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Reducing Alcohol Use in Mandated College Students: A Comparison of a Brief Motivational Intervention (BMI) and the Expectancy Challenge Alcohol Literacy Curriculum (ECALC)

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In this randomized trial, 121 mandated college students (33% female, 74% Caucasian, *M* age = 19.42 years) received either a Brief Motivational Intervention (BMI) with personalized normative feedback (PNF) or the Expectancy Challenge Alcohol Literacy Curriculum (ECALC) to compare effectiveness in reducing alcohol use and associated harms. All participants received either BMI content ($n = 63$) or ECALC ($n = 58$). ECALC was delivered as a web-based program with clinician assistance. Measures of alcohol use and harms were completed at baseline and 4 weeks postintervention. ECALC produced significant reductions on all 4 positive expectancy subscales of the Comprehensive Effects of Alcohol Scale (CEOA). Both programs were associated with significant reductions on all alcohol use variables and harms, and expectancies significantly mediated the intervention to outcome relationship in the ECALC condition. There were no significant gender differences. Two one-sided equivalence test indicated superior effects for ECALC compared to BMI on four alcohol use variables (mean blood alcohol concentration, peak blood alcohol concentration, peak drinks per sitting, and drinking days per month), and noninferior to BMI in reducing others (mean drinks per sitting, mean drinks per week, & binge drinking). Superior effects of ECALC versus BMI are based on a short-term follow-up, and longevity of ECALC effects have yet to be established. ECALC has previously been found to be effective as a group-delivered program for male fraternity members, and these findings provide preliminary support for effectiveness for both males and females when delivered individually using a web-based clinician-assisted format.

Public Health Significance

This study suggests that the Expectancy Challenge Alcohol Literacy Curriculum (ECALC) is equivalent or superior to a Brief Motivational Intervention with personalized normative feedback for reducing risky drinking among mandated college students. ECALC has the added advantage of being delivered in a single 45-min session by individuals with minimal training. Superior effects of ECALC are based on a short-term follow-up, and longevity of effects has yet to be established.

Keywords: ECALC, BMI, personalized normative feedback, BASICS, expectancy challenge

College students drink more frequently and engage in more binge drinking than their noncollege peers, and students frequently suffer from drinking-related negative consequences (e.g., academic failure, sexual assault, and nearly 2,000 fatalities annually; Center for Behavioral Health Statistics & Quality, 2016; White & Hingson, 2013). Approximately 110,000 college students are arrested each year for alcohol-related violations (Hingson, Heeren, Zakocs, Kopstein, & Wechsler, 2002), and those who are sanctioned report more drinking-related problems and more high-risk drinking in comparison to nonsanctioned peers (Barnett et al., 2004; Wray, Simons, & Dvorak, 2011). Sanctioned students are typically mandated to complete an assessment of their drinking behavior often followed by brief intervention or treatment (Anderson & Gadaleto, 2006). Positive outcomes of the most effective interventions are moderated by readiness to change (RTC; Fromme & Corbin, 2004), a problematic finding as most heavy

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Preliminary findings from this study were presented at the Annual Meeting of the Research Society on Alcoholism, San Antonio, Texas, June 2015. This presentation included preliminary analyses of expectancy and alcohol use changes but did not include mediation or equivalency (inferiority/superiority) analyses.

Dataset OSF link: https://osf.io/7pzjc/?view_only=a8b05f00b40e40d99748e9ef1784bfc1.

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drinking students are in a precontemplative stage for behavior change and are unlikely to actively engage in treatment (Carey, Scott-Sheldon, Carey, & DeMartini, 2007).

A meta-analysis of interventions for mandated students concluded that active interventions (those that require participation and are intended to reduce alcohol use) produce larger reductions in alcohol use than the decrease associated with being mandated without being required to complete an intervention, and these programs can be effective as a harm reduction strategy to reduce risky drinking (Carey, Scott-Sheldon, Garey, Elliott, & Carey, 2016). Interventions that focus solely on alcohol education, however, may be counterproductive as this component is associated with less change (Carey et al., 2016). Several mandated student interventions have been successful, including expectancy challenge (EC; Scott-Sheldon, Terry, Carey, Garey, & Carey, 2012), goal setting (Locke & Latham, 2002), personalized normative feedback (PNF; Prochaska, DiClemente, & Norcross, 1992), alcohol skills training, and brief motivational intervention (BMI; Larimer & Cronce, 2007). Intervention is associated with reduced drinking frequency when programs encouraged goal setting, challenged alcohol expectancies, and did not provide alcohol education (Carey et al., 2016).

BMI often involves an assessment of quantity, frequency, and consequences of drinking, PNF, and motivational strategies to reduce alcohol use (Dimeff, Baer, Kivlahan, & Marlatt, 1999). BMI is effective in reducing heavy, problematic drinking, as well as alcohol-related problems in mandated and general populations of students, particularly when delivered face-to-face (Carey et al., 2007; Carey, Scott-Sheldon, Elliott, Garey, & Carey, 2012; Carey et al., 2016; Carey et al., 2018). Several successful programs have been developed using motivational interviewing (MI) strategies and basic alcohol skills training (Carey et al., 2016; Dimeff et al., 1999; Larimer & Cronce, 2007). Although MI and BMI are effective, they are relatively expensive requiring a trained clinician to complete individual sessions with each student.

EC interventions have been effective in reducing alcohol use among mandated and nonmandated college students (Carey et al., 2016). EC is based on evidence that alcohol expectancies are an important influence on drinking (Goldman, Darkes, & Del Boca, 1999) and predict current and future alcohol use (Stacy, Widaman, & Marlatt, 1990). Expectancies are learned information stored in memory about anticipated effects of alcohol consumption and may be a causal variable in determining alcohol use (Goldman, 1999). Expectancies are present before alcohol use begins (e.g., Dunn & Goldman, 1996), predict drinking initiation (Christiansen, Smith, Roehling, & Goldman, 1989), develop throughout adolescence (e.g., Dunn & Goldman, 1998), and are changeable with predictable changes in alcohol use (e.g., Darkes & Goldman, 1993, 1998). Positive expectancies are significantly associated with greater alcohol consumption, specifically among college-aged individuals (Christiansen, Goldman, & Inn, 1982; LaBrie, Grant, & Hummer, 2011; McBride, Barrett, Moore, & Schonfeld, 2014). Low-risk drinkers tend to associate alcohol with more negative and sedative effects, whereas heavy and high-risk drinkers hold more positive and arousing beliefs about alcohol, making positive expectancies a prime target for EC (Dunn & Goldman, 1998; Rather & Goldman, 1994).

Experiential EC was developed to demonstrate how alcohol expectancies influence experienced effects of alcohol consumption using a bar lab and alcohol administration (Darkes & Goldman, 1993, 1998). Some nonexperiential EC methods have been effective without alcohol administration using presentations rather than experiential learning (as cited by Scott-Sheldon et al., 2012). Meta-analyses have found that EC reduces positive expectancies, general alcohol consumption, and heavy drinking among mandated students and the general student population (Carey et al., 2016; Scott-Sheldon et al., 2012). Although information on expectancies is often part of BMI (Dimeff et al., 1999), EC strategies work as stand-alone approaches (Carey et al., 2016; Scott-Sheldon et al., 2012) offering a cost-effective means of reducing alcohol use requiring less time to administer and less staff training than a BMI.

The Expectancy Challenge Alcohol Literacy Curriculum (ECALC; Fried & Dunn, 2012) is a nonexperiential EC method that has been successful in modifying expectancies and reducing drinking. When delivered to groups of fraternity members in a single 45-min session, ECALC produced significant positive expectancy decreases and significant reductions in alcohol use during a 4-week follow-up (Fried & Dunn, 2012). A web-based ECALC was developed by the creator of the original ECALC (Michael E. Dunn) to provide consistent delivery of content with minimal training of facilitators. Each element of the original college version of ECALC was incorporated into the web-based program before it was piloted and revised to improve clarity without changing content. Web-based programs are less resource intensive and are increasingly being used on college campuses for prevention and as interventions for mandated students (Walters, Miller, & Chiauzzi, 2005). Research demonstrates mixed results, however, on the clinical utility of computer-delivered interventions with high-risk populations (Barnett, Murphy, Colby, & Monti, 2007; Carey et al., 2012). A meta-analytic review of the efficacy of in-person versus computer-delivered interventions found no differences between delivery methods on short-term alcohol outcomes (Cadigan et al., 2015). Another meta-analytic review of 48 studies found that face-to-face interventions were more successful at reducing alcohol use and alcohol-related problems at short-term (1-month) and longer-term follow-ups (3-, 6-, and 12-month; Carey et al., 2012). Further, effect sizes for face-to-face interventions were significantly larger when working with mandated college students (Carey et al., 2012), supporting the use of an in-person BMI as a comparison condition for this study of the web-based, clinician assisted ECALC.

The purpose of our study was to measure the effectiveness of the web-based ECALC in changing expectancies and reducing alcohol use among mandated college students, and to compare outcomes with BMI. The previous format of ECALC relied on a presenter to provide scripted information, whereas the web-based ECALC includes recorded narration in place of a presenter to guarantee consistency of content delivery. Electronic narration allows for self-administration or group administration with minimal training of the facilitator. In contrast, BMI requires explicit clinical training for individual administration (Bernstein et al., 2017; Dimeff et al., 1999). In this randomized trial, we intended to demonstrate comparable reductions in alcohol use and related problems among mandated students who received ECALC or BMI. Further, we predicted that completion of ECALC would be associated with significant reductions in positive expectancies, and that reductions in expectancies would mediate the relationship between intervention and reduced alcohol consumption at 4-week follow-up.

Changes in positive expectancies more readily predict success following treatment (Nielsen, 1992), and a previous ECALC study demonstrated significant changes only on positive expectancies in addition to significant reductions in drinking (Fried & Dunn, 2012). Support for our hypotheses would provide evidence of the effectiveness of ECALC, providing a cost-effective web-based alcohol intervention for mandated college students requiring minimal facilitation and little training for those who deliver the program.

Previous meta-analytic reviews found that EC is most efficacious in reducing alcohol use when targeted to male-only groups, whereas for EC delivered to women, changes in expectancies did not produce significant reductions in drinking (Labbe & Maisto, 2011). Prior research on brief intervention has been mixed. Some studies report no differences between men and women (Collins, Parks, & Marlatt, 1985) whereas several others found that women may be more responsive to brief interventions (see Carey et al., 2007, for review), or that the effectiveness of BASICS (a BMI) is more robust for men (DiFulvio, Linowski, Mazziotti, & Puleo, 2012). Previous findings of gender differences for both EC and BMI necessitate the examination of effectiveness for men and women separately, however, we expected that there would be no significant differences in effectiveness of either program based on gender.

Method

Design

In this outcome comparison study, mandated college students completed baseline measures and those eligible were randomly assigned to receive a BMI with PNF or ECALC. All participants completed an alcohol expectancy measure at baseline and at the end of the intervention session. Four weeks after the intervention, participants completed measures of alcohol use and alcohol-related harms. Intervention outcome variables were alcohol expectancies, alcohol-related harms, and seven alcohol use variables.

Participants

Approval for this study was obtained from the University of Central Florida Institutional Review Board (IRB# SBE-11–07534, Title: The Digital Generation: Leveraging Technology to Reduce High Risk Drinking). At a large state university, prospective participants were 407 mandated undergraduate students referred for intervention over the course of three consecutive semesters (1 year). Students were mandated based on violations of campus policy or laws regarding alcohol or drug use. Self-reported race/ethnicity was 75.3% White/Caucasian, 10.7% Hispanic/Latino, 4.1% Black/African American, 2.5% Asian/Pacific Islander, and 2.9% multiracial/other. Minorities were underrepresented as the composition of the student body is 49.2% white/Caucasian, 24.9% Hispanic/Latino, 11.1% Black/African American, 6.2% Asian/Pacific Islander, and 3.6% multiracial/other.

Inclusion criteria were (a) age $\geq$18 years; (b) self-reported risky drinking behavior based on scoring $>$7 and $<$20 on the Alcohol Use Disorders Identification Test (AUDIT; Babor, De La Fuente, Saunders, & Grant, 1992), or at least one binge episode (four drinks for women, five for men) within the past 30 days (criteria based on O'Hare & Sherrer, 1999; DeMartini & Carey, 2012); and (c) willingness to provide informed consent for inclusion of data in this study. Exclusion criteria were (a) AUDIT score $\geq$20 indicating a need for further evaluation for alcohol dependence (Babor et al., 1992); (b) frequent use of other substances within the past three months; or (c) score $\geq$8 on the Cannabis Use Disorders Identification Test (CUDIT; Adamson & Sellman, 2003) indicating possible cannabis abuse (Adamson & Sellman, 2003).

Of the 155 participants who met inclusion criteria and agreed to participate, four failed to attend the psychosocial interview. Information collected during the psychosocial interview led to removal of 16 students who required a higher level of care and one student who was referred to an intensive outpatient program. Following the intervention, 13 students were removed from the BMI condition due to provider treatment infidelity. These participants represented all cases assigned to a single provider who was unable to faithfully provide all elements of the intervention. No significant differences were found between these 13 participants and other participants who completed either condition. Analyses were conducted on data from the remaining 121 students (see Figure 1 for consort). Participants were informed that they would be asked to complete survey measures anonymously after receiving individual feedback on alcohol use (BMI) or a presentation on media literacy and a summary of research findings focused on the effects of alcohol (ECALC). Because o f random assignment to condition, 58 participants received ECALC (18 female) and 63 received BMI (22 female). Most participants were freshmen or sophomores and their mean age was 19.42 years (SD = 1.74; complete demographics are presented in Table 1).

Measures

Information collected at screening included sex, age, year in school, race/ethnicity, living situation (campus housing, off-campus, etc.), and Greek system involvement.

AUDIT. The AUDIT is a 10-item screening measure that assesses alcohol use, dependence symptoms, and harmful alcohol use (Babor et al., 1992). It has been validated for use in a variety of treatment settings and across sex, age, and different cultures (Saunders, Aasland, Babor, De La Fuente, & Grant, 1993). An AUDIT cutoff score of 8 was used for this study because this value has demonstrated good sensitivity for problematic drinking (mid .90's) and specificity averaged over 0.80 (Saunders et al., 1993). An AUDIT score of 8–15 represents a moderate level of alcohol problems, 16–19 represents high level, and 20 or more represents the need for further evaluation for dependence (Babor et al., 1992).

CUDIT. The CUDIT is a 10-item screen for cannabis abuse and dependence (Adamson & Sellman, 2003), and a cutoff score of 8 demonstrates sensitivity of 73.3% and positive predictive power of 84.6%.

Other substance use. This measure assesses frequency of substance use other than alcohol within the past three months.

Timeline follow-back. Daily alcohol consumption was obtained using the self-report timeline follow-back (TLFB), a reliable and valid method for obtaining retrospective estimates of daily alcohol use (Sobell & Sobell, 1992). We modified the TLFB to include duration of each drinking episode for computation of estimated blood alcohol concentration (BAC; formula provided by Matthews & Miller, 1979). Seven measures of alcohol use were

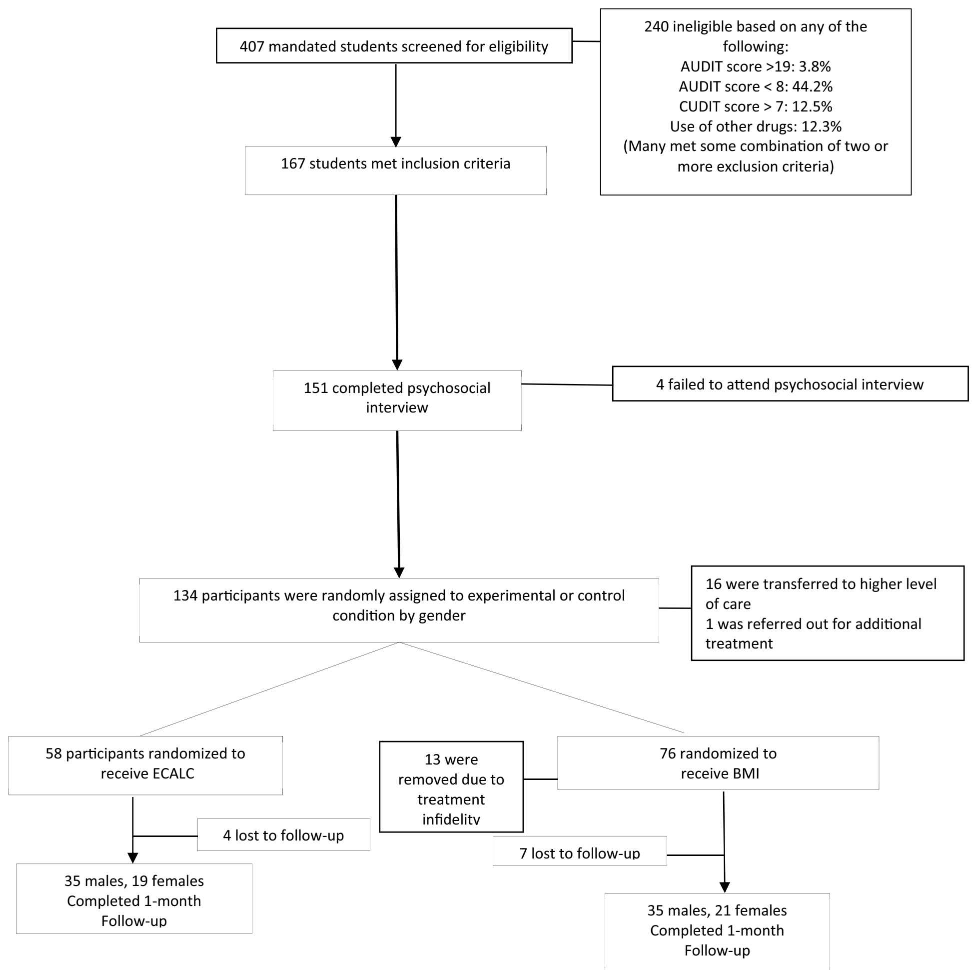

Figure 1. Consort diagram of participant flow.

computed from the TLFB because each provides unique information on drinking behavior. Frequency was represented by number of drinking days over the month, typical cumulative quantity was represented by mean drinks per week, typical quantity for a drinking episode was represented by mean drinks per sitting, and typical intoxication was represented by mean BAC. Number of binge episodes is reported in college drinking studies due to its association with negative consequences. Peak drinks per sitting and peak BAC were computed because both are more precise indicators of high-risk drinking.

Comprehensive Effects of Alcohol Scale. Alcohol expectancies were assessed using the Comprehensive Effects of Alcohol Scale (CEOA; Fromme, Stroot, & Kaplan, 1993). This measure is recommended in the BASICS manual, a BMI that has been used as a model for other BMI studies (Bernstein et al., 2017; Carey et al., 2018; Yurasek et al., 2015) and has been used in previous evaluations of ECALC. The CEOA includes four positive subscales (Sociability, Tension Reduction, Liquid Courage, and Sexuality) and three negative (Cognitive and Behavioral Impairment, Risk and Aggression, and Self-Perception).

The Brief Young Adult Alcohol Consequences Questionnaire. The Brief Young Adult Alcohol Consequences Questionnaire (BYAACQ) assesses 24 consequences of alcohol consumption for the previous 30 days (Kahler, Strong, & Read, 2005). This measure includes items such as "I have passed out from drinking," "I have taken foolish risks when I have been drinking," and "My drinking has gotten me into sexual situations I later regretted." It has high internal consistency, good reliability, minimal item redundancy, and covers a range of problem severity relevant to college students (Kahler et al., 2005).

University of Rhode Island Change Assessment. The University of Rhode Island Change Assessment (URICA) is a 12-item measure to assess stage of change (DiClemente & Prochaska, 1998) and is comprised of three subscales: Precontemplation, Contemplation, and Action (McConnaughy, Prochaska, & Velicer, 1983).

Motivational Interviewing Treatment Integrity Scale. The Motivational Interviewing Treatment Integrity Scale assesses fidelity to the MI process using a coding system that is comprised of two global scores (empathy and MI spirit) and seven behavior counts (giving information, MI adherent, MI nonadherent, Open question, closed question, simple reflection, and complex reflection; Moyers, Martin, Manuel, & Miller, 2004). Global scores are derived by having trained coders assign scores along a seven-point scale on each dimension, ranging from 1 (*low*) to 7 (*high*). Behaviors such as asking "closed" versus "open" questions and provid-

Table 1
Demographic Characteristics by Condition

Variable	BMI Frequency	BMI %	ECALC Frequency	ECALC %
Sex				
Male	41	65.1	40	69.0
Female	22	34.9	18	31.0
Class standing				
Freshman	33	52.4	31	53.4
Sophomore	15	23.8	10	17.2
Junior	9	14.3	10	17.2
Senior	6	9.5	7	12.1
Living situation				
Residence hall	22	34.9	23	39.7
UA off-campus	10	15.9	7	12.1
Greek house[a]	6	9.5	0	0
Independent	25	39.7	28	48.3
Race/ethnicity				
White	48	76.2	41	70.7
Black/African American	3	4.8	5	8.6
Hispanic/Latino	8	12.7	9	15.5
Asian	1	1.6	0	0
Other	3	4.8	3	5.2
Stage of change				
Precontemplation	25	39.7	26	44.8
Contemplation	2	3.2	2	3.4
Action	36	57.1	30	51.7

Note. BMI = Brief Motivational Intervention; ECALC = Expectancy Challenge Alcohol Literacy Curriculum; UA = University Affiliated. BMI age, $M = 19.30$ ($SD = 1.64$); ECALC age, $M = 19.55$ ($SD = 1.85$).
[a] Nonsignificant difference, χ^2 (3, $N = 121$) = 6.53, $p = .09$. There were no significant differences in assignment to condition based on demographics or stage of change.

ing "simple" versus "complex" reflections are tallied throughout a random 20-min session excerpt.

Intervention Program Content

ECALC. ECALC is a 45-min web-based interactive program suitable for individual or group administration. Content consists of alcohol expectancy research findings, media literacy training, and interactive exercises designed to improve acquisition and processing of information. In the present application, ECALC was provided in an individual format with the assistance of a master's level clinician to be consistent in clinician contact time with delivery of the BMI. Clinicians were directed to be an observer and to answer navigational questions if the participant had problems moving from one screen to the next. The program itself provided the content of the intervention, and clinicians provided no MI or other intervention. Clinicians received 4 hours of training on ECALC content and functioning of the web-based program. Clinicians facilitating ECALC did not receive supervision due to the self-administering nature of the ECALC program and the lack of intervention being provided by the clinician.

BMI. Master's level clinicians were provided a minimum of 20 hr of training in MI and the BMI protocol (the feedback session specified in the BASICS manual, Dimeff et al., 1999) by Michael E. Dunn and Thomas V. Hall, who have extensive experience using MI and delivering BMI. Previous BMI research has been conducted using the BASICS manual as a model for session content (Bernstein et al., 2017; Carey et al., 2018; Yurasek et al., 2015). All clinicians received weekly supervision from the fourth author, an experienced, licensed doctoral level clinician who reviewed session notes and tapes. Treatment fidelity was ensured via this close supervision to ensure integrity to the BMI model, and a check-list review of intervention fidelity was conducted by the fourth author to evaluate clinician adherence to the BMI protocol. Intervention content was based on baseline measures and information from the psychosocial interview. The BMI content session lasted between 45 and 55 min and included five components: (a) information on the effects of alcohol and alcohol expectancies, (b) PNF, (c) information regarding the student's current pattern of alcohol use and their individual risk factors, (d) protective behavioral strategies, and (e) increasing motivation to change drinking.

Procedure

Baseline. Four to six weeks elapsed between receiving a mandate for intervention and completion of baseline measures as part of the standard assessment protocol (AUDIT, CUDIT, other substance use measure, TLFB, CEOA, BYAACQ, & URICA). Those who met inclusion criteria were invited to participate and students who agreed provided written informed consent.

Psychosocial interview. Within 2 weeks of baseline, all participants completed a psychosocial interview.

Random assignment. Random assignment to condition (BMI or ECALC) occurred after completion of the psychosocial interview using a coin toss. Time between the psychosocial interview and the intervention was two weeks for both conditions.

Intervention. Participants in the BMI condition received the intervention in an individually delivered session that was identical to session two of BASICS (Dimeff et al., 1999). Students in the ECALC condition received the single session individually delivered web-based ECALC program with assistance in navigating the program provided upon request by a clinician who was seated in the room. All participants received the same amount of contact time with a clinician allowing for direct comparison of ECALC to BMI, and all participants completed the CEOA again at the end of both interventions to measure expectancy changes.

Follow-up. Four weeks after completion of the intervention, participants attended an appointment to complete measures of drinking (TLFB) and alcohol-related harms (BYAACQ). Data was collected continuously through three consecutive semesters throughout periods during which alcohol use may have been more or less prevalent. Baseline and follow-up were equally likely to fall during periods of higher or lower use making it unlikely that results could be attributable to time of data collection.

Planned analysis. Analyses proceeded in a stepped fashion and were conducted in *SPSS* (V25) unless otherwise noted. First, we tested for baseline differences across demographic characteristics and intervention conditions. Next, we examined differences between completers and noncompleters, followed by examination of hypotheses. We examined differences in expectancies across conditions using analysis of covariance (ANCOVA), followed by an examination of differences in alcohol use and alcohol-related harms. To compare differences in effects on alcohol outcomes, we used the two one-sided test approach (Cipriani, Girlanda, & Barbui, 2009; Lakens, 2017) within symmetric equivalence intervals to examine inferiority, equivalence, noninferiority, or superiority of effect size differences between conditions. We assumed an effect size difference of Cohen's $d = 0.20$ (a small effect; Cohen, 1992) represents a clinically relevant difference in effect sizes (one-sided $\alpha = .025$). Equivalence is shown if 95% confidence intervals (CIs) fall within an equivalence margin (−0.20, 0.20). Noninferiority of ECALC is shown if the lower end of the CIs is greater than a difference in Cohen's d of −0.20. Superiority of ECALC is shown if the lower end of end of the CI does not include 0. If the lower end of the 95% CI is less than −0.20, but the upper end of the 95% CI is greater than 0, then the test is said to be inconclusive. If the lower end of the 95% CI is less than −0.20, and the upper end of the 95% CI is less than 0, then the new treatment (ECALC) is inferior to the previous treatment (BMI). Finally, we tested the hypothesis that differences in alcohol outcomes by condition are mediated via expectancies. To do this, we conducted separate mediation analyses for each of the alcohol outcomes (8 models) in M*plus* 8 (Muthén & Muthén, 2017). These models utilized a latent expectancy variable derived from the four observed expectancy subscales. Mediated effects were tested using bias corrected standard errors derived from 5000 random draws (MacKinnon, 2008). All coefficients are standardized for ease of interpretation.

Results

Power Analysis and Outliers

Separate power analyses were conducted for each of the three primary outcome measures. Based on the most conservative estimate for sample size, a sample of 120 is needed to detect a medium effect size ($\alpha = .05$, $\beta = .80$; Faul, Erdfelder, Buchner, & Lang, 2009). All variables were checked for outliers and deviations from normality and outliers greater than 3.29 *SD*s above the mean ($p < .001$) were incrementally recoded to one unit above the next lowest value (Borsari et al., 2007; Tabachnick & Fidell, 2006). Only one outlier was identified and recoded (follow-up peak drinks per sitting).

Comparability of Groups at Baseline

No significant differences between groups were found based on class standing, living situation, ethnicity, age, readiness to change, alcohol expectancies, total AUDIT scores, total CUDIT scores, or any alcohol use measure. Females assigned to the ECALC condition reported significantly fewer harms (ECALC $M = 4.11$, $SD = 5.00$; BMI $M = 13.00$, $SD = 12.33$; $t = 2.86$, $df = 37$, $p < .01$). For living situation, six individuals reported a fraternity or sorority as their residence, and all of these students happened to be randomly assigned to the BMI condition. Analysis of baseline and follow-up measures indicated no significant differences on any measured variable between these individuals and other students in either condition.

Follow-Up Completion

Of the 121 participants who completed the psychosocial interview and the intervention, 110 (90.9%) completed 4-week follow-up measures (ECALC = 93.1%, males $n = 35$, females $n = 19$; BMI = 88.9%, males $n = 35$, females $n = 21$). Statistical comparisons of those who completed follow-up with those who did not revealed no significant differences on demographic characteristics or any measured variable.

Evaluation of Internal Validity

Twenty-minute video segments of BMI sessions were rated to evaluate integrity of the intervention and adherence to treatment protocol. Eighteen (28.6%) of the 63 feedback sessions were randomly selected and reviewed. Mean global rating score for Empathy/Understanding was 6.5, and 5.6 for Spirit. Overall, reviewed sessions exhibited 86.6% MI adherence (MI adherent/MI adherent + MI nonadherent; Moyers et al., 2004).

Alcohol Expectancy Analysis

Between-groups differences in expectancies at follow-up were assessed using a series of ANCOVAs with baseline expectancy values as covariates. Type I error was controlled for using the Bonferroni procedure ($p < .0125$ for each ANCOVA). Consistent with a priori hypotheses, participants in the ECALC condition had significantly lower mean scores on all four CEOA subscales compared to those in the BMI condition. Further, there were no significant group by gender interactions, indicating that ECALC was equally effective for males and females in the modification of expectancies. The distributional properties for expectancy subscales were within normal range at baseline and follow up—baseline sociability scale skewness = −0.187 ($SE = 0.224$), kurtosis = −0.379 ($SE = 0.444$), follow-up skewness = −0.821 ($SE = 0.229$), kurtosis = 0.630 ($SE = 0.455$); baseline tension reduction scale skewness = 0.102 ($SE = 0.222$), kurtosis = −0.329 ($SE = 0.444$), follow-up skewness = −0.691 ($SE = 0.229$), kurtosis = 0.244 ($SE = 0.455$); baseline liquid courage scale skewness = 0.049 ($SE = 0.224$), kurtosis = 0.180 ($SE = 0.444$), follow-up skewness = −0.060 ($SE = 0.229$), kurtosis = −0.835 ($SE = 0.455$); baseline sexuality scale skewness = 0.348 ($SE = 0.224$), kurtosis = −0.602 ($SE = 0.444$), follow-up skewness = 0.373 ($SE = 0.299$), kurtosis = −0.757 ($SE = 0.455$).

For the Sociability scale, there was a significant difference in mean scale score, $F(1, 107) = 27.19$, $p < .001$, $\eta_p^2 = .203$, between the BMI ($M = 3.01$, $SD = 0.48$) and ECALC ($M = 2.41$, $SD = 0.82$) conditions, when adjusting for baseline Sociability score (BMI: $M = 3.08$, $SD = 0.60$; ECALC: $M = 3.06$, $SD = 0.51$). For the Tension Reduction scale, there was a significant difference in mean scale score, $F(1, 107) = 26.13$, $p < .001$, $\eta_p^2 = .196$, between the BMI ($M = 2.79$, $SD = 0.47$) and ECALC ($M = 2.21$, $SD = 0.72$) conditions, when adjusting for baseline Tension Reduction score (BMI: $M = 2.34$, $SD = 0.58$; ECALC: $M = 2.32$, $SD = 0.79$). For the Liquid Courage scale, there was a significant difference in mean scale score, $F(1, 107) = 8.46$, $p = .004$, $\eta_p^2 = .073$, between the BMI ($M = 2.36$, $SD = 0.67$) and ECALC ($M = 2.01$, $SD = 0.78$) conditions, when adjusting for baseline Liquid Courage score (BMI: $M = 2.38$, $SD = 0.68$; ECALC: $M = 2.35$, $SD = 0.58$). Finally, for the Sexuality scale, there was a significant difference in mean scale score, $F(1, 107) = 7.23$, $p = .008$, $\eta_p^2 = .063$, between the BMI ($M = 2.02$, $SD = 0.70$) and ECALC ($M = 1.75$, $SD = 0.66$) conditions, when adjusting for baseline Sexuality score (BMI: $M = 1.92$, $SD = 0.73$; ECALC: $M = 1.99$, $SD = 0.65$).

Alcohol Use Analysis

A series of repeated measures analyses of variance focused on alcohol use variables revealed a significant effect of time for both ECALC and BMI ($ps = .010$ to $< .001$), however, there were no between-groups differences ($ps = .231$ to $.916$) and no interactions between condition and time or gender ($ps = .079$ to $.812$). Thus, both conditions resulted in significant decreases in alcohol use across time for males and females. To evaluate the change observed in each treatment condition, within-subjects effect sizes *dw* were calculated as the difference between baseline and follow-up data divided by the pooled standard deviation (see Table 2; Cohen, 1988; Morris & DeShon, 2002; Scott-Sheldon et al., 2012).

Next, we used a two one-sided equivalence test (TOST), to compare the two active treatments (Lakens, 2017). This allows for a comparison of a new treatment against the observed effects of an existing treatment (rather than against the traditional null hypothesis). In doing so, we specified an "equivalence" margin of Cohen's d -0.20 to 0.20 (a small effect in both directions). We then calculated 95% confidence intervals of the effect size difference (Δd) between BMI and ECALC. A positive value of Δd indicates a stronger effect of ECALC relative to BMI, while a negative value indicates a weaker effect of ECALC relative to BMI. This approach allows for the statistical determination of whether the observed effect is equivalent to the standard treatment, superior to the standard treatment, or inferior to the standard treatment. The results of this analysis are depicted in Figure 2.

In the TOST analysis, ECALC showed superior effects over BMI for mean BAC ($\Delta\ d = 0.23$), peak BAC ($\Delta d = 0.25$), peak drinks per sitting ($\Delta d = 0.28$), and drinking days per month ($\Delta d = 0.28$). The effects of ECALC were noninferior to BMI on mean drinks per sitting ($\Delta d = 0.16$), binge drinking episodes ($\Delta d = 0.05$), and mean drinks per week ($\Delta d = 0.18$). Thus, ECALC performed as well, or better, on every measure of alcohol consumption, assuming an equivalence margin of $\Delta d = -0.20$ to 0.20.

Alcohol-Related Harms Analysis

Because there was a baseline difference in harms among female participants, we added gender as an independent variable in the harms analysis. Both ECALC and BMI produced significant reductions in alcohol-related harms ($p < .001$), but there was no significant effect of condition, or interaction of time by condition, or interaction of Time $\times$ Condition $\times$ Gender despite the baseline difference between groups ($ps = .122$ to $.850$). Equivalence testing to compare the effects of ECALC to BMI indicated that BMI resulted in a qualitatively larger effect than ECALC (see Figure 2). However, the confidence intervals encompassed 0, indicating that BMI was not superior to ECALC in this regard. Under equivalence testing, this result is referred to as "inconclusive" (rather than noninferior) as the results tend to favor the standard treatment. This result may be due to baseline differences noted above. Mean baseline harms for females in the ECALC group was only 4.11 ($SD = 5.00$) compared to 13.65 ($SD = 12.28$) for females in the BMI group (males in ECALC were $M = 11.31$, $SD = 15.24$, males in BMI were $M = 9.91$, $SD = 13.38$).

Table 2
Baseline and Follow-Up (4 Weeks Following Intervention) Alcohol Use and Harms by Intervention Condition

Variable and group	Baseline mean (*SD*)	Baseline skew/ kurtosis	Follow-up mean (*SD*)	Follow-up skew/ kurtosis	95% Confidence interval for follow up mean lower, upper	*df*	*F* (Group)	*dw*
Mean BAC						1, 99	1.001	
ECALC	.053 (.043)	1.155/1.353	.034 (.035)	1.049/.326	.024, .044	1, 99	1.001	.48
BMI	.053 (.044)	1.895/4.270	.039 (.039)	1.141/.614	.032, .050			.25
Peak BAC							1.640	
ECALC	.093 (.068)	1.598/4.836	.055 (.052)	.686/−.588	.041, .068	1, 99		.62
BMI	.094 (.070)	1.374/2.608	.066 (.061)	1.152/.762	.054, .080			.37
Mean DPS							1.766	
ECALC	4.26 (2.35)	1.078/3.165	3.08 (2.32)	.345/−.362	2.47, 3.68	1, 99		.48
BMI	4.53 (2.45)	1.839/7.523	3.65 (2.23)	.464/.605	3.04, 4.19			.32
Peak DPS							2.757	
ECALC	6.21 (3.48)	1.919/7.345	4.04 (3.36)	.640/.140	3.30, 5.01	1, 99		.62
BMI	6.52 (3.31)	.655/.978	5.24 (3.47)	.842/1.053	4.31, 5.92			.34
Binge							.789	
ECALC	2.48 (2.77)	2.216/6.422	1.81 (2.73)	1.976/3.959	1.17, 2.51	1, 99		.23
BMI	2.71 (2.62)	1.683/3.454	2.20 (3.20)	2.562/7.471	1.61, 2.87			.18
Mean DPW							1.485	
ECALC	4.45 (3.88)	1.651/3.566	3.28 (4.35)	2.285/5.691	2.16, 4.42	1, 99		.28
BMI	4.77 (4.01)	1.854/5.471	4.27 (5.75)	3.619/16.443	3.16, 5.30			.10
DDPM							4.853*	
ECALC	4.96 (3.67)	1.338/1.833	3.48 (3.39)	1.412/2.611	2.72, 4.22	1, 99		.41
BMI	5.06 (3.66)	1.111/1.416	4.64 (3.82)	1.246/2.057	3.90, 5.33			.13
Harms total								
ECALC	9.81 (14.97)	2.455/5.416	3.96 (7.80)	2.696/7.770	2.28, 6.17	1, 104	.099	.48
BMI	10.97(12.73)	2.493/7.148	4.83 (7.55)	2.493/7.148	2.70, 6.24			.62

Note. BMI = Brief Motivational Intervention; ECALC = Expectancy Challenge Alcohol Literacy Curriculum; d_w = within subject effect size; DPS = drinks per sitting; DPW = drinks per week; DDPM = drinking days per month.
* $p < .05$.

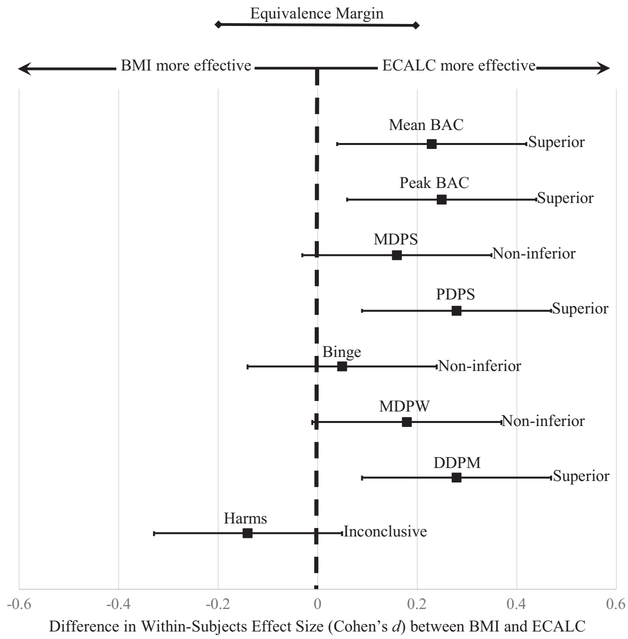

Figure 2. Equivalence testing of the difference in within-subject effects for an Equivalence Margin of −0.20 to .0.20 Δ Cohen's d between ECALC and BMI. Symmetric equivalence intervals utilize 95% Confidence Bands. ECALC = Expectancy Challenge Alcohol Literacy Curriculum; BMI = Brief Motivational Intervention; BAC = blood alcohol concentration; MDPS = mean drinks per sitting; PDPS = peak drinks per sitting; MDPW = mean drinks per week; DDPM = drinking days per month. Superior: lower band > 0, upper band > 0.20; Non-inferior: lower band < 0, upper band > 0.20; Inconclusive: lower band < −0.20, upper band > 0 but < 0.20.

Mediation Analyses

Finally, we examined mediated effects of the intervention on alcohol outcomes via expectancies. Expectancies were specified as a latent mediator and a separate model was tested for each alcohol outcome. There was significant correlated error between liquid courage expectancies and sexual expectancies, and thus these observed indicators were allowed to covary. Model parameters, model fit, and boot strapped bias corrected indirect effects from 5,000 random draws are shown in Figure 3. Overall, model fit was adequate-to-good across the eight mediation models (see Figure 3).

There was a significant effect of ECALC on expectancy, whereby ECALC lead to robust differences in latent expectancies ($\beta = -0.44$, $p < .001$). Latent expectancies were not associated with drinking days per month, nor was the indirect effect between ECALC and drinking days per month statistically significant. There were significant negative indirect effects from ECALC to all other alcohol outcomes, via decreased expectancies. Despite inconclusive differences in the reduction of harms between BMI and ECALC in equivalence testing analysis, the effect of ECALC on harms, via lower postintervention expectancies, was the most robust indirect effect (IND = −0.14, 95% CI: −0.24, −0.05). Overall, the effect of ECALC on alcohol outcomes operated via the intervention target of alcohol expectancies.

Discussion

Our purpose was to compare the effectiveness of a clinician-assisted web-based ECALC to BMI with PNF when delivered to mandated college students, and to confirm that the mechanism of influence of ECALC is changes in expectancies. Supporting our hypotheses, results indicate that both programs were effective in reducing alcohol use and associated harms, with no significant differences in effectiveness for males and females. Although BMI has been effective for both sexes (Carey et al., 2016), the literature on effectiveness of EC programs is inconsistent (Labbe & Maisto, 2011). ECALC has previously been found to be effective as a group-delivered program for male fraternity members (Fried & Dunn, 2012), and our current findings support effectiveness for both sexes. Also consistent with hypotheses, ECALC participants demonstrated significant decreases in expectancies, and mediation analyses identified significant negative indirect effects from ECALC to all alcohol outcomes via decreased expectancies (with the exception of drinking days per month). ECALC appears to have been successful in aligning expectancies with pharmacological effects of alcohol, and the effect of ECALC on alcohol outcomes operated through expectancies.

TOST indicated that ECALC was superior to BMI with PNF in reducing several measures of alcohol use, and noninferior in reducing others. One interpretation of the greater impact of ECALC on the most risky drinking (peak drinks per sitting and peak BAC) is decreased motivation to drink excessively produced by reduction of positive expectancies associated with higher dose effects (i.e., heightened awareness of the inconsistency between desired effects and those experienced at higher doses). Overall, targeting expectancies could be more effective than PNF because alcohol expectancies may be a causal factor in determining alcohol use

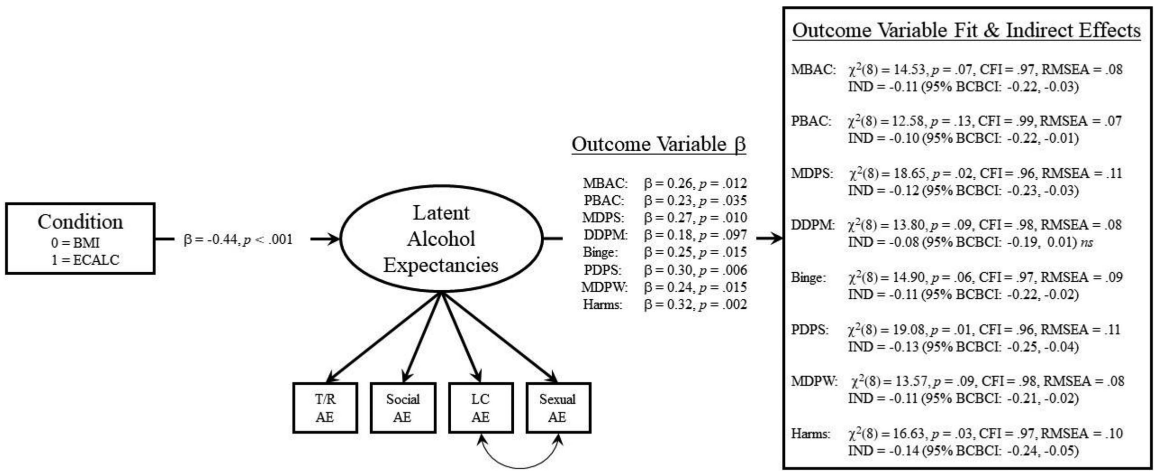

Figure 3. Mediation models with model fit indices and indirect effects for each alcohol-related outcome. ECALC = Expectancy Challenge Alcohol Literacy Curriculum; BMI = Brief Motivational Intervention; MBAC = mean blood alcohol concentration; PBAC = peak blood alcohol concentration; MDPS = mean drinks per sitting; PDPS = peak drinks per sitting; MDPW = mean drinks per week; DDPM = drinking days per month; T/R = tension reduction; LC = liquid courage; AE = alcohol expectancies; BCBCI = bias corrected boot-strapped confidence intervals.

patterns (Goldman, 1999). Rather than addressing the fundamental motivation to drink, PNF takes advantage of the desire to avoid standing out from one's peers in a potentially negative way, and the effectiveness of PNF may be limited by an individual's personal experience. If individuals typically drink with those who have consumption habits similar to their own, there will be little discrepancy to identify, and these peers might be a stronger influence than the more general peer group referred to in PNF. In support of this conclusion, if there is a disparity identified, PNF has been found to be more effective in reducing drinking when norms are based on more similar individuals (Larimer et al., 2011). Using BASICS as a guide, we provided norms based on age and sex, more specific than "typical student," but lacking in characteristics found to be important including ethnicity, residence type, involvement in athletics, and fraternity/sorority involvement (Hummer, LaBrie, & Lac, 2009; LaBrie, Hummer, Neighbors, & Pedersen, 2008; Grossbard et al., 2009). The superiority of ECALC on some measures of alcohol use must be interpreted with caution in the absence of replication and evaluation of duration of effects. The effectiveness of BMI in reducing alcohol use has been confirmed in numerous studies (Carey et al., 2016) and been found to extend for up to 12 months (Terlecki, Larimer, & Copeland, 2010).

Both programs significantly reduced alcohol-related harms, but they cannot be considered to be equivalent in effectiveness because TOST indicated that the comparison of program effects was inconclusive. This analysis must be interpreted with caution because results were likely affected by a significant baseline difference in harms among females in the ECALC condition. Had this not been the case, ECALC may have fared better. Regardless, it should be noted that BMI (BASICS) has been found to reduce alcohol-related harms for up to 12 months (Terlecki et al., 2015).

The few studies that have evaluated outcomes of EC at 6 and 12 months postintervention have generally found a decay in effects (Scott-Sheldon et al., 2012). A meta-analysis on EC, however, concluded that because EC interventions are successful in changing expectancies and reducing alcohol use in the short-term, the continued investigation of EC interventions is merited (Scott-Sheldon et al., 2012). The design of ECALC may be more successful in producing durable reductions in drinking. Other EC studies typically rely on alcohol administration ("experiential" EC) followed by an explanation of expectancy and pharmacological effects. ECALC is nonexperiential (no alcohol administration) and provides similar expectancy information but uses a series of tasks to facilitate cognitive processing of information in relation to one's own expectancies to personalize the effect. These tasks were based on a series of theoretical studies focused on the mechanism by which expectancies might influence drinking (Dunn & Goldman, 2000; Dunn, Lau, & Cruz, 2000; Goldman, 1999). ECALC also includes a media literacy component to highlight the discrepancy between alcohol effects typically portrayed in the media and pharmacological effects. Media literacy teaches participants to deconstruct alcohol advertising and other media portrayals of the effects of alcohol, recognize information that is inconsistent with the pharmacology of alcohol, and apply these skills when exposed to alcohol-related media and when they experience themselves and others exhibiting behaviors under the influence of alcohol. Cognitive processing of expectancy effects in relation to one's own expectancies, development of media literacy skills, and the ongoing challenge to differentiate expectancy effects from pharmacological effects may reinforce changes in expectancy processes over time and corresponding decreases in drinking.

There are limitations to our study that must be noted. First, alcohol use and alcohol-related harms were only assessed at four weeks postintervention. Second, we were prevented from including a no-treatment or wait-list control by an ethical obligation to provide effective intervention for at-risk students as soon as possible, and a university requirement to provide rapid access to effective treatment. Terlecki et al. (2015) addressed this limitation in a 12-month BMI outcome study by recruiting a sample of nonmandated heavy drinkers to serve as a control condition. Although nonmandated students are not ideal, future ECALC studies may benefit from a similar approach. A meta-analysis of studies focused on mandated students concluded that being mandated produces reductions in alcohol use in the absence of any active intervention, however, active interventions produced significantly greater reductions in alcohol use compared to no-treatment controls (Carey et al., 2016). Lack of a waitlist control group prevented us from measuring the simple effect of being mandated, therefore, interpretation of our effect sizes should take this into consideration. A third limitation involves use of a clinician facilitator for the web-based ECALC. Although clinicians were instructed to provide no information beyond answering participant questions regarding navigation of the program, the amount and content of dialogue was not assessed. Therefore, effectiveness of delivering ECALC to mandated students without a facilitator is unclear. Fourth, seven measures of alcohol use were analyzed increasing the possibility of Type I error. We believe this is not the case, however, because effects across these variables were uniform in direction, though not necessarily in magnitude. This is consistent with the notion that each variable may be tapping into unique information, although we acknowledge that this may also simply represent random variability in effects across similar measures. The current study provides an important initial test of ECALC with mandated students, and thus, we felt it appropriate to provide more, rather than fewer measures of consumption. Finally, underrepresentation of nonwhite/Caucasian students limits generalizability of findings.

A previous study provided support for the short-term (1 month) effectiveness of group-delivered ECALC in reducing alcohol use among fraternity members (Fried & Dunn, 2012), and our current findings provide preliminary support for an individually delivered web-based format. Although we had a clinician assist students in navigating the web-based ECALC, the program was designed for individual or group administration facilitated by nonclinicians after completion of a 4-hr training. The next iteration of ECALC development will be a smart-phone delivered version explicitly designed for remote delivery without assistance. Computer-delivered interventions can be advantageous because they are less resource intensive, increase accessibility, reduce cost, and reach larger audiences. Future research should attempt to replicate these findings with an assessment-only control condition and evaluate duration of effects. Of particular interest would be an examination of potential additive effects of ECALC and a BMI delivered together.

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