UCSF
UC San Francisco Previously Published Works

Title

Self-Regulation as a Mediator of the Effects of a Brief Behavioral Economic Intervention on Alcohol-Related Outcomes: A Preliminary Analysis

Permalink

https://escholarship.org/uc/item/1900g6nz

Journal

Experimental and Clinical Psychopharmacology, 26(4)

ISSN

1064-1297

Authors

Soltis, Kathryn E
Acuff, Samuel F
Dennhardt, Ashley A
et al.

Publication Date

2018-08-01

DOI

10.1037/pha0000213

Peer reviewed

Self-Regulation as a Mediator of the Effects of a Brief Behavioral Economic Intervention on Alcohol-Related Outcomes: A Preliminary Analysis

Kathryn E. Soltis, Samuel F. Acuff, and Ashley A. Dennhardt
University of Memphis

Brian Borsari
San Francisco Veterans Affairs Health Care System, San Francisco, California and University of California–San Francisco

Matthew P. Martens
University of Missouri

James G. Murphy
University of Memphis

Behavioral economic theory suggests that increased engagement in constructive, substance-free activities that are in the service of long-term goals (e.g., college graduation, career development, health) can decrease alcohol use and related problems. However, engaging in activities such as these in the high-risk college environment requires the ability to self-regulate by avoiding rewarding but risky behaviors (e.g., drinking) while also effectively organizing behavior in the pursuit of delayed academic and career-related rewards. The current secondary data analyses evaluated self-regulation as a potential mechanism of behavior change in an alcohol intervention trial that compared a standard alcohol-focused brief motivational intervention (BMI) plus a behavioral economic substance-free activity session (SFAS) with an alcohol BMI plus relaxation training (reaction time [RT]) session (Murphy et al., 2012). Participants were 82 first-year undergraduate students (50% women; M_{age} = 18.5, SD = .71) who reported 2 or more past-month heavy drinking episodes. After completing a baseline assessment and an individual alcohol-focused BMI, participants were randomized to either the SFAS or the RT session. The BMI + SFAS condition reported greater mean self-regulation at 1 month compared with BMI + RT. Furthermore, self-regulation at 1 month significantly mediated the relation between condition and alcohol-related outcomes at 6-month follow-up. Although preliminary, these results suggest that brief behavioral economic intervention elements that an attempt to increase future goal pursuit and substance-free activities can enhance the short-term efficacy of standard alcohol BMIs and that this effect may be due in part to increases in self-regulation.

Public Health Significance
This study suggests that a brief motivational intervention plus a behavioral economic supplement for heavy drinking in young adult college students enhances self-reported self-regulation, which in turn leads to decreased alcohol-related problems. This study highlights self-regulation as a potentially important treatment target for brief alcohol interventions with young adults.

Keywords: self-regulation, alcohol-related problems, brief motivational interventions, behavioral economics, mechanisms of behavior change

Kathryn E. Soltis, Samuel F. Acuff, and Ashley A. Dennhardt, Department of Psychology, University of Memphis; Brian Borsari, Mental Health Service (116B), San Francisco Veterans Affairs Health Care System, San Francisco, California, and Department of Psychiatry, University of California–San Francisco; Matthew P. Martens, Department of Educational, School, and Counseling Psychology, University of Missouri; James G. Murphy, Department of Psychology, University of Memphis.

Behavioral economic theory conceptualizes alcohol and drug use disorders as reinforcer pathologies that reflect a pattern of persistent overvaluation of the immediate rewards associated with substance use despite the experience of delayed health and social problems (Bickel, Johnson, Koffarnus, MacKillop, & Murphy, 2014). This is due in part to a general tendency to discount future rewards and often is accompanied by diminished engagement in substance-free activities that might ultimately yield these rewards, thereby increasing the relative valuation of more immediate alcohol and drug rewards. As such, self-regulation failure, specifically consistent failure to choose the delayed reward (Karniol & Miller, 1983), may be important to target as a mechanism of behavior change. Behavioral economic theory is compatible with dual-process theories (e.g., competing neurobehavioral decision systems; Bickel et al., 2016), which suggest that an interaction between two neural systems results in an increased propensity for addiction (Stacy & Wiers, 2010). Specifically, the impulsive/reflexive system, implicated in decision making and frequently associated with immediate reward, exerts more influence than the executive system, which is associated with planning and organizing activities in the service of future goals (Bickel, Johnson, et al., 2014; Luehring-Jones et al., 2016; Stacy & Wiers, 2010). Brown (1998) suggests that self-regulation is an individual's ability to form, implement, and adhere to long-term goals or plans, through processes such as planning, self-monitoring, self-evaluation, and implementing behavioral changes. Self-regulation might impact both initial decisions about whether or not to drink (vs. engaging in another activity) and also the amount and manner in which one drinks.

Interventions targeting characteristics such as self-regulation should enhance the functioning of an individual's executive system and their ability to inhibit appetitive impulses and to effectively self-regulate in the service of long-term rewards. Similarly, behavioral economic theory suggests that reinforcer pathologies can be altered by interventions that enhance future orientation and increase engagement in patterns of goal-directed activities (Bickel, Johnson, et al., 2014; Murphy et al., 2012), which generally require some level of self-regulatory capacity to consistently pursue. The current study proposes that brief alcohol interventions that include behavioral economic elements will increase self-regulation, which will in turn lead to reduced alcohol-related problems.

Self-Regulation and Alcohol Misuse in College Student Young Adults

Previous research indicates that self-regulation is consistently associated with alcohol problems but, interestingly, not with alcohol consumption (Carey, Neal, & Collins, 2004; D'Lima, Pearson, & Kelley, 2012; Hustad, Barnett, Borsari, & Jackson, 2010). One previous study showed that individuals with higher levels of self-regulation had a lower probability of experiencing alcohol-related problems compared with those with lower levels, even at higher comparable blood alcohol content levels (Neal & Carey, 2007). Self-regulation and related constructs have also been implicated in response to brief alcohol interventions. In a randomized controlled trial of a brief alcohol intervention, Carey, Scott-Sheldon, Carey, and DeMartini (2007) found that at follow-up, regardless of study group, those high in self-regulation at baseline reported less

follow-up drinking. This suggests that individuals who are high in self-regulation may benefit from simply recalling and reporting on their alcohol use and problems in the assessment battery. Despite the fact that impaired self-regulation among young adult drinkers is a risk factor for alcohol problems and poor response to intervention, most brief alcohol interventions focus on alcohol-specific regulatory behaviors, such as protective behavioral strategies, but do not attempt to increase more general self-regulatory ability.

The Substance-Free Activity Session and Self-Regulation

Murphy et al. (2012) developed a single-session behavioral economic intervention, the substance-free activity session (SFAS; Dennhardt, Yurasek, & Murphy, 2015), that attempts to motivate reductions in alcohol use and problems by increasing motivation to engage in patterns of rewarding, constructive, substance-free activities related to future goals. The SFAS includes a discussion of the student's college and personal goals and how alcohol might impact goal progress. The session also includes personalized feedback on patterns of time allocation related to drinking versus goal-relevant behavior (attending class, studying, exercise) and information on the associations between patterns of time allocation and future rewards (e.g., more time spent drinking is associated with lower grades, which is, in turn associated with lower future income). The SFAS also attempts to increase the value of future outcomes and decrease the value of alcohol by connecting both positive and negative outcomes (e.g., grades, future income) with current choices and decisions (e.g., decisions to spend time studying and attending class vs. drinking). Students are invited to set new time allocation goals that might better accord with their academic and personal goals. The clinician then helps the student to set reasonable goals and to track his or her progress. Thus, the SFAS may help individuals enhance their general ability to self-regulate, which might contribute to their ability to make choices about whether and how much to drink in a manner that reduces the risks of alcohol-related problems (e.g., avoiding drinking the night before class, or drinking in situations that might jeopardize their health, academic, or social/interpersonal functioning). As such, self-regulation might function as a mechanism of behavior change (MOBC; Magill, Kiluk, McCrady, Tonigan, & Longabaugh, 2015) associated with the SFAS.

Present Study

The present study is a secondary analysis from a randomized trial (Murphy et al., 2012) that found that participants receiving brief motivational intervention (BMI) + SFAS sessions demonstrated greater decreases in alcohol-related problems, but not use, at the 6-month follow-up than those receiving BMI + relaxation training (RT). That study also found that the advantage for the SFAS was partially mediated by increases in protective behavioral strategies. The goal of the current analysis is to extend this work by investigating another possible MOBC associated with the BMI + SFAS in light of recent theoretical advances integrating dual-process and behavioral economic principles and theories (Bickel et al., 2016; Bickel, Quisenberry, Moody, & Wilson, 2015). Given that the SFAS focuses on enhancing self-regulation processes that take time to develop and produce change in other behaviors, we hypothesized that (a) self-regulation will be related

to alcohol-related problems, (b) individuals in the BMI + SFAS condition will report greater self-regulation at the 1-month follow-up compared with the BMI + RT condition, and finally (c) self-regulation at 1 month will mediate the relation between condition and alcohol-related problems at 6 months.

Method

Participants and Procedure

As described by Murphy et al. (2012), participants were 82 undergraduate students (50% women; M_{age} = 18.5, SD = 0.71) recruited from a public university in the southern United States. Students were eligible to participate if they were enrolled full time in their first year of college, between 18 and 21 years old, and reported two or more heavy drinking episodes (four/five or more standard drinks for women/men, respectively) in the past month. The sample was 80.5% White/European American, 12.2% Black/African American, 1.2% Native American, 3.6% indicating multiple races, and 2.4% Hispanic/Latino.

Participants completed a baseline assessment and alcohol-focused BMI session that included personalized feedback delivered in motivational interviewing (MI) style (Miller & Rollnick, 2012) and were then randomized to receive either the SFAS or the active control, individual RT including diaphragmatic breathing and progressive muscle relaxation (see Murphy et al., 2012) for a description of all interventions and primary outcomes). The SFAS was administered in MI style and included discussions highlighting long-term income implications of graduating college with a high grade point average, the association between academic engagement and grade point average, personalized feedback on weekly time allocation to alcohol versus academic and other constructive activity categories, and personalized lists of local, available substance-free activities associated with the student's personal and educational/career interests, and short- and long-term goal setting. The university's institutional review board approved all procedures (IRB #2152, Memphis College Adjustment Study).

Measures

Alcohol consumption. Participants estimated the total number of standard drinks they consumed each day during a typical week in the past month using the Daily Drinking Questionnaire (Collins, Parks, & Marlatt, 1985). These numbers were summed to produce an estimate of drinks per week.

Alcohol problems. The Young Adult Alcohol Consequences Questionnaire (YAACQ; Read, Merrill, Kahler, & Strong, 2007) was used to assess alcohol-related problems experienced in the past month. Internal consistency for the YAACQ at baseline and 6-month follow-up was .91 and .95, respectively.

Self-regulation. Behavioral regulation and the ability to delay gratification were measured using the 31-item Short Self-Regulation Questionnaire (Carey et al., 2004). Statements related to self-regulation, such as "I usually keep track of my progress toward my goals" and "I have a hard time setting goals for myself" were rated on a 5-point Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree). All items were then summed to create a total self-regulation score, with higher scores indicating better self-regulation. Internal consistency for the Short Self-Regulation Questionnaire at baseline and 1-month follow-up was .94 and .93, respectively.

Data Analysis Plan

Outliers were winsorized by correcting values outside 3.29 SD above the mean to 1 unit higher than the largest nonoutlier (Tabachnick & Fidell, 2013). Drinks per week and past-month alcohol problem values were square root transformed at all time points to be within an acceptable range of skewness and kurtosis (−2 to 2). The PROCESS macro (Hayes, 2013) for SPSS (Statistics for Mac, version 24.0, released 2016; IBM Corp., Armonk, NY) was used to test the hypotheses that study condition would influence self-regulation at 1-month follow-up, which in turn would impact alcohol-related outcomes at 6-month follow-up. Given that the effect sizes of mediation analyses are typically small and most mediation studies are underpowered in terms of sample size, we elected to utilize a bias-corrected nonparametric bootstrapping method of 5,000 samples with a 95% confidence interval because this approach makes no assumptions about the sampling distribution (Hayes, 2013) and affords greater power compared with other mediation methods (Fritz & Mackinnon, 2007). Our model included baseline self-regulation and alcohol consumption, as well as baseline alcohol-related problems, as covariates, which were accounted for in each path of the mediation model.

Results

All 82 randomized participants completed both intervention sessions. One participant did not complete the 1-month follow-up (N = 81, 99% follow-up rate), and 11 participants did not complete the 6-month follow-up (N = 71, 87% follow-up rate). Another eight participants completed an abbreviated telephone follow-up at 6 months that did not include the YAACQ. Therefore, our final mediation sample consisted of 63 participants who completed all measures at all three time points. Self-regulation total scores at baseline were negatively correlated with the number of alcohol-related problems reported at baseline but were not associated with past-month alcohol consumption (see Table 1). There were no significant baseline differences in drinking, alcohol problems, or self-regulation across conditions. At 6-month follow-up, eight participants across both conditions reported no alcohol consumption in the past month.

Self-Regulation as a Mediator of the Relation Between Study Condition and Alcohol-Related Problems

Participants in the BMI + SFAS condition reported a significant increase in self-regulation from baseline to 1-month follow-up, whereas participants in BMI + RT did not (see Figure 1). In a mediation model including baseline self-regulation, alcohol-related problems, and alcohol consumption as covariates, 1-month self-regulation significantly mediated the relation between condition (unstandardized a path = 6.8[2.4], p = .006) and 6-month alcohol-related problems (unstandardized b path = −.04[.02], p = .012), such that individuals in the BMI + SFAS condition demonstrated greater mean self-regulatory capacity at 1-month follow-up, which in turn was associated with fewer reported alcohol-

Table 1
Descriptive Statistics and Correlations Across Time Points

Total	N	M (SD)	Range	Skew	1	2	3	3a	3b	4	4a	4b	5	5a
1. Gender	82	—			—									
2. Race	82	—			.00	—								
3. T1 self-regulation	82	110.17 (18.4)	88	−.30	−.16	−.08	—							
3a. T2 self-regulation	78	111.04 (16.8)	76	−.07	−.17	−.09	.80**	—						
3b. T3 self-regulation	67	113.52 (17.6)	82	−.02	−.12	−.15	.73**	.79**	—					
4. T1 alcohol problems[a]	82	13.88 (8.6)	37	.53	.04	.03	−.36**	−.42**	−.31*	—				
4a. T2 alcohol problems[a]	78	9.88 (9.2)	40	1.19	−.08	.04	−.37**	−.47**	−.38**	.64**	—			
4b. T3 alcohol problems[a]	67	9.16 (9.7)	40	1.40	−.11	.05	−.37**	−.50**	−.49**	.54**	.74**	—		
5. T1 alcohol use[a]	82	16.87 (11.5)	55	1.25	−.20	.19	−.12	−.13	−.18	.59**	.59**	.53**	—	
5a. T2 alcohol use[a]	80	10.36 (8.4)	38	1.39	−.17	.14	−.19	−.19	−.22	.50**	.73**	.60**	.72**	—
5b. T3 alcohol use[a]	71	12.48 (11.1)	50	1.39	−.23*	.12	−.13	−.27*	−.27*	.43**	.57**	.69**	.58**	.71**

BMI + SFAS	N	M (SD)	Range	Skew		BMI + RT	N	M (SD)	Range	Skew
3. T1 self-regulation	41	111.29 (20.4)	88	−.55		3. T1 self-regulation	41	109.05 (16.3)	72	.06
3a. T2 self-regulation	39	115.41 (18.0)	76	−.56		3a. T2 self-regulation	39	106.67 (14.5)	65	.33
3b. T3 self-regulation	37	118.19 (20.3)	82	−.49		3b. T3 self-regulation	30	107.77 (11.4)	43	−.26
4. T1 alcohol problems[a]	41	12.95 (8.0)	30	.36		4. T1 alcohol problems[a]	41	14.80 (9.0)	37	.61
4a. T2 alcohol problems[a]	39	7.18 (6.6)	27	1.06		4a. T2 alcohol problems[a]	39	12.59 (10.6)	40	.86
4b. T3 alcohol problems[a]	37	6.72 (7.2)	27	1.30		4b. T3 alcohol problems[a]	30	12.17 (11.5)	40	1.05
5. T1 alcohol use[a]	41	16.06 (11.3)	51	1.39		5. T1 alcohol use[a]	41	17.68 (11.9)	55	1.16
5a. T2 alcohol use[a]	41	9.45 (6.7)	27	1.00		5a. T2 alcohol use[a]	39	11.32 (9.9)	38	1.33
5b. T3 alcohol use[a]	37	10.92 (9.3)	36	.92		5b. T3 alcohol use[a]	34	14.18 (12.7)	50	1.43

Note. T1 = baseline; T2 = 1-month follow-up; T3 = 6-month follow-up. Italicized skew values indicate posttransformation skew value.
[a] Variable transformed for correlations.
* $p < .05$.   ** $p < .01$.

related problems at 6-month follow-up (unstandardized indirect effect = −.27 [SE = .16], 95% confidence interval [CI] [−.66, −.03]; standardized indirect effect = −.12 [SE = .07], 95% CI [−.29, −.01]; direct effect = .05[.30], p = .86; see Figure 2). Because of inconsistent mediation and suppression effect (Mac-Kinnon, Krull, & Lockwood, 2000), it is impractical to interpret the derived percentage mediation effect (P_M = ratio of indirect effect to total effect) of self-regulation because the resulting value is greater than 1 (P_M = 1.24). The absolute value of the ratio of the indirect effect to the direct effect, an alternative index of explained variance, was greater than 1, indicating that more of the total effect

in the model was determined by the indirect effect of self-regulation.

Although there were no significant differences in alcohol consumption at follow-up between the two conditions, because mediation can be present in the absence of direct effects (Hayes, 2009), we conducted exploratory analyses to evaluate self-regulation as a mediator of change in alcohol consumption. In a mediation model including gender and baseline self-regulation and alcohol consumption as covariates, 1-month self-regulation significantly mediated the relation between condition and 6-month alcohol consumption (standardized indirect effect = −.12 [SE = .07], 95% CI [−.29, −.01]). Gender was included in this model because previous research has demonstrated gender differences in alcohol consumption.
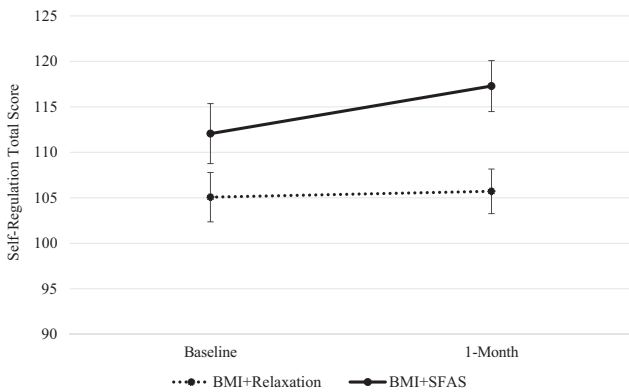

Figure 1. Mean total self-regulation scores reported from baseline to 1 month by condition note. Figure presents mean scores for only those who completed all time points.
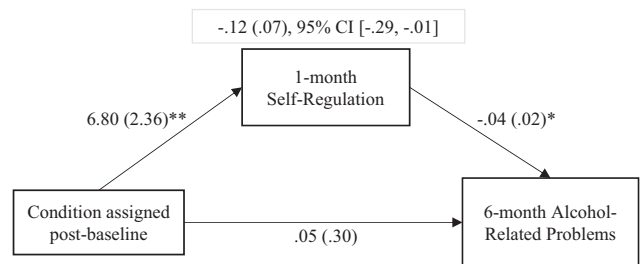

Figure 2. Single mediator conceptual model predicting alcohol-related problems with unstandardized pathway coefficients and standard errors. * $p < .05$, ** $p < .01$ or 95% confidence interval does not include zero.

Discussion

This is the first study to evaluate the effect of a brief behavioral economic intervention on self-regulation. Baseline self-regulation was associated with baseline alcohol-related problems, which is consistent with previous research indicating relations between self-regulation and alcohol problems, even in the absence of direct relations between self-regulation and alcohol use (Carey et al., 2004; D'Lima et al., 2012; Hustad et al., 2010). Furthermore, self-regulation was a significant MOBC, such that those who received the BMI + SFAS intervention on average reported greater self-regulation at the 1-month follow-up, compared with those who received BMI + RT, which in turn led to lower alcohol consumption and fewer reported alcohol-related problems at the 6-month follow-up. Notably, participating in a standard alcohol-focused BMI + RT did not increase self-regulation or reduce alcohol problems.

These results should be considered preliminary in light of the small sample size but suggest that the various elements in the SFAS (e.g., goal setting, feedback on activity patterns and possible substance-free activities to pursue, discussions of the impact of drinking and time allocation on future goals) may impact drinking and alcohol problems via enhancing one's overall ability to self-regulate in the context of choices between drinking and pursuing other activities. Encouraging students to expand their time horizon to include the more distant future, and to connect patterns of their current behavior and decision making to valued future outcomes, may enhance their ability to effectively organize their behavior around distal outcomes, thereby delaying gratification. This is consistent with previous analyses that showed that the SFAS increased future time orientation and evening studying, although those variables did not mediate the treatment effects (Murphy et al., 2012). These prior analyses, taken together with the current study, suggest that the SFAS works in part because of increasing future orientation and the effective organization of behavior in pursuit of those goals. Additionally, the clinicians' use of MI during the SFAS may contribute to increased self-regulation because this style encourages evoking personal arguments for change (Miller & Rollnick, 2012), making the decision-making process more salient by facilitating reflection on behaviors and choices and focusing on the personal future benefits of behavior change. Indeed, research supports that the strength of change talk predicts a higher percentage of days abstinent from drugs at follow-up (Amrhein, Miller, Yahne, Palmer, & Fulcher, 2003). As such, verbalizing discrepancy (vs. simply acknowledging internally) may contribute to increased self-regulation. Future research should investigate the utility of the SFAS components for other disorders characterized by deficits in self-regulation (e.g., other substance use disorders, behavioral addictions).

Of note, the SFAS followed an alcohol BMI, which may have prompted other self-regulatory behaviors, such as protective behavioral strategies (PBS)—which have previously been described as drinking-specific self-regulation (Pearson, Kite, & Henson, 2013) and were also a significant mediator in this sample (Murphy et al., 2012). However, bivariate correlations between self-regulation and PBS in this sample demonstrated only a small amount of shared variance, $r = .23$, $p = .04$, suggesting that self-regulation and PBS are at least somewhat distinct. Thus, consistent with the content across the two sessions, the BMI +

SFAS was associated with increases in both alcohol specific and general self-regulatory abilities, and both of these proximal outcomes were associated with reductions in alcohol problems. Future research should evaluate multiple or sequential mediation with a more powered sample. Another study showed that individuals low in self-regulation benefited more from PBS compared with those high in self-regulation, indicating that PBS interventions may be most useful for those with deficits in global self-regulation (D'Lima et al., 2012). Indeed, PBS and self-regulation appear to have overlapping features but to some extent are distinct; therefore, there is a clear need for further evaluation of PBS and self-regulation as potentially unique mediators.

Despite the robust associations between self-regulation and alcohol-related outcomes (Carey et al., 2007; D'Lima et al., 2012; Hustad et al., 2010), most standard BMIs focus on self-regulation only in the context of drinking (i.e., PBS) and do not attempt to increase global self-regulation regarding short- and long-term goals that are unrelated to alcohol or substance use. Research in other health behavior domains, however, suggest that interventions that increase certain behaviors such as self-monitoring, planning, and self-evaluation may lead to enhanced global self-regulation (Baumeister, Gailliot, DeWall, & Oaten, 2006; Hofmann, Schmeichel, & Baddeley, 2012; Teixeira et al., 2015). Self-regulation may also be enhanced by interventions that attempt to increase executive functioning/working memory, reduce delay discounting, and reduce automatic approach tendencies and attentional bias toward alcohol (Bickel et al., 2015; Cristea, Kok, & Cuijpers, 2016; Dennhardt et al., 2015). In a recent systematic review of the research on self-regulation as a MOBC, Roos and Witkiewitz (2017) suggest that the inconsistent link between self-regulation and reductions in substance use may be due to the lack of attention to contextual factors (both immediate/situational and within the broader context) and propose a contextual model of self-regulation change mechanisms to address this shortcoming. This model suggests that during change processes the interaction between self-regulation and contextual factors is not stagnant or uniform across individuals; rather it is dynamic and likely unique to the individual and the situation.

Strengths, Limitations, and Future Directions

The current study utilized an RCT design that controlled for the effects of MI and contact time associated with the SFAS and demonstrated specific effects for BMI + SFAS versus BMI + RT on self-regulation. All study variables were measured at multiple time points, and we demonstrated initial evidence for enhanced self-regulation as a function of the SFAS.

Limitations to this study include a relatively small, homogenous sample and relatively short follow-up duration. Furthermore, although bias-corrected bootstrapping does result in increased power compared with other mediation methods, this approach has also demonstrated higher-than-normal rates of Type I error (Mackinnon, Lockwood, & Williams, 2004). Therefore, the results should be interpreted cautiously, and future research should attempt to replicate this study utilizing a larger, more diverse sample and longer follow-up period. Second, the study utilized retrospective self-report measures of self-regulation, alcohol consumption, and related problems. Future research should include prospective measurement of these variables using an ecological momentary assessment approach. Finally, as noted above, several aspects of the

BMI + SFAS may contribute to the change in self-regulation and reduction in alcohol problems; therefore, future research should dismantle the intervention to identify the active ingredients.

Summary and Clinical Implications

Young adulthood is a critical developmental period in which executive functioning has not fully formed and may be most susceptible to both harm (from drinking and drug use) and enhancement via interventions and establishing constructive behavior patterns. The current study supports brief interventions that include MI and behavioral economic elements focused on enhancing patterns of future oriented and goal-directed behavior. These approaches appear to have the potential to enhance self-regulatory capacity and to influence alcohol-related outcomes in high-risk young adult drinkers.

References

Amrhein, P. C., Miller, W. R., Yahne, C. E., Palmer, M., & Fulcher, L. (2003). Client commitment language during motivational interviewing predicts drug use outcomes. *Journal of Consulting and Clinical Psychology, 71,* 862–878. http://dx.doi.org/10.1037/0022-006X.71.5.862

Baumeister, R. F., Gailliot, M., DeWall, C. N., & Oaten, M. (2006). Self-regulation and personality: How interventions increase regulatory success, and how depletion moderates the effects of traits on behavior. *Journal of Personality, 74,* 1773–1801. http://dx.doi.org/10.1111/j.1467-6494.2006.00428.x

Bickel, W. K., Johnson, M. W., Koffarnus, M. N., MacKillop, J., & Murphy, J. G. (2014). The behavioral economics of substance use disorders: Reinforcement pathologies and their repair. *Annual Review of Clinical Psychology, 10,* 641–677. http://dx.doi.org/10.1146/annurev-clinpsy-032813-153724

Bickel, W. K., Mellis, A. M., Snider, S. E., Moody, L., Stein, J. S., & Quisenberry, A. J. (2016). Novel therapeutics for addiction: Behavioral economic and neuroeconomic approaches. *Current Treatment Options in Psychiatry, 3,* 277–292.

Bickel, W. K., Quisenberry, A. J., Moody, L., & Wilson, A. G. (2015). Therapeutic opportunities for self-control repair in addiction and related disorders: Change and the limits of change in trans-disease processes. *Clinical Psychological Science, 3,* 140–153. http://dx.doi.org/10.1177/2167702614541260

Brown, J. M. (1998). Self-regulation and the addictive behaviors. In W. R. Miller & N. Heather (Eds.), *Applied clinical psychology. Treating addictive behaviors* (2nd ed., pp. 61–73). New York, NY: Plenum Press. Retrieved from http://dx.doi.org/10.1007/978-1-4899-1934-2_5

Carey, K. B., Neal, D. J., & Collins, S. E. (2004). A psychometric analysis of the self-regulation questionnaire. *Addictive Behaviors, 29,* 253–260. http://dx.doi.org/10.1016/j.addbeh.2003.08.001

Carey, K. B., Scott-Sheldon, L. A. J., Carey, M. P., & DeMartini, K. S. (2007). Individual-level interventions to reduce college student drinking: A meta-analytic review. *Addictive Behaviors, 32,* 2469–2494. http://dx.doi.org/10.1016/j.addbeh.2007.05.004

Collins, R. L., Parks, G. A., & Marlatt, G. A. (1985). Social determinants of alcohol consumption: The effects of social interaction and model status on the self-administration of alcohol. *Journal of Consulting and Clinical Psychology, 53,* 189–200. http://dx.doi.org/10.1037/0022-006X.53.2.189

Cristea, I. A., Kok, R. N., & Cuijpers, P. (2016). The effectiveness of cognitive bias modification interventions for substance addictions: A meta-analysis. *PLoS ONE, 11,* e0162226. http://dx.doi.org/10.1371/journal.pone.0162226

Dennhardt, A. A., Yurasek, A. M., & Murphy, J. G. (2015). Change in delay discounting and substance reward value following a brief alcohol and drug use intervention. *Journal of the Experimental Analysis of Behavior, 103,* 125–140. http://dx.doi.org/10.1002/jeab.121

D'Lima, G. M., Pearson, M. R., & Kelley, M. L. (2012). Protective behavioral strategies as a mediator and moderator of the relationship between self-regulation and alcohol-related consequences in first-year college students. *Psychology of Addictive Behaviors, 26,* 330–337. http://dx.doi.org/10.1037/a0026942

Fritz, M. S., & Mackinnon, D. P. (2007). Required sample size to detect the mediated effect. *Psychological Science, 18,* 233–239. http://dx.doi.org/10.1111/j.1467-9280.2007.01882.x

Hayes, A. F. (2009). Beyond Baron and Kenny: Statistical mediation analysis in the new millennium. *Communication Monographs, 76,* 408–420. http://dx.doi.org/10.1080/03637750903310360

Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach.* New York, NY: Guilford Press.

Hofmann, W., Schmeichel, B. J., & Baddeley, A. D. (2012). Executive functions and self-regulation. *Trends in Cognitive Sciences, 16,* 174–180. http://dx.doi.org/10.1016/j.tics.2012.01.006

Hustad, J. T. P., Barnett, N. P., Borsari, B., & Jackson, K. M. (2010). Web-based alcohol prevention for incoming college students: A randomized controlled trial. *Addictive Behaviors, 35,* 183–189. http://dx.doi.org/10.1016/j.addbeh.2009.10.012

Karniol, R., & Miller, D. T. (1983). Why not wait? A cognitive model of self-imposed delay termination. *Journal of Personality and Social Psychology, 45,* 935–942. http://dx.doi.org/10.1037/0022-3514.45.4.935

Luehring-Jones, P., Dennis-Tiwary, T. A., Murphy, J. G., Dennhardt, A., Lindgren, K. P., Yarmush, D. E., & Erblich, J. (2016). Favorable associations with alcohol and impaired self-regulation: A behavioral economic analysis. *Drug and Alcohol Dependence, 163,* 172–178. Advance online publication. http://dx.doi.org/10.1016/j.drugalcdep.2016.04.017

MacKinnon, D. P., Krull, J. L., & Lockwood, C. M. (2000). Equivalence of the mediation, confounding and suppression effect. *Prevention Science: The Official Journal of the Society for Prevention Research, 1,* 173–181. http://dx.doi.org/10.1023/A:1026595011371

Mackinnon, D. P., Lockwood, C. M., & Williams, J. (2004). Confidence limits for the indirect effect: Distribution of the product and resampling methods. *Multivariate Behavioral Research, 39,* 99–128. http://dx.doi.org/10.1207/s15327906mbr3901_4

Magill, M., Kiluk, B. D., McCrady, B. S., Tonigan, J. S., & Longabaugh, R. (2015). Active ingredients of treatment and client mechanisms of change in behavioural treatments for alcohol use disorders: Progress 10 years later. *Alcoholism, Clinical and Experimental Research, 39,* 1852–1862. http://dx.doi.org/10.1111/acer.12848

Miller, W. R., & Rollnick, S. (2012). *Motivational interviewing: Helping people change.* New York, NY: Guilford Press.

Murphy, J. G., Dennhardt, A. A., Skidmore, J. R., Borsari, B., Barnett, N. P., Colby, S. M., & Martens, M. P. (2012). A randomized controlled trial of a behavioral economic Supplement to brief motivational interventions for college drinking. *Journal of Consulting and Clinical Psychology, 80,* 876–886. http://dx.doi.org/10.1037/a0028763

Neal, D. J., & Carey, K. B. (2007). Association between alcohol intoxication and alcohol-related problems: An event-level analysis. *Psychology of Addictive Behaviors, 21,* 194–204. http://dx.doi.org/10.1037/0893-164X.21.2.194

Pearson, M. R., Kite, B. A., & Henson, J. M. (2013). Predictive effects of good self-control and poor regulation on alcohol-related outcomes: Do protective behavioral strategies mediate? *Psychology of Addictive Behaviors, 27,* 81–89. http://dx.doi.org/10.1037/a0028818

Read, J. P., Merrill, J. E., Kahler, C. W., & Strong, D. R. (2007). Predicting functional outcomes among college drinkers: Reliability and predictive validity of the Young Adult Alcohol Consequences Questionnaire. *Ad-*

dictive Behaviors, 32, 2597–2610. http://dx.doi.org/10.1016/j.addbeh .2007.06.021

Roos, C. R., & Witkiewitz, K. (2017). A contextual model of self-regulation change mechanisms among individuals with addictive disorders. *Clinical Psychology Review, 57,* 117–128. http://dx.doi.org/10 .1016/j.cpr.2017.08.008

Stacy, A. W., & Wiers, R. W. (2010). Implicit cognition and addiction: A tool for explaining paradoxical behavior. *Annual Review of Clinical Psychology, 6,* 551–575. http://dx.doi.org/10.1146/annurev.clinpsy.121208.131444

Tabachnick, B. G., & Fidell, L. S. (2013). *Using multivariate statistics* (6th ed.). Boston, MA: Allyn & Bacon.

Teixeira, P. J., Carraça, E. V., Marques, M. M., Rutter, H., Oppert, J.-M., De Bourdeaudhuij, I., . . . Brug, J. (2015). Successful behavior change in obesity interventions in adults: A systematic review of self-regulation mediators. *BMC Medicine, 13,* 84. http://dx.doi.org/10.1186/s12916-015-0323-6