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The Phenotype of Recovery III: Delay Discounting Predicts Abstinence Self-Efficacy Among Individuals in Recovery From Substance Use Disorders

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Abstinence self-efficacy (ASE) and delay discounting predict treatment outcomes and risk of relapse. Associations between delay discounting and ASE among individuals in recovery from substance use have not been investigated. Data from 216 individuals in recovery from substance abuse recruited from The International Quit & Recovery Registry, an ongoing online data collection program used to understand addiction and how people succeed in recovery, were included in the analysis. Discounting rates were assessed using an adjusting-delay task, and ASE was assessed using the Relapse Situation Efficacy Questionnaire (RSEQ). Delay discounting was a significant predictor of ASE, even after controlling for age, gender, race, ethnicity, annual income, education level, marital status, and primary addiction. Context-specific factors of relapse included Negative Affect, Positive Affect, Restrictive Situations (to drug use), Idle Time, Social-Food Situations, Low Arousal, and Craving. A principal component analysis of RSEQ factors in the current sample revealed that self-efficacy scores were primarily unidimensional and not situation specific. The current study expands the generality of delay discounting and indicates that discounting rates predict ASE among individuals in recovery from substance use disorders. This finding supports the recent characterizations of delay discounting as a candidate behavioral marker of addiction and may serve as a basis to better identify and target subgroups that need unique or more intensive interventions to address higher risks of relapse and increase their likelihood of abstinence.

Keywords: addiction, delay discounting, abstinence, self-efficacy, recovery

Substance use disorder can be a treatable disease with attainable recovery (American Addiction Centers, 2018; The National Institute on Drug Abuse [NIDA], 2018). However, only about 10% of adults with substance use disorder are in recovery, with relapse rates for those in treatment being between 40 and 60% (NIDA, 2018). Given the substantial negative impact of substance use disorder, and the high rates of relapse (Foxcroft et al., 2016; Klimas et al., 2012; Rösner, Hackl-Herrwerth, Leucht, Lehert, et al., 2010; Rösner, Hackl-Herrwerth, Leucht, Vecchi, et al., 2010), research has shifted focus to understanding the mechanisms underlying successful recovery instead of comparing the successfulness among different treatment types.

Abstinence Self-Efficacy (ASE), the confidence in one's ability to abstain from the drug of use (DiClemente, Fairhurst, & Pi-

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otrowski, 1995), has been identified as an important causal mechanism predicting behavior change in drug abuse (Burling, Reilly, Moltzen, & Ziff, 1989; Fiorentine & Hillhouse, 2000; Maisto, Connors, & Zywiak, 2000) and has been suggested as a critical component in successful cessation treatments (Bricker et al., 2010; Hendricks, Delucchi, & Hall, 2010; Hyde, Hankins, Deale, & Marteau, 2008). Clinical research on substance abuse has demonstrated that ASE predicts treatment outcome and risk of relapse (Baer, Holt, & Lichtenstein, 1986; Chavarria, Stevens, Jason, & Ferrari, 2012; Condiotte & Lichtenstein, 1981; Elfeddali, Bolman, Candel, Wiers, & De Vries, 2012; Greenfield et al., 2000; Gulliver, Hughes, Solomon, & Dey, 1995; Johnson, Finney, & Moos, 2006), with one study reporting ASE's ability to predict treatment outcomes (e.g., alcohol consumption) at 8- and 16-year follow-up (Moos & Moos, 2007).

A defining technique to prevent relapse is the determination of high-risk situations that increase the risk of relapse. Context-specific ASE identifies situations that pose a threat to abstinence, through associations with coping effort (i.e., coping is less likely to be initiated or maintained when context-specific ASE is low; Witkiewitz & Marlatt, 2004). For example, individuals who have low confidence to abstain from a specific drug while experiencing stress are unlikely to attempt or maintain coping efforts in stressful situations, which may promote relapse. Various instruments have been designed to measure how ASE relates to substance abuse, including the Relapse Situation Efficacy Questionnaire (RSEQ; Gwaltney et al., 2001a; Gwaltney et al., 2001b). The RSEQ aims to provide a comprehensive assessment of possible lapse contexts and has demonstrated the ability to predict relapse (Gwaltney et al., 2001b). The RSEQ samples a wide range of environmental contexts and affective states that help determine the level of perceived ability in each type of situation, which, therefore, predicts the situations in which relapse might occur (Gwaltney et al., 2001b; Sumner et al., 2016).

Previous studies have suggested that the predictive utility of self-efficacy can be enhanced by the inclusion of personality trait variables such as impulsivity (Churchill, Jessop, & Sparks, 2008; Churchill & Jessop, 2010). Behavioral economics, which incorporates insights from psychology and economics to better understand human behavior, has been used extensively to understand the decision-making process (including impulsivity) in individuals with substance use disorder (Bickel, Johnson, Koffarnus, MacKillop, & Murphy, 2014; Bickel, Moody, & Higgins, 2016; Heather & Vuchinich, 2003). One of the most studied decision processes within behavioral economics is delay discounting (Bickel et al., 2014) Delay discounting, a measure of impulsivity that refers to the subjective change in the value of a reward based on the delay to its receipt, is strongly associated with substance use (Madden & Bickel, 2010). For example, delay discounting covaries with drug use status, with current users discounting delayed rewards more steeply compared to nonusers (Amlung, Vedelago, Acker, Balodis, & Mackillop, 2017; Bickel, Koffarnus, Moody, & Wilson, 2014; MacKillop et al., 2011; Mitchell, Fields, D'Esposito, & Boettiger, 2005). This finding is consistent among most drugs of abuse, including alcohol (Mitchell et al., 2005), nicotine (Baker, Johnson, & Bickel, 2003), cocaine (Coffey, Gudleski, Saladin, & Brady, 2003), and opiates (Madden, Bickel, & Jacobs, 1999). Moreover, delay discounting rates measured at the beginning of a quit attempt are predictive of treatment outcomes (Krishnan-Sarin et al., 2007; MacKillop & Kahler, 2009; Sheffer et al., 2012; Sheffer et al., 2014; Washio et al., 2011; Yoon et al., 2007). When compared to other neurocognitive measures (e.g., Continuous Performance, IA Gambling, Stroop, Tower, WI Card Sorting, and Letter Number Sequencing) differentiating substance users from controls (Bickel, Moody, Eddy, & Franck, 2017) and neurocognitive measures (e.g., Barratt Impulsiveness Scale 11, Eysenck Impulsiveness Scale, Frontal Systems Behavior Scale) predicting treatment outcomes postintervention (Coughlin, Tegge, Sheffer, & Bickel, 2018), delay discounting was the best predictive neurocognitive measure of substance dependence when each substance group was compared to controls (Bickel et al., 2017) and the single best predictor of treatment outcome, correctly predicting treatment outcomes of 80% of the sample posttreatment and 81% at follow-up (Coughlin et al., 2018).

Previous studies reported heterogeneity in the degree of discounting among people in recovery when compared to current users or never users. In one of many studies comparing discounting rates in current, ex-, and never substance-dependent individuals, Bickel, Odum, and Madden (1999) observed higher rates of discounting among current smokers but no significant difference between never and ex-smokers. However, Petry (2001) and Odum, Madden, and Bickel (2002) reported that rates of discounting by ex-alcohol-dependent individuals and ex-smokers are intermediate to those of current and never users of alcohol and cigarettes, respectively. Moreover, in a study conducted by Bretteville-Jensen (1999), former heroin and amphetamine users reported lower rates of discounting compared to current users but higher rates of discounting compared to nonusers. However, these studies did not determine whether ex-users were specifically in treatment or not. Interestingly, among individuals with substance dependence, relationships between discounting and addictive behaviors have state-along with trait-based components, suggesting a possible reversible effect of substance abuse (Koffarnus, Jarmolowicz, Mueller, & Bickel, 2013; Story, Vlaev, Seymour, Darzi, & Dolan, 2014).

Both ASE and discounting may be associated with success in treatment programs, based on a review conducted by Renaud and Halpern (2010). However, to our knowledge, the relationship between delay discounting and ASE among individuals in recovery from substance use disorders has not been previously examined.

In this study, we assessed the relationship between delay discounting (measured using an adjusting-delay discounting task, a brief but accurate method of obtaining a discount rate) and ASE among individuals in recovery from substance use disorder. Data were collected from the International Quit & Recovery Registry (IQRR), an ongoing online registry designed to understand the phenotype of recovery (see also Athamneh, Stein, Quisenberry, Pope, & Bickel, 2017). We hypothesized that higher rates of discounting (higher impulsivity) would be associated with lower ASE (higher risk of relapse). Given the association between rates of discounting and successful attempts at drug abstinence reviewed above (Krishnan-Sarin et al., 2007; MacKillop & Kahler, 2009; Sheffer et al., 2012; Sheffer et al., 2014; Washio et al., 2011; Yoon et al., 2007), establishing the association between delay discounting and ASE might help identify individuals in recovery who are at greater risk of relapse.

Methodology

Participants

Participants were 227 individuals in recovery from addiction who were recruited from the IQRR, an online community and registry that was initiated in September 2011 and is accessible internationally through the IQRR website (https://quitandrecovery.org) to adults who self-report being in recovery from at least one behavioral or substance addiction. The IQRR collects data through administration of research assessments to its members. Individuals in recovery who are interested in participating may become IQRR members. To register, individuals provide general contact information and complete a detailed initial questionnaire including demographics, and personal and family history of behavioral addictions and/or substance use. Once registered, IQRR members have access and can complete any available research assessments with no minimum commitment to stay in the registry. For each assessment completed, participants earn a badge (available on their profile) and $1.00, or $2.00 if they complete the assessment the first week it is posted. In addition, participants have access to resources aimed at promoting recovery and are encouraged to utilize those available on the IQRR website.

Inclusion criteria for the present study required that participants be 18 years or older and self-report recovery from one or more primary substance use disorder. Given the unique set of risks associated with substance dependence (not seen in nonsubstance addictions) such as the specific substance impacts on one's physical health and the differential effects of addictive substances on both the brain and body (including effects on discounting rates) we decided to exclude individuals indicating a nonsubstance related primary addiction from the study. Individuals were excluded (n = 11) from analysis if they reported a nonsubstance related primary addiction such as gambling (n = 1), overeating (n = 2), excessive sexual activity (n = 3), viewing pornography (n = 1), or other (n = 4); thus, the final sample consisted of 216 participants. This study was approved by the Institutional Review Board at Virginia Polytechnic Institute and State University.

Study Measures

Demographic data including age, gender, race, ethnicity, annual income, education level, marital status, smoking status, years in recovery and the primary addiction were collected (see Table 1). All participants self-reported being in recovery from at least one substance addiction. To determine relapse status, participants completing the assessment were asked if they have used their primary addiction during the previous 30-days. Answering with "yes" was considered a relapse. To determine the ongoing drug use status, participants were asked "Do you consider your use of the substance currently ongoing? Yes/No", and the use status for those who answered yes was considered "ongoing." In addition, participants were asked "When was the last time you engaged in your primary addiction?" and days since last relapse were calculated by subtracting the response to that question from the date of completing the assessment (see Table 1).

The Relapse Situation Efficacy Questionnaire (RSEQ). The RSEQ was used to measure ASE. The RSEQ is a 75-item questionnaire that was developed and validated by (Gwaltney et al., 2001b) to assess one's confidence in his or her ability to resist the temptation to use substances in a wide variety of contexts. The RSEQ provides a comprehensive assessment of possible relapse contexts and samples a wide range of environmental contexts and affective states (see Table 2) in order to identify high-risk relapse situations. Each question addresses only one context and answers range from 1 = Not at all confident to 4 = Extremely confident. The average score for the 75 items is calculated to provide a self-efficacy score, with lower scores indicating situations of lower confidence and a higher risk of relapse. Previous research has separated RSEQ questions into statistically determined factors (Gwaltney et al., 2001a) however we failed to replicate this finding. We conducted a principal component analysis of the same subset of 43 questions used by Gwaltney et al. to derive their factors. Our results indicated that a single factor for all 43 questions was most appropriate, accounting for 70% of the variance among these 43 questions. Adding an additional factor only improved the variance accounted for by 4%. Therefore, similar to other studies (Baer et al., 1986; Condiotte & Lichtenstein, 1981; DiClemente, 1981), ASE was represented as one general factor and all subsequent analyses were conducted on the mean self-efficacy score derived from all 75 questions.

Delay discounting. Delay discounting was measured using an adjusting-delay task (Koffarnus & Bickel, 2014) to determine the delay at which the larger reward loses about 50% of its value compared to the immediate reward. In the task, participants were

Table 1
Sample Characteristics (N = 216)

Characteristics	Mean (*SD*)/Frequency (%)
Years in recovery (Median)	4.72 (9.56)
Age	47.76 (13.9)
Delay discounting rate (lnk)	−5.04 (2.50)
Days since last relapse (Median)	1,780 (3,984)
Ongoing use of drug	21 (9.7)
Female	128 (59.3)
Income	
Less than $9,999	59 (27.3)
$10,000–$29,999	48 (22.2)
$30,000–$49,999	40 (18.5)
$50,000–$69,999	28 (13.0)
$70,000–$89,999	13 (6.0)
More than $90,000	23 (10.8)
White	172 (79.6)
Not-Hispanic	201 (93.1)
Primary Addiction	
Alcohol	135 (62.5)
Cannabis products	12 (5.6)
Nicotine	7 (3.2)
Prescription pain relievers	7 (3.2)
Stimulants	32 (14.8)
Opioids	21 (9.7)
Tranquilizers/Depressants	2 (.9)
Country	
Australia	2 (.9)
Canada	7 (3.2)
Indonesia	2 (.9)
Philippines	5 (2.3)
United Kingdom	3 (1.4)
United States	176 (81.5)
Vietnam	9 (4.2)
Other	12 (5.6)

Table 2
Sample Questions From the Relapse Situation Efficacy Questionnaire

Negative Affect
- How confident are you that you can resist the temptation to drink/use drugs when you are Irritable?
- How confident are you that you can resist the temptation to drink/use drugs when you are frustrated or angry?
Positive Affect
- How confident are you that you can resist the temptation to drink/use drugs when you are Happy?
- How confident are you that you can resist the temptation to drink/use drugs when your arousal or energy level is high?
Restrictive Situations
- How confident are you that you can resist the temptation to drink/use drugs when you must change the location to drink/use drugs?
- How confident are you that you can resist the temptation to drink/use drugs where your drinking/drugs is/are forbidden?
Idle Time
- How confident are you that you can resist the temptation to drink/use drugs when you are alone?
- How confident are you that you can resist the temptation to drink/use drugs when you are in transition between activities?
Social/Food
- How confident are you that you can resist the temptation to drink/use drugs when you have had food or drink in the last 15 minutes?
- How confident are you that you can resist the temptation to drink/use drugs when people are drinking/using drugs in your group?
Low Arousal
- How confident are you that you can resist the temptation to drink/use drugs when you are tired?
- How confident are you that you can resist the temptation to drink/use drugs when you are finding it hard to concentrate?
Craving
- How confident are you that you can resist the temptation to drink/use drugs when your craving is moderate?
- How confident are you that you can resist the temptation to drink/use drugs when your craving is high?

asked to choose between an immediately delivered $500 and a delayed $1,000 reward of hypothetical money. The larger reward was delayed by 3 weeks on the first trial and depending on the prior choice the delay either increased or decreased on the subsequent trial. This process continued for a total of five choice trials (Koffarnus & Bickel, 2014). Underlying the adjusting-delay task is the assumption that the value of the delayed reward is discounted hyperbolically according to Mazur's equation (Mazur, 1987).

In the adjusting-delay task, the measure of ED_{50} (i.e., the delay expected to reduce the value of the larger reward by 50%) was provided by the indifference point (expressed in days). We calculated the inverse of this ED_{50} ($1/ED_{50}$) to provide an estimate of discounting rate (k) based on Mazur's hyperbolic discounting equation (Koffarnus & Bickel, 2014; Yoon & Higgins, 2008). As the observed k values were non-normally distributed (positive skew), the natural log transformation of k was used in analyses.

Statistical Analysis

Zero-order correlations were first conducted to identify relationships between various independent variables. Next, a multiple regression analysis was conducted to determine what variables predicted RSEQ scores. Race was not included in the model because our sample was 78% Caucasian, limiting the comparison of RSEQ scores among the different groups. Age was also not included in the regression model because of its high multicollinearity with the number of days in recovery reported by the participant (as determined by variance inflation factor, $VIF = 44$). Finally, no statistically significant interactions were found. Therefore, only main effects are reported. Because of the large difference in scales among predictors (e.g., income, age, lnk), standardized β coefficients are also reported. All statistical analyses were conducted using in R (R Core Team, 2018).

Results

A total of 216 participants were included in the analysis and sociodemographic characteristics are shown in Table 1. Of the study sample, the majority identified alcohol as their primary drug of dependence. Twenty-one participants self-reported being currently in relapse (ongoing substance use) compared to 195 participants reporting no ongoing use. The total RSEQ score ($Mean = 3.21$, $SD = .78$), consisting of 75 items, was highly reliable ($\alpha = .99$).

Delay discounting and the number of days in recovery were significantly correlated ($r[192] = -0.257$, $p < .001$) indicating that that the longer the participant reported abstinence, the less they discounted. Also, because age was not included in the regression model due to high multicollinarity with the number of days abstinent (see section on statistical analyses above), a zero-order correlation was conducted and a significant relationship was found ($r[192] = 0.41$, $p < .001$) indicating that older participants reported greater ASE. The number of days in recovery and RSEQ scores were also significantly correlated ($r[192] = 0.380$, $p < .001$) meaning that, without controlling for other variables, participants that reported greater periods of abstinence were more confident about their ability to remain abstinent. Finally, Figure 1 shows the relationship of delay discounting to RSEQ scores in participants currently in relapse compared to those not in relapse. The relationship of *lnk* and RSEQ scores was only apparent in participants not currently in relapse, $r = -0.391$, $p < .001$. No relationship of *lnk* and RSEQ scores was found in the participants currently in relapse, $r = -0.133$, $p = .597$, though this sample is too small to derive definitive conclusions.

A multiple regression model ($R^2 = 0.31$, $RMSE = 48.83$) was conducted to predict RSEQ scores (see Table 3). Delay discounting significantly predicted RSEQ scores ($b = -4.96$, $p < .01$) indicating that participants with lower degrees of delay discounting reported higher levels of ASE. Days since last relapse ($b = 0.003$, $p < .001$) and if relapse is currently ongoing ($b = -0.46$, $p < .001$) also predicted RSEQ scores meaning that the longer a participant has maintained abstinence, the more confident they feel in their ability to remain abstinent. Income ($b = 0.001$, $p < .05$) and education ($b = 3.38$, $p < .05$) also predicted RSEQ scores

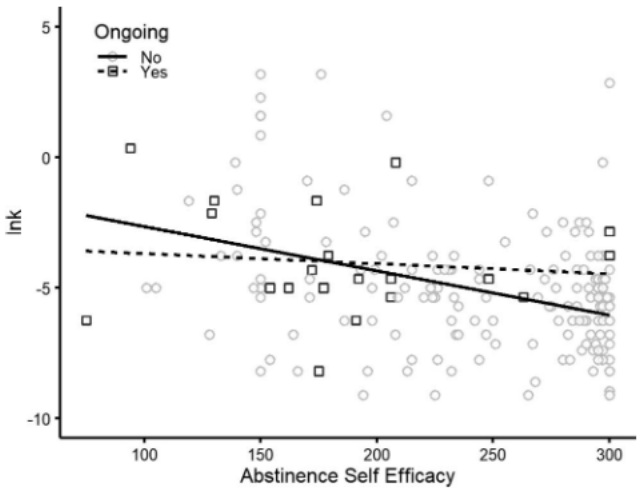

Figure 1. Scatter plot showing the relationship between rates of discounting and self-efficacy score for individuals not in relapse (circles) or currently in relapse (squares).

with higher income and higher education predicting greater ASE. Importantly, no significant moderating interactions were found.

In order to better validate the relationship of delay discounting to RSEQ scores, a hierarchical regression analysis was conducted. First, a model without delay discounting was conducted (R^2 = 0.28) and compared to the regression model above which included delay discounting (R^2 = 0.31). The unique variance accounted for by delay discounting was statistically significant, $F(186) = 9.15$, $p < .01$, further supporting the validity of delay discounting as a predictor of RSEQ scores. In summary, participants who discounted less, were not currently in relapse, reported longer periods of recovery, had higher income, and more education reported greater confidence in their abilities to remain abstinent.

Discussion

In this study, we investigated the association between discounting of delayed monetary rewards and ASE in a sample of individuals from the International Quit and Recovery Registry who were in recovery from substance dependence. The results from the present study indicate significant associations between ASE and discounting, age, and drug use status. Greater ASE scores were observed among those with lower rates of discounting, those who were older in age, and those whose drug use was not ongoing. These results extend the findings of previous research by reporting a significant relationship between rates of discounting and ASE among individuals in recovery from substance dependence. Below, we discuss these findings in detail.

The significant association between discounting and ASE is in concordance with previous studies reporting an inverse association between discounting and the likelihood of successful abstinence following substance abuse treatment (Krishnan-Sarin et al., 2007; MacKillop & Kahler, 2009; Sheffer et al., 2012; Sheffer et al., 2014; Washio et al., 2011; Yoon et al., 2007). However, when assessed among those who identified their drug use as ongoing, discounting did not significantly predict ASE. One possible explanation for this finding is the small number of participants reporting ongoing drug use in this study sample (n = 21), reducing the power to detect an effect. Future research that examines the association between discounting and ASE among a larger sample of individuals in recovery who report ongoing drug use might be warranted.

Given that individuals in recovery with lower ASE are more sensitive to immediate rewards compared to the delayed ones may suggest the need to include interventions that enhance valuation of the future when designing support for continued recovery in this population. Articulating the importance of the long-term reinforcing value of abstinence might be vital in deterring relapse among individuals in recovery with higher rates of discounting. For example, Episodic Future Thinking (EFT), a narrative manipulation in which participants imagine or simulate events that might occur in one's personal future, increases valuation of future rewards while decreasing valuation of immediate rewards such as drugs (Dassen, Jansen, Nederkoorn, & Houben, 2016; Lin & Epstein, 2014; Snider, LaConte, & Bickel, 2016; Stein et al., 2016). Investigating the effect of adding an EFT component (or other interventions that decrease discounting) to interventions that aim to increase self-efficacy or the likelihood of abstinence among this population might be beneficial.

In this study, older age significantly predicted higher ASE scores. Past research has observed heterogeneous results on the relationship between age and self-efficacy. Older age can be an indicator of higher exposure to a variety of experiences and therefore can lead to greater self-confidence across behaviors (Dolan, Martin, & Rohsenow, 2008). On the other hand, lower self-efficacy may sometimes be observed in older age due to a diminished social network, poorer mental health, or higher number of prior unsuccessful treatment attempts (Grella, Hser, Joshi, & Anglin, 1999). Additionally, age has shown no association with ASE (Warren, Stein, & Grella, 2007) when controlling for time spent in treatment. Our results support Warren et al.'s (2007) findings. A potential explanation of the current finding could be that older participants in our sample might have spent more years in recovery and thus may have greater understanding of and confidence in their abstinence abilities though this finding is not as potent as the model main effects would suggest.

Table 3
The Multiple Regression Coefficients for the Self-Efficacy Score, Delay Discounting Rates, and the Study Demographics

Coefficient	Multiple Regression		
	b (SE)	β	CI
Intercept	145.60 (26.70)***	NA	92.85–198.21
Days since last relapse	.003 (.001)***	.23	.002–.005
Rates of discounting (lnk)	−4.96 (1.64)**	−.21	−8.19–1.72
Ongoing use(yes)	−.46 (1.22)***	−.24	−70.04–21.74
Gender	−.65 (7.54)	−.01	−15.54–14.23
Income	.001 (<.000)*	.13	<.000–.004
Education	3.38 (1.82)*	.13	.20–6.96
Substance Type	2.16 (1.89)	.07	−1.57–5.89
Observations	194		
R^2	.31		
RMSE	48.83		

Note. *SE* = Standard error.
* $p < .05$. ** $p < .01$. *** $p < .001$.

A principal component analysis of RSEQ factors in the current sample revealed that self-efficacy scores are primarily unidimensional and not situation specific which appear at odds with findings from Gwaltney et al. (2001a). We believe that these different conclusions can be attributed to several factors. First, Gwaltney et al.'s (2001a) clusters were obtained from prequit RSEQ data, whereas the current principal component analysis used data from individuals in recovery from substance use disorders (postquit data). However, previous studies using postquit data have reported that ASE scores are better in predicting relapse compared to those obtained from pretreatment ASE scores (Becoña, Frojan, & Lista, 1988; Gwaltney, Metrik, Kahler, & Shiffman, 2009; Nicki, Remington, & MacDonald, 1984). Second, the study by Gwaltney et al. (2001a) included smokers only, whereas the current study included individuals in recovery from substance use disorders. Furthermore, as the current study did not replicate Gwaltney et al.'s factors analysis and used all 75 items to calculate the mean score on the RSEQ (Gwaltney et al. used only 43 items), and including individuals with substance use disorders (not only cigarettes) might have contributed to the higher mean score on the RSEQ (3.21 ± .78) reported by the current study compared to those reported by Gwaltney et al. (2.91 ± .65).

A significant feature of the current study was the opportunity to use data from the IQRR, which represents different groups of individuals in recovery from substance use and provides an insight on the association between the likelihood of relapse and delay discounting rates in this specific population. The current study suggests several areas for future investigation. Further research is needed to establish the reliability of the current findings and determine that delay discounting predicts not only ASE but actual relapse. In addition, examining the predictive utility of delay discounting with other types of behavioral problems (e.g., gambling, overeating, exercise noncompliance) maybe worthwhile. Moreover, further research is needed to illuminate the relationships between changes in delay discounting over time and fluctuations in relapse.

Despite the findings of the present study, several limitations are worth considering. First, although the IQRR is a valuable research tool to better understand the phenotype of recovery, the online-based assessment consists of self-report measures and limits our sample to include only those individuals in recovery who use technology, have an e-mail address, and opt-in to the IQRR. In addition, as the precise demographic of individuals in recovery are not known, we could not determine the representativeness of the IQRR sample to individuals in recovery in the United States or internationally. Second, although the present study assessed the relationship between delay discounting and context-specific factors that affect ASE, several variables were not assessed and they may have affected the results. For example, the study did not collect data about the severity of substance use disorder, social support, other psychiatric comorbidities, or stress levels. As those variables may alter rates of discounting and/or ASE, future research that includes assessments of these factors might be necessary to better understand the relationship between ASE and delay discounting. In addition, substance use or abstinence was determined by self-report and not validated biologically. Hence, rates of relapse could have been underreported. Future research that confirms abstinence status biologically or validate the self-reported substance use patterns in the IQRR might be necessary. Moreover, as delay discounting tasks can be affected by intoxication and withdrawal, future research that confirm abstinence at the time of testing (especially among those reporting ongoing use) might be necessary to better assess the association between discounting and ASE in nonabstinent participants. Moreover, we asked participants to self-report being in recovery, relapse, and ongoing substance use but did not provide a specific definition to those terms. Hence, participants might have interpreted the meaning of those terms differently. Finally, although all qualified individuals are encouraged to join the registry, self-selection bias for those who volunteered to join might be present.

Conclusions

The current study expands the generality of previous research investigating rates of discounting and indicates that discounting rates predict abstinence self-efficacy among individuals in recovery from substance use disorders. This finding supports the recent characterizations of delay discounting as a candidate behavioral marker of substance use disorder and may serve as a basis to better identify and target subgroups that need unique or more intensive interventions to address their higher risk of relapse and increase their likelihood of abstinence. Future research that examines the relationship between rates of discounting and abstinence self-efficacy among individuals with other behavior problems involving impulsivity (e.g., gambling, overeating), as well as whether rates of discounting may predict actual relapse might be warranted.

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