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Behavioral Economic Analysis of Natural Resolution of Drinking Problems using IVR Self-Monitoring

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Abstract

This study investigated whether a behavioral economic index of the value of rewards available over different time horizons predicted patterns of alcohol consumption shortly after natural resolution when the risk of relapse is high. Using a computerized Interactive Voice Response (IVR) telephone system, untreated problem drinkers ($n = 41$) self-monitored their daily drinking, monetary expenditures, and surrounding contexts over intervals that ranged from a maximum of 42 to 128 days. Expanded Timeline Followback interviews were conducted before and after the IVR interval and one year after the baseline assessment. Stable resolutions generally and moderation resolutions specifically were associated with proportionally more pre-resolution expenditures on savings and less on alcohol compared to heavy drinking outcomes. The findings replicated and extended earlier research and suggested that the extent to which problem drinkers organized their behavior over longer intervals, even when drinking abusively, helped identify who resolved, including who transitioned to stable moderation.

Keywords

problem drinking; low-risk drinking; natural resolution; behavioral economics; IVR self-monitoring

Since its origins in the experimental analysis of choice behavior in animals (e.g., Rachlin & Green, 1972), behavioral economics has been widely applied to an analysis of drug self-administration and other addictive behaviors in humans (e.g., Bickel & Marsch, 2001; Green & Kagel, 1996; Vuchinich & Tucker, 1988, 1996, 1998; Vuchinich & Heather, 2003). Behavioral economics is a transdisciplinary merger of operant approaches to understanding choice behavior, impulsivity, and impulse control (Ainslie, 1975) with related concepts in micro-economic models of consumer behavior (Rachlin, Battalio, Kagel, & Green, 1981). Both foundation disciplines focus on how consumers allocate limited resources such as time, behavior, and money to obtain commodities available at different costs and over different delays. The merger has yielded conceptual synergies and robust findings about how behavioral allocation varies depending on what other activities are available in the context of choice and the constraints on access to them (e.g., cost to obtain, delay to receipt). For example, the well established *matching law* quantifies how humans and animals alike distribute or “match” their relative rates of responding in proportion to the relative rates of reinforcement available from each activity (Herrnstein, 1970; Rachlin & Laibson, 1997). Conversely, the relative reinforcement value of a given activity can be inferred from the relative resource allocated to obtain it.

Behavioral economics is well suited to guide theory and research on substance abuse, given that the defining behavioral characteristic is excessive demand for drugs in relation to alternative activities that support adaptive functioning (e.g., education, employment, marriage). Substance abuse involves a persistent preference for short-term rewards that lead to long-term costs, and a devaluation of larger, delayed rewards that support adaptive functioning (Vuchinich & Tucker, 1988, 1998). Research has consistently shown that preference for substance use decreases as constraints on access to the substance increase, and as constraints on access to valued non-drug-related alternatives decrease. Moreover, persons with addiction problems tend to devalue, or *discount*, delayed rewards more than normal controls (Bickel & Marsch, 2001; Petry, 2001). Although the extent to which discounting is a cause or effect of addictive behaviors remains unclear, greater discounting indicates that control of current behavior is less sensitive to delayed consequences, such as the adverse long-term effects of substance use.

When considered in relation to the resolution of alcohol and drug problems, this suggests that shifting control of behavior from shorter- to longer-term contingencies should promote and stabilize resolution, and that individuals with greater sensitivity to longer term contingencies, even when using substances excessively, should have a better prognosis. This behavioral economic perspective on resolution received initial support in our earlier prospective studies of natural and intervention-assisted resolution attempts among problem drinkers recruited from the community (Tucker, Vuchinich, & Rippens, 2002; Tucker, Vuchinich, Black, & Rippens, 2006). Shortly after the initiation of abstinence or moderation drinking without problems, participants' expenditures on alcoholic beverages and other activities and commodities during the year prior to resolution onset were assessed comprehensively using an expanded version of the Timeline Followback (TLFB) interview (Sobell & Sobell, 1992). Of primary interest were the proportions of discretionary spending on alcoholic beverages compared to money put into savings for future use, which were conceptualized as representing the value of rewards available over shorter and longer time horizons, respectively. Non-essential expenditures (e.g., for entertainment, gifts, drinking) were the focus of study because personal preference structures should be readily expressed in this economic arena, particularly among middle-income problem drinkers who are typical of natural recovery samples. Relatively greater allocation to savings than to drinking, reflected in lower values on this "*Alcohol-Savings Discretionary Expenditure*" (ASDE) index, was considered indicative of higher relative preferences for delayed rewards made possible by savings compared with more immediate drinking. Lower ASDE values thus should predict resolution stability during the one to two year follow-up intervals used in this research.

As hypothesized, problem drinkers who maintained stable abstinent or non-abstinent resolutions without any problem drinking had lower pre-resolution ASDE values compared with those who had unstable resolutions and relapsed at any point during the follow-up. In addition to contributing to the correct classification of outcomes of natural resolution attempts (Tucker et al., 2002), the ASDE index had unique incremental utility in predicting drinking outcomes in multivariate models that included multiple established predictors (e.g., drinking practices and problems, alcohol reinforcement and self-efficacy expectations, stage of change) (Tucker et al., 2006). It also had predictive utility across natural and intervention-assisted resolution groups (Tucker et al., 2006).

Collectively, these studies showed that contextually sensitive, temporal relations between drinking and other activities as represented by the ASDE added unique information in an account of resolution outcomes. However, many more participants achieved stable abstinent than non-abstinent resolutions, so predictors of moderation apart from abstinence could not be investigated. This issue has gained renewed importance as interventions continue to expand beyond abstinence-oriented treatments for alcohol dependent persons to include population-

based public health interventions for the untreated majority with less serious problems for whom moderation is a more common and acceptable outcome (Tucker, Donovan, & Marlatt, 1999). Although early treatment outcome research found moderation to be associated with lower problem severity, younger age, and stable life circumstances (reviewed Miller & Munoz, 2005; Rosenberg, 1993), there have been few recent advances (Saladin & Santa Ana, 2004).

The present study was a conceptual replication and extension of our TLFB-based studies using Interactive Voice Response self-monitoring (IVR SM) to investigate relationships between behavior economic and drinking variables during the early natural resolution period. Untreated problem drinkers who had stopped drinking abusively within the past 1–3 months self-monitored their drinking, monetary expenditures, and surrounding contexts for up to 128 days. Our interest in the IVR application, which was similar to one previously implemented (Searles, Perrine, Mundt, & Helzer, 1995), was three-fold. First, using daily prospective data collection, we sought to replicate the ASDE-drinking outcome relationships observed in our studies that relied on retrospective TLFB interviews. Although the two methods often show good concordance (Sobell & Sobell, 2003), when differences have been found automated SM yielded higher and presumably more complete reports of sensitive information like substance use or sexual activities (Blumberg, Cynamon, Osborn, & Olson, 2002; Searles, Helzer, Rose, & Badger, 2002).

Second, the IVR SM assessment focused on the early post-resolution period when the risk of relapse is high and drinking practices tend to be variable and unstable. Studying this dynamic period may illuminate the pathways, processes, and contexts that lead to long-term abstinence or moderation, and suggest avenues for stabilizing initial positive change. Compared to clinical samples, moderation outcomes are more common among untreated drinkers who quit on their own (Sobell, Cunningham, & Sobell, 1996). The present study offered an opportunity to investigate early change processes involving moderation and abstinence using new concepts and methods from behavioral economics.

Third, IVR SM holds promise for telehealth applications with problem drinkers who will not seek clinical care but want to quit drinking abusively. In addition to serving as a data collection tool, SM often facilitates positive change (Miller & Wilbourne, 2002) and can be used to monitor progress over long intervals, thereby supporting stepped care when IVR users are at risk for or resume problem drinking (Mundt, Moore, & Bean, 2006).

Based on our prior research, the main hypothesis was that higher ASDE values, reflecting proportionally more pre-resolution expenditures on alcohol and less on savings, should predict a return to abusive drinking during the IVR interval. Although more exploratory, we also sought to evaluate the utility of the ASDE index in predicting moderate drinking during the IVR interval. Over two decades ago, Marlatt (1985, pp. 329–344) suggested that moderation involves a different behavioral regulation process compared to abstinence or relapse, which may be opposite ends of the same dynamic regulation process reflecting over- and under-control of the discrete act of intoxication, respectively. Marlatt hypothesized that stable moderation involves a pattern of repetitive choices about drinking that remain well inside the boundaries of extreme restraint or loss-of-control drinking. Framed in terms of the present behavioral economic analysis, stable moderation appears to require organizing behavior into patterns over longer time frames compared to abstinence or relapse, which appear to reflect shorter term over- or under-control of the problem behavior. Thus, lower ASDE values, reflecting a relative shift in monetary allocation away from drinking toward saving for the future, should predict moderate drinking compared to other drinking outcomes, especially abusive drinking.

Method

Sample Recruitment and Characteristics

Media advertisements in cities in the Southeastern United States were used to recruit untreated problem drinkers who had recently stopped drinking in a problem manner. Respondents who called a toll-free number were screened for eligibility by phone and then by questionnaire using the Michigan Alcoholism Screening Test (MAST; Selzer, 1971), Alcohol Dependence Scale (ADS; Skinner & Horn, 1984), and Drinking Problems Scale (DPS; Cahalan, 1970). As in prior research on natural resolution (Sobell, Cunningham, & Sobell, 1992; Tucker et al., 2002, 2006), eligibility criteria included a minimum 5-year drinking problem history; no prior alcohol treatment or attendance of > 2 Alcoholics Anonymous (AA) meetings; and no current abuse of illicit or prescribed drugs other than tobacco products. Participants were recruited within 1–3 months of initial resolution (abstinence or low-risk drinking), which was deliberately earlier than in our previous TLFB studies that used a 2–6 month window, in order to obtain more variability in drinking during the IVR interval. Moderation was assessed following Sobell et al. (1992) using established criteria based on the health risks of drinking (cf. World Health Organization [WHO], 2000): consumption of < 55 g of 190-proof ethanol per drinking day (assessed by the TLFB interview), no dependence symptoms (assessed by the ADS), and no significant alcohol-related negative consequences (assessed by the DPS).

About two-thirds of ad respondents who screened eligible (64.6%) were scheduled for interviews as part of a pilot study to finalize procedures that involved 42 days of IVR SM or the subsequent main study that involved 128 days of IVR SM. Those who were not successfully enrolled declined participation (10), could not be scheduled or failed to attend the interview (15), or were found ineligible during the interview (4). The enrolled sample included 9 pilot and 44 main study participants; 41 of the 53 consented participants provided baseline ASDE and IVR SM data used in the main analyses. As summarized in Table 1, the sample was predominately middle-aged and middle-class, which is typical of natural recovery samples. The gender composition was similar to the population of problem drinkers, and the racial-ethnic composition approximated the population of the Southeastern United States. Although not an inclusion criterion, all participants met *Diagnostic and Statistical Manual of Mental Disorders, 4th edition* criteria for alcohol dependence (American Psychiatric Association, 1994).

The study was approved by the University Institutional Review Board, and a confidentiality shield was obtained from U.S. Department of Health and Human Services. Participants were told about the shield as part of obtaining their written informed consent.

Procedures

The 9 pilot participants who engaged in up to 42 days of IVR SM completed interview assessments before and after the IVR interval, but did not complete follow-up interviews at 1-year. An additional 44 participants were interviewed, trained, and enrolled in the main 128-day IVR study and completed follow-up interviews at the end of the IVR SM interval and again one year after the initial assessment. At screening, they had been abstinent (88.6%) or drinking moderately (11.4%) for a mean of 2.47 months ($SD = 0.66$). Except for the differences in the IVR interval and 1-year follow-up assessment, the same interview and IVR data collection procedures, described below, were implemented in both phases of the research.

Interviews—Trained interviewers typically conducted the sessions in accessible, physically safe, and mutually agreeable locations near participants' residences (e.g., public library, coffee shop). After giving their written informed consent and being administered a breath test to verify sobriety (Alco-Sensor III, Intoximeters, Inc., St. Louis, MO), participants' drinking practices,

money spent on alcohol and other commodities, and life-events during the pre-resolution year were assessed in initial 2- to 3-hour individual interviews. The follow-up interviews at the end of the IVR SM interval and about 12-months after the study started covered the time since the last interview. Participants received \$40 per interview.

The interview procedures that formed the basis of the present paper are summarized next and were described in earlier publications (e.g., Tucker et al., 2002, 2006). Daily drinking practices were assessed using established TLFB procedures (Sobell & Sobell, 1992), and participant reports of oz. of beer, wine, and liquor intake were converted to ml of 190-proof ethanol for analysis. Following Tucker et al. (2002, 2006), during each TLFB assessment participants also reported how much money they spent each day on alcoholic beverages, regardless of whether the beverages were consumed.

Participants reported their monetary income and expenditures during the same time period using an expanded set of commodity classes derived from the U.S. federal consumer expenditure surveys (Vuchinich & Tucker, 1996). Participants were instructed to bring in financial records (e.g., bank records, paycheck stubs), and documented information was recorded first. Then TLFB interviewing techniques were used to complete the financial assessment. Income in dollars was reported by source (e.g., work income, unemployment benefits, pensions, loans). Expenditures were reported in three general categories, each with subcategories, including housing (e.g., mortgage, rent, utilities), consumable goods (e.g., food, tobacco, alcohol), and other (e.g., entertainment, transportation, loan payments, money saved). Reports typically involved many transactions in each commodity class during the assessment interval and were summed to obtain category totals for analysis. As reported in Tucker et al. (2006), reliability and internal consistency checks on participants' reports of monetary allocation patterns supported the accuracy of reports of financial information.

Following Tucker et al. (2002, 2006), expenditures during the pre-resolution year were separated into obligatory and discretionary categories. Obligatory expenditures were for essential, ongoing, and largely fixed costs of living, including housing, food, medical, loan, retirement, tax, and transportation costs. Discretionary expenditures were for less essential commodities that could be purchased intermittently, including entertainment, recreation, alcohol, tobacco, other consumable goods, gifts, and money saved. The ASDE index was computed as the proportion of discretionary expenditures spent on drinking minus the proportion of discretionary expenditures put into savings. ASDE values could range from -1.0 to 1.0, with lower scores representing proportionally less spending on alcohol and more on savings.

IVR self-monitoring—After the initial interview assessment, participants were trained to use the IVR system and received a workbook that included the IVR questions and definitions of behaviors and events. They were assigned a Personal Identification Number to access the system using a toll free 800 number, which was programmed using commercial software (Ease CT Solutions, Version 4.7.2, Atlanta, GA). Calls could be made at any time, but half were completed by 4:00 pm. To promote compliance, participants accrued points for daily calls that were credited to their “electronic bank” account (Searles et al., 1995). Each daily call was worth 50 cents plus 1 bonus point worth \$1.00. To promote IVR compliance, participants received an additional 3 bonus points for a perfect week. Points were paid out by check every 32 days, and participants could receive up to \$246 for full IVR compliance (128 days, or 18.3 weeks). If they missed a day, they could call in their reports to a staff member; after two missed days, a staff member attempted to call them. Participants completed 77.4% of IVR calls on schedule themselves ($SD = 17.96$), and they received a mean of 70.5% of the total possible IVR monetary compensation ($SD = 33.74$).

The IVR protocol included a daily survey and a weekly survey presented every Monday. The daily survey assessed, for the preceding day, oz. of beer, wine, and liquor consumed, dollars spent on alcoholic beverages and other discretionary commodities (e.g., entertainment, money saved), and numbers of positive and negative life events. On days when no drinking was reported, questions about strategies used to avoid drinking yesterday balanced call duration. The weekly survey asked about drinking days during the past week, life-health functioning, income, and expenditures on commodities other than those assessed daily. On average, the daily and weekly surveys were each completed in ≤ 4 minutes.

Questionnaires—At the end of the initial session, participants completed the Situational Confidence Questionnaire (SCQ; Annis & Graham, 1988) to assess self-efficacy expectations to resist drinking in high-risk situations and the physical health portion of the Health and Daily Living (HDL) Form (Moos, 1985). Table 1 presents total scores from the initial assessment.

Checks on data quality—Participants were asked for a collateral informant (e.g., spouse), but collaterals were not required to avoid biasing the sample in favor of problem drinkers with intact social networks. Collaterals were interviewed at least once for 32 of the 53 participants (60.38%) and verified their reports relevant to the inclusion criteria. In addition, extensive reliability checks were conducted between participants' IVR SM and 6-month TLFB interview reports of drinking and behavior economic variables. Correlations were > 0.90 for aggregated measures of heavy, moderate, and total drinking days and the percentage of days involving expenditures on alcoholic beverages. When directional differences were found between measures, in all cases mean reports were higher on the more contemporaneous IVR, which is consistent with normal forgetting processes. These findings, reported in Tucker, Foushee, Black, and Roth (2007), were indicative of high data quality and added to similar findings from earlier studies (Tucker et al., 2002, 2006).

IVR Compliance and Data Analyses

Most participants engaged in some IVR SM. Seven of 9 pilot participants completed the 42-day IVR interval, 1 quit after 16 days because of a severe hand injury, and 1 did not participate. Seven of 44 participants in the main 128-day study (15.91%) did not participate, saying in some cases that the IVR task was "too much" or "too stressful." The remaining 37 participants completed a mean of 86.41 IVR days ($SD = 43.08$) and a median of 99 days, and 33 provided 1-year follow-up data. Financial data were not available for 5 participants early in the study because of an error in the data collection schedule that was corrected thereafter. Analysis of the IVR data was based on the 41 IVR participants in the pilot and main studies combined who provided a useable baseline ASDE index. The sample of 41 provided daily IVR reports on a mean of 81.6% days ($SD = 21.83$) during their 42- or 120-day study intervals.

To evaluate predictors of moderation, participants were individually classified into one of three mutually exclusive drinking groups (continuous abstainers, 23/41 [56.1%]; low-risk drinkers, 10/41 [24.4%]; or high-risk drinkers, 8/41 [19.5%]) based on their IVR reports using established criteria for safe and hazardous drinking practices (International Center for Alcohol Policies, 2003; National Institute on Alcohol Abuse and Alcoholism, 2005; Sobell et al., 1992; WHO, 2000). Thresholds for hazardous drinking are typically placed at ≥ 5 drinks/day for men and ≥ 4 drinks/day for women, and recommended patterns for low-risk drinking are ≤ 3 drinks/day with ≤ 21 drinks/week for men and ≤ 2 drinks/day with ≤ 14 drinks/week for women. Consistent with these guidelines, low-risk drinkers consumed a mean intake of < 4 drinks (< 60 ml ethanol) per drinking day ($M = 37.52$ ml, $SD = 15.84$), and the highest mean quantity consumed on a single day was 60.18 ml ($SD = 37.83$). High-risk drinkers consumed a mean quantity of > 6 drinks per drinking day ($M = 101.84$ ml, $SD = 26.31$), and the highest mean quantity consumed on a single day was 339.49 ml ($SD = 180.69$).

Unless otherwise specified, 3-group multinomial logistic regression analyses were used to evaluate predictors of IVR drinking categories. The low-risk drinker group was the referent because of our interest in evaluating predictors of moderation apart from abstinence or high-risk drinking. Because of the variable study length and IVR participation in the sample and the changing relapse risk associated with the passage of time, number of days from the first to last IVR call (“study days”) was included as a covariate in analyses that involved drinking reports during the IVR interval. Odds ratios (OR) based on a one standard deviation change in the predictor variable and associated 95% confidence intervals (CI) are reported for continuous variables to allow direct comparisons.

Results

Utility of the ASDE Index to Predict Drinking during the Early Resolution Period

Table 2 presents descriptive statistics and univariate differences between the three IVR drinking groups for the ASDE index and the expenditure components from which it was derived. The basic ASDE relationship found in our earlier studies that compared long-term stable and unstable resolutions without separating moderation from abstinent resolutions was evaluated first in a logistic regression analysis that included the ASDE index and study days as predictors. Consistent with the earlier studies, the ASDE index (but not study days) was a significant predictor of drinking patterns during the early post-resolution period. Compared to high-risk drinkers ($M = 0.43$, $SD = 0.36$), maintaining resolution (abstainers and low-risk drinkers combined) was associated with relatively lower ASDE values ($M = 0.16$, $SD = 0.28$) (OR = 2.99, 95% CI = 1.07, 8.35, $p = .037$), which reflected proportionately less discretionary spending on alcoholic beverages and more on savings prior to resolution. The significant odds ratio showed that a one standard deviation increase in the ASDE index was associated with a 3-fold increase in the odds of high-risk drinking during the IVR period.

Additional 3-group logistic regression analyses that included the abstinent, low-risk, and high-risk drinking groups provided some support for the differential regulation hypothesis. Using the low-risk group as the referent, the low-risk vs. high-risk contrast was significant for the ASDE index (OR = 3.70, 95% CI = 1.09, 12.57, $p = .036$), but not for study days. The odds ratio indicated that a one standard deviation increase in the ASDE index was associated with a 3.7-fold increase in the odds of high-risk drinking compared to low-risk drinking. When the abstinent group was the referent, the abstinent vs. high-risk contrast approached significance (OR = 2.67, 95% CI = 0.91, 7.82, $p = .074$). The contrast between the abstinent and low-risk drinker groups was not significant. Thus, the ASDE index distinguished high- and low-risk drinking among participants who engaged in post-resolution drinking, but did not predict abstinence or low-risk drinking among the resolved participants.

ASDE Index Components

To examine the ASDE findings further, the two components of the index (proportional discretionary expenditures on alcohol versus savings) were compared across the three drinking groups in 3 x 2 (Group x Expenditure Type) repeated-measures analysis of covariance (ANCOVA) using study days as a covariate. The ANCOVA yielded an expected allocation main effect, indicating that participants spent proportionately more on alcohol than savings during the pre-resolution year, $F(1, 37) = 4.97$, $p = .032$, and a significant Group x Expenditure interaction, $F(2, 37) = 3.34$, $p = .046$, which is shown in Figure 1. Comparisons using Fisher’s LSD procedure showed that, as hypothesized, low-risk drinkers had significantly lower discrepancies between alcohol and savings allocations compared to high-risk drinkers ($p = .037$). Abstainers showed the same tendency compared to high-risk drinkers ($p = .055$). The low-risk and abstainer groups did not differ significantly. As shown in Table 2, on average low-risk drinkers saved over 7 times more money than did abstainers and saved more than 14

times more money than did high-risk drinkers. Low-risk drinkers spent 5.2% fewer dollars on alcohol than did abstainers and 46.3% fewer dollars than did high-risk drinkers.

The relative proportions of discretionary spending allocated to drinking and savings prior to resolution thus differentiated the drinking groups in the predicted pattern. Low-risk drinkers showed the smallest and high-risk drinkers showed the largest differential between discretionary spending on alcohol and savings. Abstainers were intermediate between the two drinker groups.

Predictive Utility of the ASDE Index Relative to Other Moderation Predictors

Given the positive results showing that the ASDE index discriminated moderation outcomes during the IVR interval, a series of multinomial logistic regressions were conducted using the RNA group as the referent that included the ASDE index, study days, and one other established moderation predictor. This approach maintained an adequate subject-to-variable ratio in each analysis, given the relatively small number of participants in the three outcome groups. If the ASDE index was a significant predictor under these circumstances, then it explained unique variance in outcomes after accounting for the other predictor. These analyses showed that the high- vs. low-risk drinker contrast was significant or near significant for the ASDE index in models that also included drinking problem duration ($p = .048$), age ($p = .084$), income ($p = .014$), pre-resolution drinking days ($p = .035$), ADS ($p = .036$), MAST ($p = .044$), SCQ ($p = .032$), and physical health scores on the HDL form ($p = .027$). The sole exception was the model that also included mean quantities of alcohol consumed per pre-resolution drinking day. Although this variable showed considerable variability (see Table 1), it was not significantly correlated with the ASDE ($r = .20$, $p = .21$) or with IVR reports of mean quantities consumed per post-resolution drinking day ($r = -.03$, $p = .87$). Overall, the ASDE index continued to predict outcomes among the subset of participants who drank during the follow-up even when paired with another moderation predictor, although it did not discriminate among participants who maintained stable resolutions.

Utility of the ASDE Index to Predict 1-Year Drinking Outcomes

Using the 33 main study participants with 1-year follow-up data, a final set of analyses evaluated the ASDE-drinking outcome relationships observed in our earlier studies over 1–2 year follow-up periods (Tucker et al., 2002, 2006). As in the prior studies, participants' drinking status at 1-year fell into natural categories of stable resolution ($n = 23$), defined as continuous abstinence or low-risk drinking with no episodes of problem drinking, or unstable resolution ($n = 10$) that involved high-risk drinking at some point during the follow-up. Similar to the observed IVR drinking patterns, the stable resolution group at 1-year included resolved abstinent ($n = 13$) and resolved low-risk drinker ($n = 10$) participants.

The univariate logistic regression comparing the stable and unstable resolution groups yielded an odds ratio in the expected direction, but it was not statistically significant (OR = 1.94, 95% CI = 0.79, 4.15, $p = .163$). In the 3-group logistic regression using the resolved low-risk drinker group as the referent, the contrast between the low-risk versus high-risk groups was significant (OR = 3.84, 95% CI = 1.00, 10.22, $p = .05$). ASDE means (*SDs*) for the low-risk, abstinent, and unstable resolution groups were 0.02 (0.35), 0.26 (0.31), and 0.34 (0.32), respectively. Similar to the IVR results, the significant odds ratio showed that a one standard deviation increase in the ASDE index was associated with a 3.84-fold increase in the odds of failing to maintain stable low-risk drinking compared to resuming high-risk drinking during the first year post-resolution. The contrast for the two resolved groups was in the predicted direction, but did not reach significance (OR = 2.68, 95% CI = 0.84, 7.25, $p = .102$).

Discussion

Using an intensive prospective daily self-monitoring method with recently resolved untreated problem drinkers, the present study replicated and extended our earlier TLFB-based findings concerning behavioral economic predictors of stable resolutions that involved abstinence or moderation. Consistent with prior research, participants who remained resolved during the early months of the post-resolution period had significantly lower ASDE values, indicating proportionally more pre-resolution expenditures on savings and less on alcohol, compared to those who engaged in abusive drinking, and the trend remained present at 1-year. The findings contributed further evidence that resource allocation to substance use relative to non-drug alternatives is a viable way to represent the relative reinforcement value of each option and one that has prognostic utility.

The study also provided some support for Marlatt's (1985) differential regulation hypothesis that stable moderation involves a different longer-term process compared to relapse or abstinence. As predicted, even when drinking abusively, problem drinkers who allocated proportionately more discretionary monetary resources to saving for the future relative to more immediate drinking were more likely to achieve non-abstinent resolutions. Those who resumed high-risk drinking had allocation patterns that heavily favored spending on drinking, and abstainers had intermediate patterns. This pattern was observed in the univariate logistic regressions for the IVR and 1-year outcome data when the ASDE was the sole predictor, as well as in the IVR multinomial models that included the ASDE with another moderation predictor. The index was less successful in distinguishing outcomes in the logistic regressions among the subset of participants who did not engage in any high-risk drinking. Nevertheless, when the components of the index was examined as a function of drinking during the IVR interval (per Figure 1), as hypothesized low-risk drinkers had the smallest differential between discretionary spending on alcohol and savings, high-risk drinkers had the largest differential, and abstainers occupied the intermediate position.

The results supported the behavioral economic framework and showed that the overall relationship between lower ASDE values and resolution stability observed in the present and past studies is particularly robust for resolutions involving moderation. The extent to which problem drinkers organized their behavior over longer intervals, even when drinking abusively, helped identify who remained resolved, including who transitioned to stable moderation. These differences based on discretionary spending prior to resolution onset emerged even though the outcome groups had similar income, total expenditure, and discretionary expenditure levels. Discretionary expenditure patterns are the area in the personal economies of financially advantaged natural resolution samples in which heavily time-discounted choices to drink excessively are likely to occur initially. Obligatory expenditures may be more durable until drinking problems worsen considerably. This suggests that discretionary spending patterns generally and the ASDE index in particular may provide early indication of the growing reinforcement value of drinking relative to other activities, in addition to aiding the prediction of resolution outcomes.

If the temporal organization of behavior is a basic individual difference variable involved in addictive processes and outcomes, then developing interventions to facilitate planning skills and lengthen the intervals over which adaptive behavior is organized may promote positive change, especially among persons with shorter time horizons. Although not explicitly designed for this purpose, motivational interviewing techniques highlight the longer view of the future (Miller & Rollnick, 2002) and may promote change by helping to lengthen time horizons and shift behavior allocation patterns from impulsive to self-controlled. Daily self-monitoring of drinking and other risky behaviors appears to function in a similar way by linking daily choices to long-term patterns of behavior that, while less preferred in the short-run, are of much greater

value over the long-run (Rachlin, 1995). Such interventions appear to reduce the appeal of short-term discrete rewards like substance use by helping people with addiction problems view their choices as involving an extended series of linked behaviors, events, and outcomes with higher overall value (Chapman, 1996). Automated IVR SM may be especially well suited for this purpose because it can be made available for long periods of time and used when the need arises, much like AA functions.

The study has limitations related to the modest sample size, which was dictated in part by the obvious trade-offs between measurement intensity and numbers of participants. The observed relationships deserve replication with a larger sample, which may better separate abstinent and non-abstinent resolutions on behavioral economic variables, as well as provide more power to detect established relationships between moderation predictors and drinking outcomes.

Even with the modest sized sample, the study replicated earlier work on the behavioral economics of problem drinking and further suggested that individual differences in time horizons may distinguish moderation from other drinking outcomes. The tendency of persons with addictive disorders to organize behavior around short-term contingencies appears to be a robust finding across several distinct literatures, including behavioral economic (Bickel & Marsch, 2001), social psychology (Keough, Zimbardo, & Boyd, 1999), and adolescent risk-taking (Henson, Carey, Carey, & Maisto, 2006; Robbins & Bryan, 2004) research. This appears to be a central feature of addictive disorders that warrants more attention in clinical and public health intervention programs, particularly those aimed at the majority of problem drinkers who will not cross the clinical threshold for care. This large, under-served population segment is an appropriate target for lower threshold interventions like extended IVR SM that can support positive behavior change, including low-risk drinking. Developing more appealing interventions that can compete with an accessible valued reinforcer (substance use) to obtain the delayed and often probabilistic benefits of treatment or resolution follows from a behavioral economic analysis (Tucker et al., 2002) and is consistent with enduring public health priorities to reduce problem drinking in the population at large.

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Figure 1.

Drinking Group x Discretionary Expenditure interaction among components of the Alcohol-Savings Discretionary Expenditure (ASDE) index. The ordinate shows the proportion of discretionary spending for alcohol and savings during the year prior to resolution onset, and the abscissa shows the high-risk, abstinent, and low-risk drinker groups based on participants' IVR reports during the early post-resolution interval (respective n s = 8, 23, 10). The alcohol-savings proportional expenditure difference was greater for the high-risk drinker group compared to the low-risk drinker ($p = .037$) and abstainer ($p = .054$) groups, which did not differ significantly (see text).

Table 1
Sample characteristics at initial assessment as a function of drinking practices during the early resolution period

Variable	Low-risk drinkers (n = 10)			Abstainers (n = 23)			High-risk drinkers (n = 8)			Sample (N = 41)		
	M	SD	%	M	SD	%	M	SD	%	M	SD	%
Demographic characteristics												
Male			60.0			60.9			62.5			61.0
Female			40.0			39.1			37.5			39.0
White			70.0			65.2			75.0			68.0
Other race/ethnicity			30.0			34.8			25.0			31.7
Married			50.0			61.9			0.0			47.4
Age (years)	40.7	8.0		45.4	10.9		49.9	9.6		45.2	10.3	
Years of education	14.6	3.2		14.2	3.1		14.0	2.7		14.3	3.0	
Weeks employed pre-resolution year	42.1	17.3		27.1	23.7		22.3	25.8		30.4	23.1	
Drinking problem history												
Problem duration (years)	13.7	8.4		17.5	10.7		20.5	9.7		17.1	10.0	
Alcohol Dependence Scale (47 maximum)	18.1	6.8		21.2	11.0		25.2	9.4		21.0	9.7	
Michigan Alcoholism Screening Test (25)	12.1	3.8		14.5	5.1		14.0	3.0		13.8	4.5	
Drinking Problems Scale (40)	15.9	7.1		17.71	8.1		22.4	9.6		18.1	8.2	
Situational Confidence Questionnaire (800)	734.3	77.9		738.9	87.4		628.9	176.8		719.3	108.9	
Physical health (HDL Form; 90)	10.9	8.2		15.1	10.6		12.04	7.74		13.4	9.5	
Pre-resolution year drinking practices (TLFB)												
Total drinking days	293.5	103.0		252.5	131.4		294.0	80.4		270.6	116.0	
Days well functioning	161.6	105.8		160.4	146.4		82.8	106.6		145.6	131.4	
M quantity per drinking day (ml ethanol)	117.5	54.3		267.4	306.6		254.3	103.8		228.3	241.5	

Note. As applicable, maximum possible total scores for scaled questionnaires are given in parentheses after the variable name. P-values are from one-way analyses of variance or chi-square analyses comparing the low-risk drinkers, abstainers, and high-risk drinkers. Days well functioning = abstinent plus light drinking days (gender-adjusted), HDL Form = Health and Daily Living Form, TLFB = Timeline Followback interview.

Table 2
Behavioral economic variables during the pre-resolution year as a function of drinking status during the early resolution period

Variable	Low-risk drinkers (n = 10)		Abstainers (n = 23)		High-risk drinkers (n = 8)		p	Sample (N = 41)	
	M	SD	M	SD	M	SD		M	SD
Total income (dollars)	49,322	34,760	51,079	46,352	52,085	71,032	ns	50,847	48,347
Total expenditures	46,220	31,190	42,226	40,572	60,492	90,635	ns	46,764	51,102
Discretionary expenditures (DE)	15,533	13,112	12,453	10,442	16,595	16,729	ns	14,012	12,286
Expenditures on alcohol (A)	1,969	1,521	2,076	1,801	3,669	2,802	ns	2,361	2,026
Money saved (S)	3,710	9,367	525	1,596	261	738	ns	1,250	4,822
Alcohol/Savings DE index	0.07 ^a	0.28	0.19 ^a	0.28	0.43 ^b	0.36	.046	0.21	0.31

Note. P-values are from one-way analyses of covariance that compared the three drinking status groups from the IVR SM interval using study days as a covariate. Means are in dollars except for the ASDE index, which is a ratio computed as: (A/DE) – (S/DE). ASDE values could range from 1.0 to – 1.0 (1.0 = all DE for alcoholic beverages and – 1.0 = all DE were for saving money; 0 = equal proportions of DE for alcohol and savings). ASDE means with different superscripts differed significantly in pairwise LSD tests.