parents when compared to children from families with one alcohol-dependent parent has been reported (Hussong et al., 2005). Moreover, children with two alcohol-dependent parents exhibited greater risk for internalizing (i.e., negative behaviors that are targeted toward the self, such as anxiety and depression) and externalizing (i.e., negative behaviors that are targeted toward others such as delinquency and aggression) symptoms (Hussong et al., 2007, 2008) compared to children with one alcoholic parent. However, consistent with our findings, parent-reported internalizing and externalizing symptoms for children with one alcohol-dependent parent did not significantly differ from controls (Hussong et al., 2007, 2008), suggesting that having only one addicted parent may minimize risk of social and emotional problems for children with parental history of addiction.

This study supports and furthers the role of delay discounting as a behavioral marker of addiction (Bickel et al., 2014b) by supporting an association between discounting rates and parental history of addiction. This association may be due to biological and genetic processes that underlie addiction, parental behavioral changes caused by the addiction, and/or gene-environment interactions between these processes. Identification of the specific mechanism(s) underlying our findings awaits further investigation. Nonetheless, our findings are corroborated by prior work on cigarette smoking. Specifically, in a study examining delay discounting among mothers with and without nicotine dependence and their children (Reynolds et al., 2009) smoking mothers and their children had significantly higher rates of discounting compared to non-smoking mothers and their children, suggesting that delay discounting may function as a behavioral risk factor for adolescent cigarette smoking that precedes any significant nicotine use. However, in order to reach firm well-founded conclusions future work assessing the relationship between family history and discounting that aim to understand and explain reasons of inconsistency in findings from the current

study and some previous ones of significant association (Dougherty et al., 2014; Smith et al., 2015; VanderBroek et al., 2016) compared to other findings of no association (Herting et al., 2010; Sanchez-Roige et al., 2016) is needed. In addition, investigating other risk factors that might alter rates of discounting as a function of abstinence such as cessation duration, severity of addiction, and the presence of any ongoing secondary addictions and how they can affect the relationship between rates of discounting, having a family history of addiction and recovery might be beneficial.

This study has both strengths and weaknesses. Using the IQRR that represents different groups of individuals in recovery from substance dependence provides a valuable image of the association between parental history of addiction and delay discounting rates in this specific population. However, one of the limitations of this study was using the online-based assessment, which limited our sample to include only those individuals in recovery who use technology and an email address. Future studies that include individuals with substance dependence in recovery who do not have or use technology might be necessary to identify the specific effect of parental history on delay discounting rates, since differences in demographics, if they exist, might be quite important. In addition, this study did not address all parental, personal, or environmental factors that may affect the relationship between parental history of addiction, rates of discounting, and developing negative outcomes. For example, the study did not collect data about the co-occurring parental psychopathology (Solis et al., 2012), the parents' status of recovery (Hussong et al., 2012; Solis et al., 2012), the severity of addiction, any ongoing use for other problematic substances, cessation duration, stress levels, type of parental addiction, and whether participants were raised by their addicted parents or not. As those factors may alter rates of discounting and its association with family history, future research that includes assessing these factors might be necessary to better understand the relation between parental history of addiction and delay discounting rates. Finally, the IQRR is a self-reported survey, which might be subject to some potential sources of bias such as social desirability bias and recall bias. However, self-reporting about parental history of substance use has been validated in prior studies (Andreasen 1986; Ellingson et al., 2010; Sher and Descutner 1986).

5.0 Conclusion

Delay discounting rates are significantly associated with parental history of addiction, specifically the number of addicted parents in individuals in recovery from addiction. Participants who had two addicted parents displayed significantly higher rates of discounting compared to those who had no or only one parent with addiction. This information can serve as a foundation to better identify and target important subgroups that need additional or non-traditional intervention strategies to address their larger degree of impulsivity and help achieve better treatment outcomes.

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Highlights

- Delay discounting is significantly associated with parental history of addiction.
- Participants with two parents with addiction have the highest discounting rates.
- No difference in discounting among those with one or no parents with addiction.
- Gender of parent with addiction is not associated with discounting in offspring.

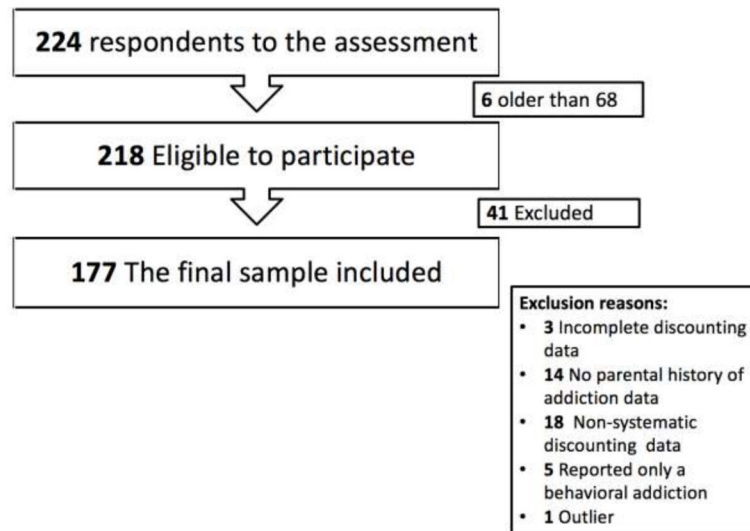


Fig. 1. Study sample of substance dependents in recovery respondents to the IQRR assessment.

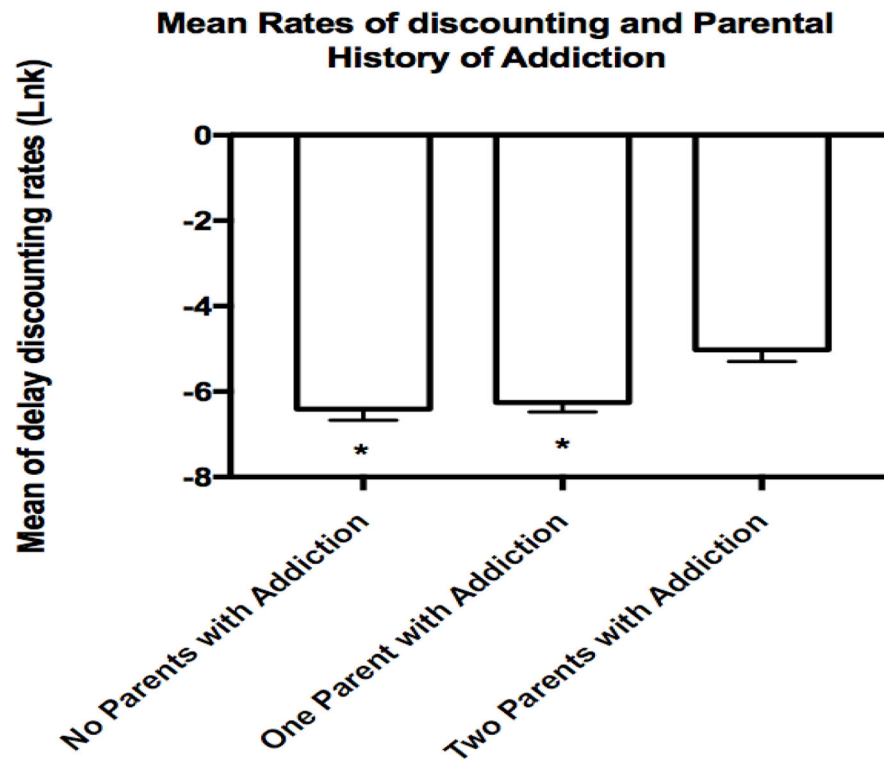


Fig. 2.

The mean (M) delay discounting rates (lnk) for participants with two parents with addiction compared to those with one parent or no parents with addiction groups. * $p < 0.05$ Compared to “Both parents” group

Error bars represent standard error.

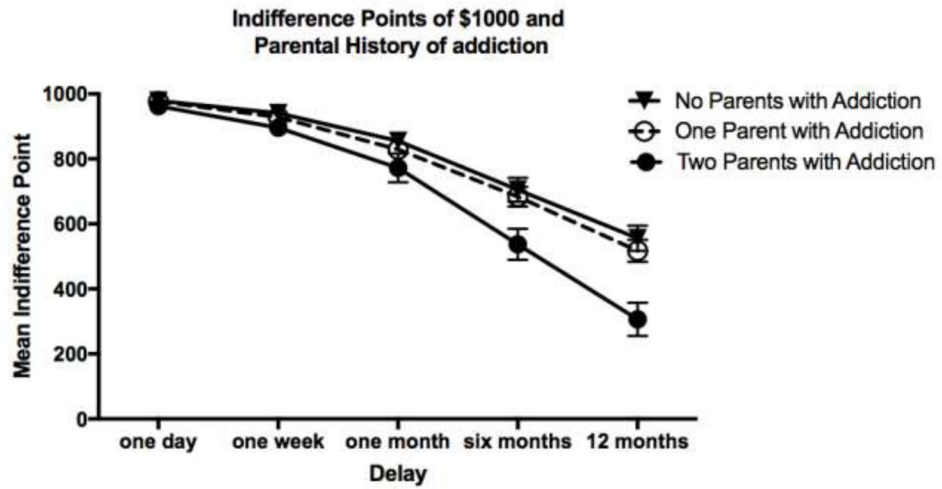


Fig. 3. The mean delay discounting indifference points of \$1000 calculated for each of the five points of time used in the adjusted amount discounting (1 day, 1 week, 1 month, 6 months, 1 year). Error bars represent standard error.

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Table 1

Sample characteristics by parental history of addiction (N=177).

Characteristics	Frequency (%)			P value
	Neither n=59	One parent n=88	Both parents n=30	
Gender				0.045*
Male	25 (42.4)	27 (30.7)	5 (16.7)	
Female	34 (57.6)	61 (69.3)	25 (83.3)	
Employment				0.123
Employed full-time	30 (50.8)	41 (46.6)	7 (23.3)	
Employed part-time	6 (10.2)	7 (8.0)	4 (13.3)	
Not currently employed	5 (8.5)	11 (12.5)	8 (26.7)	
Retired	5 (8.5)	8 (9.1)	1 (3.3)	
Self-employed	6 (10.2)	7 (8.0)	3 (10.0)	
Student	2 (3.4)	2 (2.3)	4 (13.3)	
Other	5 (8.5)	12 (13.6)	3 (10.0)	
Marital Status				0.219
Married	22 (37.3)	33 (37.5)	7 (23.3)	
Never married	10 (10.0)	17 (19.3)	9 (30.0)	
Divorced	19 (32.2)	23 (26.1)	6 (20.0)	
Separated	1 (1.7)	5 (5.7)	1 (3.3)	
Unmarried couple living together	4 (6.8)	10 (11.4)	6 (20.0)	
Widowed	3 (5.1)	0 (0.0)	1 (3.3)	
Education level				0.380
Some high school	0 (0.0)	2 (2.3)	0 (0.0)	
High school diploma or equivalency	5 (8.5)	9 (10.2)	5 (16.7)	
Some college	21 (35.6)	27 (30.7)	12 (40.0)	
Associate degree	5 (8.5)	8 (9.1)	5 (16.7)	
Bachelor degree	20 (33.9)	30 (34.1)	4 (13.3)	
Master's degree	5 (8.5)	11 (12.5)	4 (13.3)	
Doctoral degree	3 (5.1)	1 (1.1)	0 (0.0)	
Primary Addiction				0.666
Alcohol	32 (54.2)	53 (60.2)	14 (46.6)	
Cannabis products	3 (5.1)	2 (2.2)	3 (10.0)	
Nicotine	2 (3.4)	3 (3.4)	0 (0.0)	
Prescription pain relievers	10 (17.0)	15 (17.0)	8 (26.7)	
Stimulants	9 (15.3)	14 (15.9)	5 (16.7)	
Tranquilizers/Depressants	3 (5.0)	1 (1.1)	0 (0.0)	
Income				0.510
Less than \$30,000	18 (30.5)	25 (28.4)	15 (50.0)	
\$30,000 – \$49,999	10 (16.9)	19 (21.6)	5 (16.7)	
\$50,000 – \$69,999	9 (15.3)	15 (17.0)	2 (6.7)	

Characteristics	Frequency (%)			P value
	Neither n=59	One parent n=88	Both parents n=30	
\$70,000 – \$89,999	5 (8.5)	4 (4.5)	0 (0.0)	
\$90,000 – \$149,999	7 (11.9)	15 (17.0)	3 (10.0)	
\$150,000 and above	4 (6.8)	3 (3.4)	1 (3.3)	
Prefer not to answer	6 (10.2)	7 (8.0)	4 (13.3)	
Smoking Status				0.719
No	40 (67.8)	65 (73.9)	21 (70.0)	
Yes	19 (32.2)	23 (26.1)	9 (30.0)	
Delay Discounting				
Ln(k) (Mean (SD))	-6.41 (2.01)	-6.25 (2.04)	-5.02 (1.47)	0.004

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