HHS Public Access

Author manuscript

Addict Behav. Author manuscript; available in PMC 2020 November 01.

Published in final edited form as:

Addict Behav. 2019 November ; 98: 106044. doi:10.1016/j.addbeh.2019.106044.

Alcohol Demand Moderates Brief Motivational Intervention Outcomes in Underage Young Adult Drinkers

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Abstract

Introduction: The Alcohol Purchase Task (APT), a behavioral economic measure of alcohol's reinforcing value (demand), has been used to predict the effects of Brief Motivational Intervention (BMI) on alcohol use outcomes. However, it is not known whether BMI may be more or less efficacious, relative to control, among those with different levels of alcohol demand prior to treatment.

Methods: Non college-attending young adults (N=150) reporting past-month heavy drinking were randomized to a single in-person session of BMI or a relaxation training control (REL). The BMI included delivery of personalized feedback and focused on developing discrepancy between the young adults' goals and their current pattern of alcohol use. At baseline, participants completed assessments of alcohol use and the APT. Drinking levels were re-assessed at 6 weeks and 3 months post-intervention. Demand indices derived from the APT were examined as moderators of treatment effects on follow-up drinking after covarying for baseline alcohol use.

Results—Two of four APT demand indices – intensity and O_{max} - moderated treatment outcomes. Relative to REL, BMI led to greater reductions in total number of drinks consumed and drinks per drinking day among participants with higher baseline alcohol demand. This association was not observed among participants with lower levels of alcohol demand.

Conclusions: These results demonstrate that BMI may be particularly beneficial for those with a high reinforcing value of alcohol. The mechanism for this effect is unclear, and determining the

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DECLARATION OF INTERESTS

The authors have no financial conflicts of interest to disclose.

Conflict of Interest

The authors have not conflicts of interest to report.

process by which BMI confers increased benefit for these individuals is a fruitful area for future work.

Keywords

young adults; behavioral economics; treatment; alcohol

1. INTRODUCTION

Young adults have higher rates of heavy alcohol use than any other age group, and though the overall prevalence of drinking by young people is declining, approximately 11% of young adults meet criteria for an Alcohol Use Disorder[1]. A key risk factor in this age group is not attending college, which is associated with greater levels of drinking[2,3] and alcohol related problems[4,5]. However, despite the frequency of problems experienced by this group, non-college-attending youth are understudied relative to their college attending peers, and theory-based efforts to tailor treatments and identify effective intervention are needed[6]. Brief Motivational intervention (BMI) is one of the most widely supported treatments for heavy drinking among young adults[7,8]. BMI is a supportive, nonjudgmental therapeutic encounter in which the therapist works to resolve a client's ambivalence toward behavior change[9]. However, BMI's efficacy is variable (e.g.,[10]), and work is needed to better understand individual difference factors, (i.e., trait variables that vary across people), that may contribute to its efficacy among high-risk, non-college attending emerging adults.

One individual difference factor that might influence BMI efficacy is behavioral economic demand for alcohol. Demand for a substance is a key concept in the reinforcer pathology model[11,12] of psychoactive substance motivation which posits that risky alcohol use results partially from excessive preference for consuming a substance, despite negative consequences or "costs" of the substance; and partially from excessive preference for immediate reinforcement. These two behavioral processes, substance demand and delay discounting, operate in tandem to elevate the risk for developing a substance use disorder. Although delay discounting is a trans-disease process that can influence the likelihood of initiation of a substance[13], demand for a substance develops over time as a function of expectancies about the substance and experiencing the reinforcing properties of that drug[14]. More specifically, demand for a substance refers to the reinforcing value of the drug to the individual and is expressed as the amount of a substance consumed in the face of increasing costs. For example, alcohol demand is typically assessed using an Alcohol Purchase Task (APT), in which participants report how many standard drinks they would consume across an escalating range of prices[15] in a hypothetical, but realistic, scenario (e.g., an evening of drinking at a bar or party). This measure yields indices of demand including intensity (consumption at zero price), maximum expenditure (O_{max}), and persistence of demand despite increasing costs (elasticity)[16–18], among others. The alcohol purchase task demand metrics have demonstrated good test-retest reliability and construct validity among young adult populations[16,19].

Conceptually, demand for alcohol is an indicator of alcohol reinforcing value and has been linked to alcohol problem severity[19,20]. Moreoverseveral studies have examined the

relationship between demand for alcohol at baseline and behavior following participation in a BMI. MacKillop and Murphy[21] found that college students with relatively greater levels of demand for alcohol reported heavier drinking following BMI treatment. Similarly, Murphy et al.[22] found that heavy drinking college students with greater baseline levels of demand for alcohol reported more drinking at follow-up across all intervention conditions tested, including BMI, personalized feedback-only intervention, and assessment-only control. Moreover, in that study, baseline indices of alcohol demand were reduced following treatment, and reductions in alcohol demand were greater among participants in the BMI and personalized feedback-only intervention compared to those in the assessment control group. Importantly, greater reductions in demand following these brief interventions predicted greater subsequent reductions in drinking. Similarly, Dennhardt et al.[23] found that among college students who completed a BMI, changes in demand post-treatment were predictive of reduced drinking at follow-up. These studies support the validity of demand as an index of severity of use, a risk factor for poorer treatment outcomes, and as a viable target of brief alcohol intervention.

However, little is known about how indices of demand at baseline may *moderate* treatment outcomes. In contrast to a predictive relationship, in which demand at baseline can indicate how likely an individual is to reduce their drinking following treatment,, moderation explores the interaction between demand and treatment condition in order to determine if individuals with relatively high vs. low levels of demand are more likely to respond to one treatment condition relative to the other. The studies mentioned above did not explicitly examine the possibility of moderation of treatment outcomes by baseline demand. Thus, the primary aim of the current study was to explore whether demand for alcohol at baseline moderated BMI efficacy among heavy drinking young adults. We hypothesized that BMI would be relatively more efficacious than a relaxation training control (REL) among participants who valued alcohol highly, and the benefit of BMI would be attenuated at lower levels of demand; in other words, that demand would moderate treatment outcomes. Individuals with lower alcohol demand may be likely to change following assessment combined with a low-threshold intervention such as relaxation training. In contrast, individuals with higher demand may benefit from a more intense intervention that directly targets motivation to reduce alcohol use and to increase engagement in substance-free alternatives to drinking that are consistent with important life goals[24].

2. METHOD

2.1 Parent Study

Data for the current study are drawn from a parent RCT in which BMI successfully reduced heavy drinking and adverse consequences of alcohol use at follow-up relative to a relaxation training control (REL) among non-treatment seeking underage drinkers not currently attending a four-year college or university (For CONSORT diagram, see[25]). The BMI used in this study was delivered proximal to the transition out of high school (with or without graduation), as interventions timed to co-occur with such naturalistic transition points may increase the potential for altering risky drinking trajectories by intervening at a natural point of change[26]. In addition to comprising the typical components included in a BMI with

personalized drinking feedback, this BMI protocol integrated components from a behavioral economic supplement intervention,[27] including personalized feedback on participants' money and time allocation across different categories. The BMI focused on identifying current and longer-term life goals that are relevant to this developmental stage, such as progress toward employment, becoming more financially independent, and establishing stable relationships. The participant received personalized feedback including charts showing the amount of time and money spent drinking versus on other, goal-oriented activities. Then, the therapist worked to develop and explore discrepancies between current alcohol use behaviors and consequences versus progress toward achieving important life goals. In other words, the BMI used in this study explicitly addresses the possibility that participant's alcohol use may be incompatible with other goals. Further information on the intervention can be found elsewhere[25].

2.2 Participants and Procedure.

Participants were recruited from the community using advertisements in local newspapers and online, on local buses, and at in-person recruitment events at local community colleges and high schools, social service agencies, job training programs, and GED classes. To be eligible, individuals had to: 1) be between 17 and 20 years old, 2) be current drinkers, and 3) report at least one occasion of heavy drinking (4+ for women, 5+ for men) in the past month. If still in high school, students had to be within 3 months of graduation. Exclusion criteria included: 1) being enrolled or planning to enroll in a four-year college, university, or in the military within the next year, and 2) plans to move more than 60 miles outside the study area within the next three months. Of the 675 people who completed a screener, 266 were eligible, and 167 enrolled. Participants completed the APT at baseline along with demographic questionnaires.

Participants were an average of 18.14 (*SD*=.97) years old (range= 17-20). The sample was 57.3% male and 42.7% female. Regarding race, 74.0% were White, 16.7% were Black or African American, 4% were American Indian or Alaskan Native, 2.7% were Asian, and 7.3% identified as "other".

Participants completed a baseline assessment, and were randomly assigned to a BMI or REL session, lasting approximately 60 minutes. In-person follow-up assessments occurred at 6 weeks and 3 months after baseline/intervention, with 97% completing 6-week follow-up and 96% completing 3-month follow-up. Participants 18 and older provided informed consent; for those younger than 18, participants provided assent and parental consent was obtained separately by research staff. Participants received $40 for the baseline assessment, $50 for the 6-week follow-up, and $60 for the 3-month follow-up. Bonuses of $10 were provided for those who completed all three assessment sessions, and a $5 gift card was given at each appointment that occurred without rescheduling. All procedures were approved by the Institutional Review Board.

2.3. Measures.

For brevity, only measures used in the current study are described below.

2.3.1 Demographics—A demographic questionnaire assessing age, gender, and race/ethnicity, was administered at baseline.

2.3.2 Outcomes—A calendar-assisted Time Line Follow Back (TLFB)[28] was administered to participants at baseline, and 6-week and 3-months follow-ups and obtained information about daily alcohol use. The recall period was 28 days at baseline and 42 days for the follow-ups. From the TLFB, we calculated total number of standard drinks (ND) and average number of standard drinks per drinking day (DDD).

2.3.3 Alcohol demand.—An alcohol purchase task (APT) was used to measure alcohol demand at baseline. Participants were presented with a hypothetical drinking scenario which asked them assume that 1) they had not previously consumed alcohol, 2) did not have access to other sources of alcohol, and 3) were going to drink all the drinks they reported at that time (i.e., they could not 'save' drinks for later). Participants were asked how many standard drinks (e.g., 12 oz. beer, 5 oz. wine, and/or 1.5 oz of liquor) they would purchase and consume at varying prices ($0.00, $0.25, $0.50, $1.00, $1.50, $2.00, $2.50, $3.00, $4.00, $5.00, $6.00, $7.00, $8.00, $9.00, $10.00, $15.00, and $20.00), with the assumption that they did not have access to other sources of alcohol[15]. Reported consumption was plotted as a function of price, and expenditures at each price were computed by multiplying consumption by price for each amount. The resulting demand and expenditure curves yielded five indices of the incentive value of alcohol used in this study (detailed in 2.4.2 below).

2.4 Data Analysis

2.4.1 Data cleaning.—Prior to creating demand indices, all outliers (>3.29 *SD*s from the mean[29]) on the APT were recoded to the highest non-outlying score. This affected 31 scores, or 1.2% of the data. Outcome variables were log-transformed due to high positive skew. From the 167 enrolled in the parent study, on the APT we excluded 17 (resulting study N=150). As suggested by Stein and colleagues[27], we excluded n=12 participants where there was an increase in consumption at an increased price on two occasions. We also excluded participants with no consumption at a price of zero (n=4), failure to complete the last seven APT items (n=1), and being an extreme outlier at 16 prices (n=1)."

2.4.2 Demand indices calculations.—Consistent with other work (MacKillop et al., 2008; Murphy & MacKillop, 2006) four[1] demand indices were created: 1) breakpoint (first price corresponding to zero consumption); 2) O_{max} (maximum expenditure across all prices); 3) intensity (consumption when drinks are free); 4) elasticity (sensitivity to change in prices). Elasticity was calculated with Prism software (v6, GraphPad Inc.) where k=3.

The first four indices were directly observed from the raw data[16]. Elasticity is the rate parameter of the Koffarnus et al.[30] exponentiated equation:

[1] P_{max}, another derived index, was not included due its collinearity with other indices and generally weak associations with alcohol outcomes.

$$Y = Q_0 * 10^{k\left(e^{-\alpha Q0C} - 1\right)}$$

Greater elasticity values reflect a greater proportional decrease in consumption as a function of price.

2.4.3 Main effect and moderation analyses.—Regression analyses were conducted in two steps to examine main effects and interaction effects. Interaction terms indicate whether the demand indices moderated the intervention effect across four moderators (demand indices), two outcomes (ND and DDD), and two follow-up periods (6 weeks and 3 months). In the main effect model, the corresponding alcohol consumption variable at baseline, an alcohol demand index, and treatment condition, were entered as predictors. All main effects are interpreted from the main effects models. The moderation model included all terms in the main effects model, in addition to a Demand Index x Treatment Condition interaction. All significant interaction effects were probed using PROCESS version 2[31] Model 1, and the expected value of the dependent variable at low, medium, and high (one standard deviation below the mean, mean, and one standard deviation above the mean) values of the moderator are plotted for both conditions, consistent with standard practices to probe moderation effects[32,33]

3. RESULTS

3.1 APT Descriptive statistics.

On the APT, mean intensity was 10.66 drinks (SD =8.23), mean breakpoint was $8.17 (SD=6.12), mean O_{max} was $17.60 (SD=14.08), and mean elasticity was .0087 (SD=.0097). Expenditure across all prices was yielded and inverted *U*-shaped curve, and peaked at $2.50 per drink (Figure 1). At baseline, the median number of drinks during the past 28 days was 34.0, the median number of drinks per drinking day was 5.67, and the median number of alcohol-related problems was 7.0.

3.1.2. Main Effects: Baseline alcohol involvement and alcohol demand—Number of drinks at baseline was associated with number of drinks at both the week 6 (model with intensity: Wald X^2=28.91; model with Omax: Wald X^2=29.83, *ps*<.001) and 3 month follow-ups (model with intensity: Wald X^2=10.19; model with O_{max}: Wald X^2=17.97, *ps*<.01), Drinks per drinking day at baseline was related to drinks per drinking day at both the week 6 (model with intensity: Wald X^2=24.60; model with Omax: Wald X^2=36.33, *ps*<.001) and 3-month follow-ups (model with intensity: Wald X^2=20.13; model with Omax: Wald X^2=20.54, *ps*<.001). There was no direct effect of alcohol demand on follow-up drinking after controlling for baseline alcohol use. See Table 1 for more information.

3.3 Moderation by APT demand indices.

For total number of drinks (ND), intensity was a significant moderator of BMI efficacy at 6 weeks (Wald X^2=7.80, *p*<.01) and 3 months (Wald X^2=4.95, *p*<.05), while O_{max} moderated the effect of BMI efficacy at 6 weeks only (Wald X^2=4.65, *p*<05), but not 3 months (*p*>.05).

For drinks per drinking day (DDD), intensity moderated the effect of BMI efficacy at 6 weeks (Wald X^2=9.71, p<.01), and 3 months (Wald X^2=4.31, p.05), while O_{max} was a moderator at 3 months (Wald X^2=7.75 p<.01), but not 6 weeks. Full results for Intensity and O_{max} are presented in Table 1. Moderation was not observed for any of the models using breakpoint or elasticity, and these results are not reported. All significant interaction effects were probed in Figure 2. These graphs indicate that the relative benefit of BMI increases as baseline alcohol demand increases. In other words, for low demand BMI and REL are roughly comparable; BMI outperforms REL when alcohol demand is high.

4. DISCUSSION

The current study tested whether demand indices would moderate the effect of BMI treatment on drinking outcomes in non-college attending young adults. Intensity and O_{max} moderated the effect of condition on both total number of drinks consumed and average number of drinks per drinking day. The effect persisted throughout the 3 month follow up period. When moderation was significant, we found that among those with high Intensity and O_{max} values, BMI was efficacious at reducing their drinking compared to participants in the control group. The relative benefit of BMI was attenuated or eliminated among participants with lower Intensity or O_{max} after controlling for variance in baseline drinking levels. These results are consistent with other studies which indicate that Intensity, and sometimes O_{max} depending on the domain being studied[34,35], form an underlying construct called Amplitude of demand, which reflects the maximum level of reinforcement that could be derived from alcohol[3612]; while the other demand indices form a Persistence factor reflecting willingness to continue drinking in the face of increasing costs[37]. The amplitude factor of demand has been consistently associated with indicators of problem severity not only among users of alcohol[36], but also among cigarette smokers[38] and marijuana users[39], indicating that this factor may be uniquely clinically relevant.

From the perspective of the reinforcer pathology model, addictive behavior is partly the result of excessive valuation of the immediate reinforcement associated with substance use, as indexed by excessive demand, relative to alternatives reinforcers such as work or non-drug social or leisure activities[40]). The goal of many addiction treatments is to shift behavior away from the problematic substance and toward other, non-drug alternatives. There are several potential interpretations for why BMI was relatively more effective for young adults with higher alcohol demand in the current study. In the BMI used here, therapists elicited participants' observations about how their alcohol use might be affecting progress toward their goals in different developmentally-relevant life domains (e.g., education/training, work, financial independence, moving out of the parental home, social relationships) and develop discrepancy between their alcohol use behavior and these meaningful, alternative sources of reinforcement. The personalized feedback report further highlighted how the participant's drinking behavior reflected a valuation of alcohol over these other reinforcers. For example, participants received a pie chart showing the proportion of discretionary income they spent on alcohol and an estimate of annual alcohol expenditures, and a bar graph depicting time spent in various activity categories, including alcohol use; these were intended to highlight the relative prominence of alcohol within the young adult's lifestyle (e.g., [41]). When the BMI is effective, the increased focus on the value of these non-drug alternatives may shift

some behavior away from alcohol. Indeed, in a secondary analysis of BMI mediators[6], we found that BMI's efficacy in reducing heavy drinking at 3-month follow up was statistically accounted for partially by its effects on seeking alternatives to drinking. This suggests that BMI may be especially efficacious among participants who present with high baseline alcohol demand, in part by increasing the relative value for non-alcohol sources of reinforcement.

Additionally, BMI may have worked by directly reducing the value of alcohol in the participants. For example, the personalized feedback report in the BMI also showed how the participant's drinking compares to national norms for age- and gender-matched young people (which reduced perceived norms for heavy drinking) and listed recent adverse consequences of drinking that participants had experienced. Previous research[15,16] suggests that individuals with elevated demand for alcohol are likelier to have a more severe pattern of drinking, such that their BMI feedback may be more salient (e.g., their time spent drinking and/or recovering may be higher, their number of problems relative to their peers would be higher, etc.) and this may have contributed to participant insights that their drinking exceeded national norms and resulted in meaningful negative consequences. These results also demonstrate that among individuals with low baseline value for alcohol, BMI was not more effective than REL. It may be the case that for emerging adults with low alcohol demand, merely completing the study assessments and the relaxation session could have been sufficient to reduce drinking; resulting in less incremental benefit from the BMI. Alternatively, for those with lower alcohol demand, their BMI feedback around time spend drinking, etc. may already be in line with their perceptions, and therefore less likely to trigger any particular insight.

There were several limitations of this study. First, we tested a number of outcomes, potentially increasing the likelihood of Type 1 error; however, we had clear *a priori* predictions about the directions of these effects, and many of the effects surpass traditional nominal significance. Further, the nature of the significant moderation effects was consistent across outcomes, offering convergent evidence in support of the hypotheses. Second, the follow up period in the parent intervention study was relatively short (3 months). It remains important to see whether these effects extend to predict drinking outcomes over a longer period of time. Finally, we did not re-assess APT indices post-intervention, as has been done in previous studies (e.g., Dennhardt et al.[23]); such a design would have increased our understanding of the specific behavioral economic mechanism(s) by which BMI conferred greater benefit on participants with higher levels of alcohol demand at baseline (i.e., by increasing the value of alternative reinforcers, or decreasing the value of alcohol, or both).

4.1 Conclusions

The current results suggest that among those with high alcohol demand, BMI was relatively more effective. As the field moves forward, these results suggest that high alcohol demand at baseline may be a clinical diagnostic tool that would trigger the use of a BMI as treatment, particularly a BMI which focuses on the individuals' goals in developmentally-relevant domains and how alcohol may be interfering with the attainment of those goals, as in the current study. In contrast, those with low alcohol demand appear to benefit similarly from

either brief treatment, despite the differences in their content and focus. These results extend the clinical utility of the APT by identifying a subgroup of users for whom BMI treatment for alcohol use may be particularly effective.

Acknowledgments

Funding

This study was supported by AA016000 awarded to S.M. Colby. Manuscript preparation was supported in part by grant number K01CA189300 from the National Cancer Institute (Cassidy), T32DA016184 (Bernstein, trainee) and K01DA048087 (Bernstein) from the National Institute on Drug Abuse and R01AA023194 (Magill) R01AA024930 (Murphy, MacKillop) and R01 AA025911 (MacKillop) from the National Institute on Alcohol Abuse and Alcoholism.

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HIGHLIGHTS

- We examined whether baseline alcohol demand moderated brief intervention outcomes in young adult heavy drinkers who were not college students.
- Among those with high demand for alcohol (high reinforcing value), Brief Motivational Intervention (BMI) was especially efficacious.
- Non-college-attending youth who drink heavily and have high alcohol demand may especially benefit from BMI.

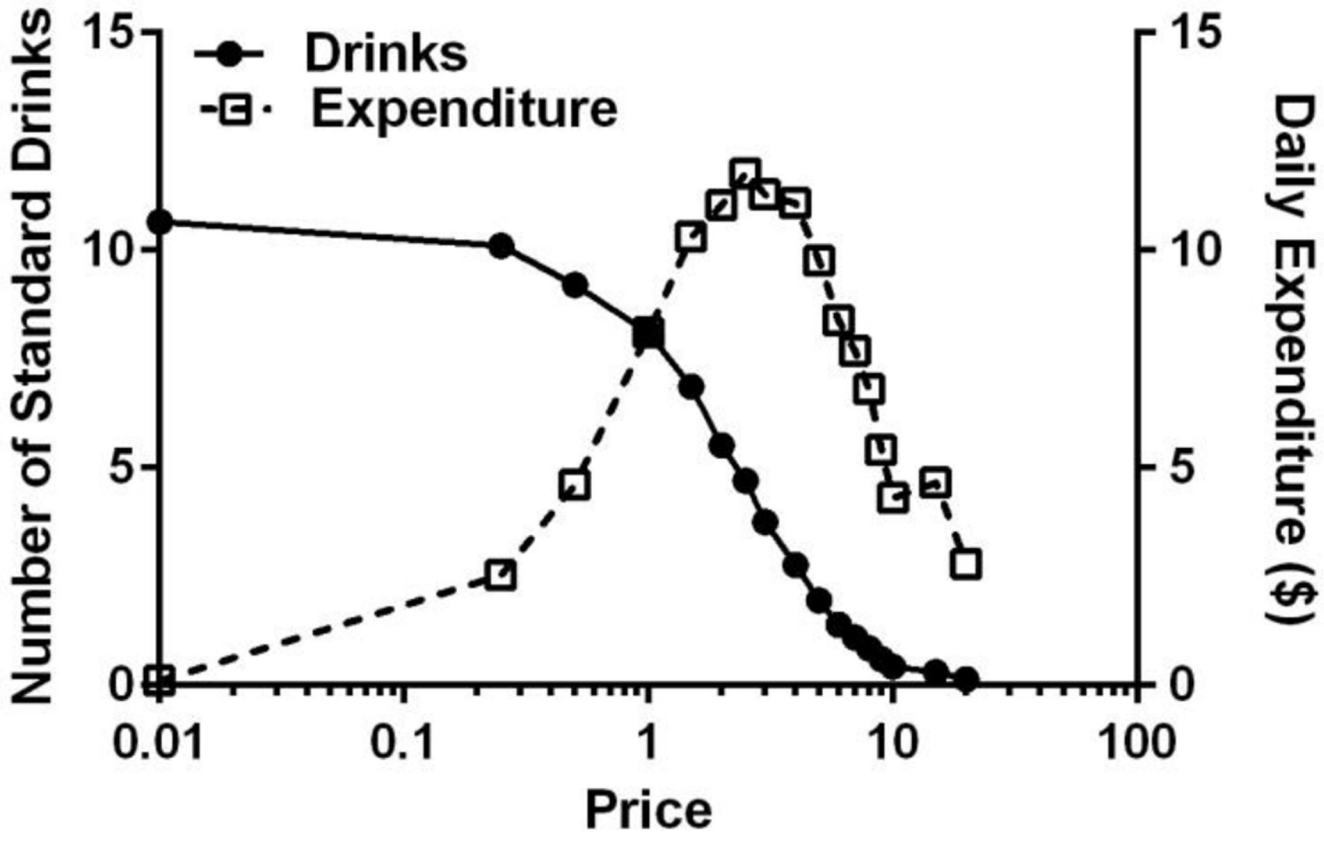

Figure 1.
Average consumption of standard drinks and maximum daily expenditure as a function of APT price. The x-axis represents each price on the APT, from $0 to $20.

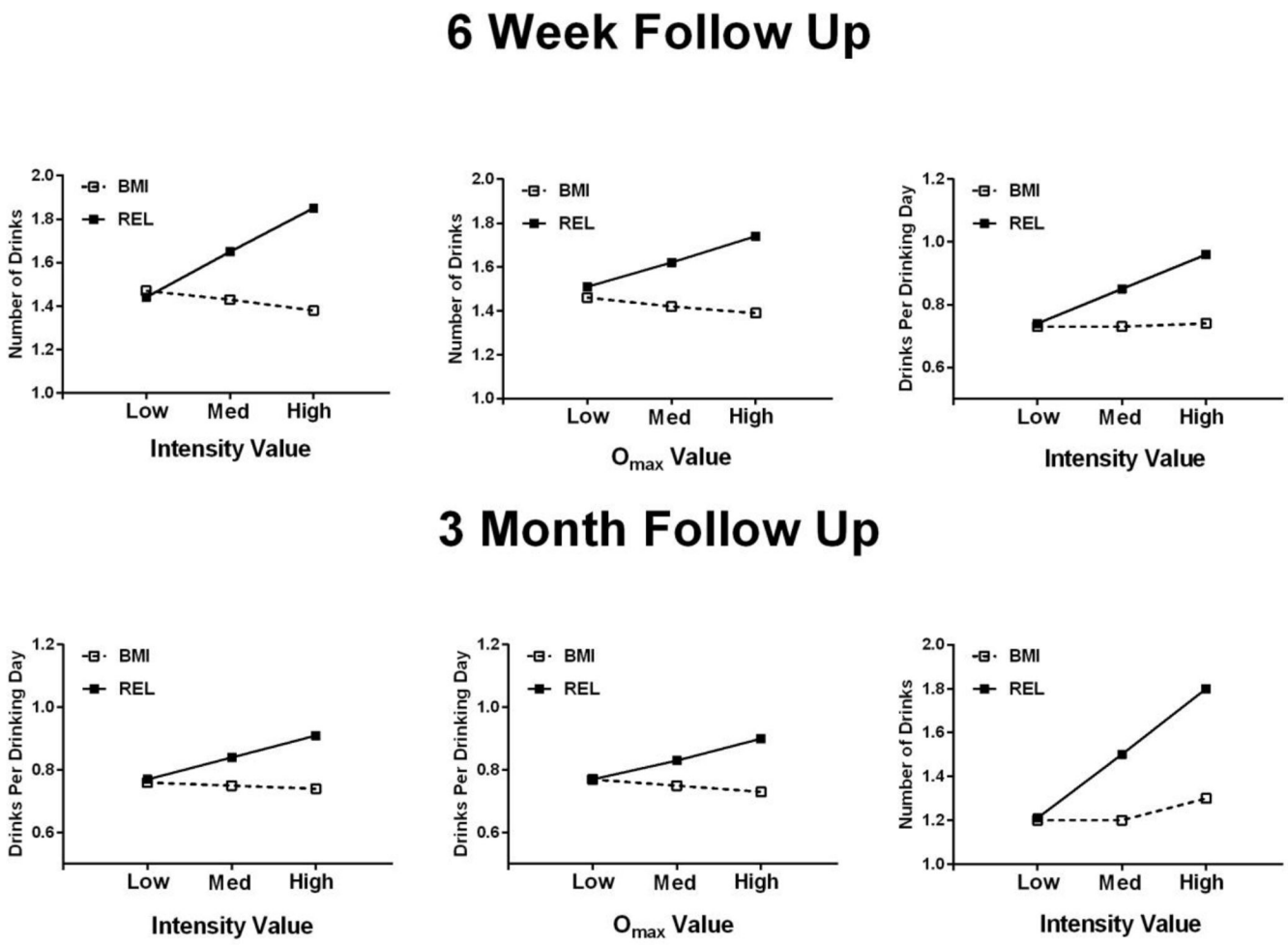

Figure 2:

Interaction Probe of Alcohol Demand Moderating Drinking Outcomes. Gray lines represent BMI condition and black lines represent relaxation control (REL) condition. All significant moderation effects from Table 1 are probed. Low, medium, and high represent −1SD, Mean, and +1SD, respectively. The y-axis represents log-transformed scores.

Table 1.

Results of regression models predicting alcohol treatment outcomes in which alcohol demand indices (Intensity – left; O_{max} – right) moderate treatment group assignment.

	Wald X^2	B	B 95% CI	Wald X^2	B	B 95% CI
Number of Drinks, Week 6						
	Intensity			O_{max}		
BMI Condition	7.96**	−.19	−.32, −.05	8.85**	−.19	−.32, −.06
BL Number of Drinks	28.91***	.00	.00, .00	29.83***	.00	.00, .00
Demand Index	0.03	−.00	−.01, .00	.65	.00	−.00, .00
Demand * Condition	7.80**	−.03	−.05, −.00	4.65*	−.01	−.02, −.00
Number of Drinks, Month 3						
BMI Condition	5.74*	−.20	−.36, −.03	4.89*	−.18	−.35, −.02
BL Number of Drinks	10.19**	.00	.00, .00	17 97***	.00	.00, .00
Demand Index	3.10	.01	−.00, .02	.31	.00	−.00, .00
Demand * Condition	4.95*	−.03	−.05, −.00	2.60	−.01	−.02, .00
Drinks per Drinking Day, Week 6						
BMI Condition	17.36***	−.19	−.15, −.05	16.37***	−.09	−.14, −.05
BL Drinks/Drinking Day	24.60***	.01	.01, .02	36.33***	.01	.01, .02
Demand Index	2.39	.00	−.00, .00	1.69	.00	−.00, .00
Demand * Condition	9.71**	−.01	−.02, −.00	3.66	−.00	−.00, .00
Drinks per Drinking Day, Month 3						
BMI Condition	7.07**	−.08	−.13, −.02	7.69**	−.08	−.14, −.02
BL Drinks/Drinking Day	20.13***	.01	.01, .02	20.54***	.01	.01, .02
Demand Index	.01	.00	−.00, .00	1.32	.00	−.00, .00
Demand * Condition	4.31*	.01	•02, .03	7.75**	.00	−.01, −.00

Notes: Complete Results of the regression models are displayed. BL=Baseline.

B=unstandardized co-efficient. Outcomes are log-transformed. All significant interactions (p<05) are probed in Figure 1.

* p< 05, two-tailed

** p< 01, two-tailed

*** p< 001, two-tailed.