Steeper Delay Discounting among Substance-Abusing and -Dependent Adolescents versus Controls

In Press: Journal of Child and Adolescent Substance Abuse

Brian Konecky and Steven R. Lawyer*
Idaho State University

*Author for Correspondence: Idaho State University, Department of Psychology, 921 S. 8th Ave, Mail Stop 8112, Pocatello, ID, 83209; phone: 208-282-2142; email: lawystev@isu.edu
Delay Discounting refers to the tendency to prefer smaller-sooner outcomes over larger-delayed outcomes and is associated with substance abuse and dependence in adult populations. However, few studies have examined delay discounting in the context of adolescent substance abuse. Adolescent substance abusers (n = 19) who met criteria for substance abuse or substance dependence and non-abusing adolescent community controls (n = 42) completed the Monetary Choice Questionnaire (Kirby, Petry, & Bickel, 1999), which provides an estimate of delay discounting rate. Substance-abusing and -dependent participants evidenced higher rates of delay discounting than did controls, even after controlling for ethnicity and gender. These findings suggest that delay discounting may represent an important behavioral process for understanding adolescent substance abuse.
INTRODUCTION

Adolescent substance abuse poses important problems for the individual, family, community, school, and economy (Dembo et al., 1987; DiClemente, 1990; Hawkins, 2009; Kipke, Montgomery, & MacKenzie, 1993; Newcomb & Bentler, 1988). One potentially important behavioral mechanism that may underlie adolescent substance abuse is delay discounting, an impulsivity-related behavior pattern of preference for smaller outcomes that are available relatively sooner over larger outcomes that are available after a delay (Ainslie, 1975). Delay discounting may represent a fundamental process that underlies substance use problems (Bickel & Johnson, 2003), in that individuals who de-value delayed outcomes are at increased risk for substance abuse problems because the negative effects (e.g., health, interpersonal, legal) of substance use and abuse tend to be delayed, while the positive effects (e.g., intoxication, social reinforcement) tend to be immediate.

Delay discounting can be measured readily in a laboratory context (e.g., Rachlin, Raineri, & Cross, 1991) by presenting participants with a series (usually dozens) of forced choices between an adjusting smaller-sooner outcome and a larger-delayed outcome. Once the value of the outcome across several delays is established, these choice patterns can be described using a hyperbolic decay function, such as one posed by Mazur (1987): \( V = \frac{A}{1 + kD} \). In this equation, \( V \) represents the current value of a delayed outcome, \( A \) represents the size of the large delayed outcome, \( D \) represents delay to the outcome, and \( k \) is a free parameter indicating discounting rate. An alternative method for assessing discounting rate is the Monetary Choice Questionnaire (Kirby, et al., 1999), which estimates an individual’s discounting rate (\( k \)) by assessing choices regarding only a few strategically-worded questions that target a different \( k \) value drawn from the hyperbolic decay function. In either case, higher \( k \) values indicate steeper discounting patterns.
Delay Discounting in Adolescents

(i.e., a preference for smaller-sooner outcomes over larger-delayed outcomes), which are positively associated with impulsive choice.

Research examining rates of discounting in adult substance abusers versus controls reveals consistent patterns of steeper discounting among drug and alcohol abusers (see MacKillop et al., 2011; Madden & Bickel, 2010). Research among adolescent substance abusers suggests a similar pattern, but the findings are mixed. Fields et al. (2009) and Reynolds and Fields (2012) found that adolescent smokers had steeper rates of discounting than did non-smokers and Field et al. (2007) found that adolescent heavy drinkers showed more pronounced discounting of both delayed hypothetical monetary and alcohol rewards than did light drinkers. However, Reynolds (2003) and Gonzalez (2012) found no differences between groups of adolescent substance abusers and controls on delay discounting.

Delay discounting may be an important behavioral phenomenon that underlies substance use across the developmental spectrum, but the literature on delay discounting in adolescents is too limited to draw substantive conclusions. The purpose of the present study was to compare rates of delay discounting between substance-abusing and -dependent adolescents and an age-similar community control group.

METHOD

Participants

Participants (age 12-18) included 19 (3 female) adolescents recruited from local juvenile drug courts (JDCs) and 50 (19 female) adolescents recruited from the community as part of a larger study on diagnostic validity. JDCs provide intensive, continuous judicial monitoring and supervision of adolescents (who reside at home) with consistent patterns of drug and/or alcohol involvement and related contact with the juvenile justice system with the goal of being an early
therapeutic intervention (Cooper, 2001). Control participants who met DSM-IV-TR (American Psychiatric Association, 2000) criteria for substance abuse or dependence were excluded.

**Measures**

Alcohol and drug dependence was measured using the *Customary Drinking/Drug Use Record* (CDDR; Brown et al., 1998), a structured interview that provides information regarding current and lifetime drug and alcohol consumption, withdrawal symptoms, dependence symptoms, and use consequences. JDC participants answered CDDR questions individually in an interview format. Control participants completed a modified self-report version of the CDDR in a group setting with anonymity protected.

Delay discounting was measured using the *Monetary Choice Questionnaire* (Kirby et al., 1999). Participants indicated a preference for one of two monetary rewards (e.g., “Would you prefer $34 now or $50 in 30 days?”) across the nine items associated with the medium reward amount used in the original measure after being read instructions adapted from Madden, et al (1999). Individual *k* estimates were derived based on each individual’s choices of immediate reward across the nine forced choice questions (see Kirby et al., 1999). The MCQ is used frequently in adolescent samples (e.g., Audrain-McGovern et al., 2004; Gonzalez et al., 2012; MacKillop & Tidey, 2011) and has excellent psychometric properties in adolescents (e.g., Duckworth & Seligman, 2005).

**Procedure**

Substance-abusing participants were recruited via flyers posted in local juvenile drug courts and distributed during court proceedings. Approximately 50 adolescents were involved in this JDC during the course of the study. Participants were included if they were 12-18 years of age and current participants in the local JDC. They were informed that their decision to
participate (or not) would not influence their drug court status and all information gathered would be completely confidential. JDC participants completed study materials individually in the context of a larger interview in local detention centers or court buildings in confidential rooms. Control group participants were recruited via flyers placed in community businesses and within several local schools with the cooperation of school district officials. Control participants were included if they were between 12 – 18 years of age. All control group measures were completed in group sessions (controls did not complete the face-to-face interview used in drug court participants) in a large classroom at Idaho State University, which allowed confidentiality in responding to study measures. All participants were compensated with a $15 gift card and a choice of an edible reward (i.e., a candy bar or healthy snack). Parental consent and juvenile assent were attained for all individuals.

RESULTS

All of the substance-abusing participants met DSM-IV-TR criteria for substance abuse disorder and 17 met criteria for both substance abuse and dependence. Seven control participants were excluded from analysis due to responses suggesting patterns of substance abuse or dependence; one control participant was excluded from analysis due to a failure to complete the MCQ. Therefore, the control group comprised 42 participants. Demographic and diagnostic comparisons between the groups are shown in Table 1.

To assess the extent to which the overall $k$ value accurately represented the individual patterns of responding, a discounting score consistency metric was calculated as the proportion of the 9 items accurately represented by the overall $k$ value. Mean choice consistency outcomes for the JDC ($M = .96; SD = .08$) and JDC ($M = .98; SD = .05$) for controls indicate that the $k$
values represented participant response patterns very well. Consistency outcomes were not significantly different between groups ($t(59) = -1.31, p = .195$).

Comparison of mean log$_{10}$-transformed $k$ values among substance-abusing ($-1.49; SD = .50$) and control ($-1.98; SD = .60$) participants revealed significant group differences ($t = 3.14, df = 59; p = .003; d = .89$). These differences were confirmed using a non-parametric Mann-Whitney U test performed on non-transformed $k$ values among substance-abusing (mean rank = 40.58) and control (mean rank = 26.67) participants ($U = 217.0; p = .003$). Figure 1 shows mean $k$ values across the groups. An analysis of covariance performed on log$_{10}$-transformed $k$ values with gender (male vs. female) and race (Caucasian vs. non-Caucasian) found that the log$_{10}$ $k$ estimated marginal means for controls ($M = -2.01$, MSE = .09) was significantly smaller than the mean log$_{10}$ $k$ for the substance-abusing participants ($M = -1.45$, MSE = .14) ($F (1, 61) = 10.78, p = .002, \eta^2 = .16$) even after controlling for gender and race.

**DISCUSSION**

In the present study, substance-abusing and -dependent adolescents evidenced significantly higher rates of delay discounting than did non-drug-abusing controls. That is, adolescents who met criteria for substance abuse or dependence are more likely to choose a smaller-sooner reward over a larger-later reward than are non-abusing controls. These findings are consistent with a limited literature linking higher rates of delay discounting in adolescent substance use (Field et al., 2007; Fields et al., 2009; Gonzalez et al., 2012; Reynolds & Fields, 2012) and with a large literature showing that substance-abusing and substance-dependent adults have higher rates than do controls (MacKillop et al., 2011). Bridging this gap between adolescents and adults suggests that similar processes may underlie substance abuse patterns in humans across the developmental spectrum.
Given the limited literature concerning delay discounting among substance-abusing adolescents, the results of the current study are meaningful. A consistent literature pointing to delay discounting as an important behavioral process that underlies adolescent substance abuse would suggest that the processes that are directly or indirectly associated with substance abuse in adolescents are the same as those for adults. Understanding the relationship between discounting in adolescent substance use and abuse may have important implications for intervention efforts not typically targeted in traditional substance abuse treatment contexts. Bickel and Mueller (2009) suggest that understanding processes that operate across problem behaviors may be important for reducing a broad range of problem behaviors. Adolescents tend to have higher rates of discounting than adults and older adults (Green, Fry, & Myerson, 1994) and the fact that this subset of adolescents exhibit higher rates of discounting than do age-similar controls suggests that this population may be at particular risk for a number of impulsivity-related outcomes.

A growing literature suggests that elevated rates of delay discounting are associated with a variety of health problem behaviors in addition to substance abuse (Chesson et al., 2006; Johnson & Bruner, 2012; Petry, 2001; Rasmussen, Lawyer, & Reilly, 2010) and emotion regulation strategies that underlie psychological disorders (Augustine & Larsen, 2011). Substance-abusing participants in this study were recruited from a juvenile justice context, where adolescents tend to have increased risks for learning disorders (Burrell & Warboys, 2000), HIV or STDs (Widom & Hammet, 1996), engagement in risky sexual behaviors (Teplin et al., 2005) and emotional/psychological functioning difficulties (Cauffman, 2004; Cauffman, Feldman, Watherman, & Steiner, 1998; Pliszka, Sherman, Barrow, & Irick, 2000). The fact that patterns of delay discounting are correlated with a range of problem behaviors suggests that it may represent
a “trans-disease” process (Bickel & Mueller, 2009) that manifests across a variety of disorders. If delay discounting is a fundamental mechanism of a range of problem behaviors, then successful efforts to reduce the rate of delay discounting may have a broad impact on adolescent health behaviors.

The findings reported here should be considered on balance with the study’s limitations. Other factors, such as socioeconomic status or race may explain some of the differences in discounting rates reported here (Stanger et al., 2012) and future research like this should consider using a non-alcohol/drug abusing control group drawn from criminal justice system. In addition, there are other methods available for measuring delay discounting (e.g., Rachlin et al., 1991) that may provide different information and the fact that the different groups completed the MCQ in different contexts (individual vs. group) may have influenced the study findings. Finally, future research should consider similar efforts with a larger sample size and with varied methods, which would increase confidence in the present findings if the outcomes were consistent.
Table 1. Comparison of Juvenile Drug Court (JDC) and community control participants across demographic and diagnostic variables.

<table>
<thead>
<tr>
<th>Demographic Variables</th>
<th>JDC</th>
<th>Controls</th>
<th>$\chi^2$</th>
<th>t (df)</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caucasian (N; %)</td>
<td>14 (73.7)</td>
<td>41 (97.6)</td>
<td>9.23</td>
<td>-</td>
<td>.03</td>
</tr>
<tr>
<td>Male (N; %)</td>
<td>16 (84.2)</td>
<td>27 (64.3)</td>
<td>2.50</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>Age (M; SD)</td>
<td>16.2 (1.3)</td>
<td>15.9 (1.4)</td>
<td>-</td>
<td>.68 (59)</td>
<td>ns</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Diagnostic Variables</th>
<th>JDC</th>
<th>Controls</th>
<th>$\chi^2$</th>
<th>t (df)</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substance Abuse (N; %)</td>
<td>19 (100.0)</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Substance Dependence (N; %)</td>
<td>17 (89.5)</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*Data presented in means (SD) and analyzed using independent-samples $t$; SUD = substance use disorder (substance abuse or substance dependence).
Figure 1. Mean (± SEM) k estimates among adolescents meeting criteria for a substance use disorder (SUD) versus community controls. *Significant differences based on comparison of log_{10}-transformed values to control for skewness.
References


