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Personalized Boosters for a Computerized Intervention Targeting College Drinking: The Influence of Protective Behavioral Strategies

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Abstract

Objective—Computerized interventions are cost-effective and can quickly deliver individual feedback to many students. However, in-person interventions are more efficacious. The current study sought to improve the efficacy of a popular online intervention via emailed boosters with personalized feedback.

Participants—Participants were 213 student drinkers at a southeastern public university, ages 18–24.

Methods—Students were randomized into: 1) intervention only, or 2) intervention plus booster. Alcohol consumption and related problems were assessed at baseline, 2 weeks post, and 4 weeks post.

Results—Boosters yielded reductions in drinking, but not alcohol-related problems. Boosters were associated with significant reductions for drinking frequency, heavy drinking days, peak drinks, and associated BAC. Protective behavioral strategies (PBS) moderated this effect, with significant reductions for students low in PBS, but not students already highly engaged in PBS use.

Conclusions—Easy dissemination and low cost make emailed boosters a very efficient way to promote student health.

Keywords

alcohol; college student drinking; brief intervention; booster; protective behavioral strategies

Heavy episodic alcohol use within the college student population is both widespread and problematic.[1,2] There are often many alcohol-related problems associated with frequent alcohol use, ranging from mild (e.g., hangovers, missed classes) to more severe (e.g., DUIs, poor grades, assault, even death).[2,3] Computerized interventions targeting alcohol use among college students have been successful at reducing both alcohol consumption and alcohol-related problems.[4] In-person interventions tend to be more successful than other mediums;[5–7] however, online interventions remain very popular among colleges due to numerous strategic advantages.[8–11] The current study sought to improve the efficacy of

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computerized interventions while maintaining the low cost and easy dissemination benefits of this medium through the use of electronic boosters, or brief, delayed follow-up communications designed to extend the effect of the intervention.

College Student Alcohol Interventions

A meta-analysis of individual-level alcohol interventions given to college students revealed that risk reduction interventions were generally efficacious for up to six months,[12] including reductions in alcohol quantity, frequency of heavy drinking, and peak blood alcohol concentration (BAC). Although in-person interventions have been generally more successful than other mediums (including computerized interventions),[5–7] computerized interventions have several advantages over in-person interventions. Computerized interventions are more cost-effective and can quickly deliver tailored individual feedback while being disseminated to more students.[4] Additionally, computerized interventions may be administered as proactive strategies, whereas in-person interventions are often reactionary. In-person interventions can place a strain on expertise, time, and resources if they are to be mass-implemented,[13] whereas computerized interventions can be administered to large groups of students (e.g., incoming students, athletes, fraternities, and sororities) before the students receive sanctions.

Despite these advantages, computerized interventions also have several drawbacks. Although multiple studies support the efficacy of an earlier version (Alcohol 101™) of the intervention used for the current study, there are contradictory findings as well. The computerized intervention Alcohol 101™ demonstrated reductions in alcohol use and/or alcohol-related problems across multiple studies,[5,14,15,16] and created less positive and more realistic expectations for the effects of alcohol use on behavior.[17] In contrast, however, two studies found that Alcohol 101™ did not improve alcohol outcomes.[18,19] One low-*n* study without a control group even found that participation in Alcohol 101™ increased positive, unrealistic expectations for alcohol use among mandated students.[20] These conflicting results question the effectiveness of this intervention and perhaps computerized interventions as a whole.

The online intervention for the current study, Alcohol 101 Plus™ (a newer version of Alcohol 101™), incorporates a number of intervention components, including alcohol education, college student drinking norms, skills training, and personalized feedback. There have been only four published randomized studies to date examining Alcohol 101 Plus™, the current web-based version of the computerized intervention. Carey, Henson, Carey, and Maisto[6] found that Alcohol 101 Plus™ was equally effective as an in-person brief motivational intervention at reducing short-term drinking for male students mandated to treatment. However, female students responded more positively to the in-person intervention than to the computerized intervention. This finding was confirmed in a second, similar study that included additional computerized interventions.[21] A study comparing Alcohol 101 Plus™ to an in-person brief motivational session combined with personalized normative feedback found that both groups reduced drinking, but stronger effects were observed for the in-person intervention than the computerized intervention.[22] Finally, a more recent study randomized participants into groups that were either allowed to choose between Alcohol 101

Plus™ and an in-person brief motivational intervention, or were randomized assigned to one of the two interventions.[23] Although alcohol use and consequences were reduced in both intervention groups, reductions were significantly stronger for the in-person intervention.

These findings for Alcohol 101 Plus™ are representative of computerized interventions in general. A meta-analysis of studies including computerized interventions found that computerized interventions were effective at reducing alcohol consumption and alcohol-related problems compared to control conditions; however, the effect sizes were often smaller than more extensive interventions delivered in-person.[4] Moreover, the effects of computerized interventions are often short-lived, especially in comparison with face-to-face interventions.[24]

A recent meta-analysis comparing in-person versus computerized interventions found that although weighted mean effect sizes for short-term follow-ups (13 weeks or less) were similar across the two modalities, computerized interventions were worse than their in-person counterparts for intermediate (14–26 weeks) and long-term (27 weeks or more) follow-ups.[24] In the short term, effects were similar for quantity of alcohol consumed per week/month (in-person $d_+ = 0.19$, computerized $d_+ = 0.14$) and alcohol-related problems (in-person $d_+ = 0.15$, computerized $d_+ = 0.11$). However, intermediate outcomes such as quantity per drinking day (in-person $d_+ = 0.23$, computerized $d_+ = 0.08$) and problems (in-person $d_+ = 0.09$, computerized $d_+ = 0.01$) favored in-person interventions. Similar results were found among long-term follow-ups for quantity per drinking day (in-person $d_+ = 0.16$, computerized $d_+ = 0.07$). These results indicate that students receiving computerized interventions may be ideal targets for additional materials to increase efficacy such as booster sessions. Boosters may increase effectiveness for behavior change when interventions yield short-lived results, such as college student drinking.

Boosters

The use of boosters, or maintenance sessions, as a technique to increase intervention efficacy or prolong the duration of intervention effects is common. Boosters are considered a key strategy in relapse prevention or intervention maintenance[25] and are recommended by federal health agencies. Despite successes in other fields,[26] prior research has not supported booster efficacy for college student alcohol interventions.[14,27] Though boosters have been successful for alcohol interventions among individuals admitted at hospital emergency departments[28] and heavy-drinking women,[29,30] boosters have been administered with the college student population with mixed results. Barnett and colleagues[14] examined the efficacy of boosters among students mandated to treatment (randomized to brief motivational interviewing or computerized intervention). Although number of drinking days was reduced three months after the intervention, by one year after the intervention participant drinking had returned to pre-sanction levels and even increased for some outcomes. Booster sessions did not significantly impact reported behaviors. Similarly, another college student booster study randomized chapters of a national fraternity to receive a skills training intervention, the intervention plus two booster sessions, or assessment only. Researchers found that consumption increased to original levels 12–18 months after the intervention, even in the booster group.[27]

Although booster sessions for interventions targeting college student drinking have not yielded desirable results thus far, the current study explores booster efficacy using improved design. By using students not mandated to treatment, we avoid confounding intervention and booster effects with the effects due to alcohol-related sanctions.[31,32] Additionally, by sending boosters via email, we reduced participant burden. Moreover, the boosters for the current study targeted descriptive normative feedback and protective behavioral strategies, whereas previous studies examining college student drinking used boosters that consisted of more time with the original intervention content (e.g., more skills training, more motivational interviewing, or more time with the computerized intervention).[14,27]

The boosters in the current study included descriptive norms, or perceived quantity or frequency of alcohol consumed by a referent group, because of their strong associations with alcohol outcomes,[33,34] and their demonstrated ability to influence those outcomes when misperceptions are corrected.[35–39] College students of the same gender at the same institution were chosen given that closer referent groups are often more effective. [34,39–41] Further, protective behavioral strategies (PBS) are behaviors or strategies that an individual might use to reduce their alcohol consumption and associated problems, such as eating before and during drinking or avoiding drinking games.[42,43] These strategies focus on a harm reduction approach (i.e., drinking mindfully) rather than abstinence. Higher PBS use is often associated with less alcohol use and fewer alcohol-related problems.[42,44,45] In addition, encouraging PBS behaviors is a frequent component for successful interventions,[46,47] and PBS have shown to be responsive to targeted directions encouraging their use.[48,49] Both mechanisms (descriptive norms and PBS) were able to be succinctly communicated via email, an essential element for boosters communicated electronically to students.

The current study evaluated the ability of follow-up emailed booster sessions to increase the efficacy of an online intervention (Alcohol 101 Plus™) on the outcomes of alcohol use and alcohol-related problems. We hypothesized that the duration of the intervention effects would be improved by adding a follow-up emailed booster, where efficacy is evidenced by reduced drinking and alcohol-related problems at week four for students who received the emailed booster after the intervention compared to those who received only the intervention. The email-format of the booster maintained the low-cost and easy-dissemination of the original intervention while providing new intervention material not necessarily used by the original intervention.

Methods

Participants

Participants were college drinkers who received course credit (e.g., extra credit or participation points) for baseline participation after first consenting to participate. For each follow-up survey, students received course credit or entry into a weekly raffle for a $25 gift card. Baseline data were collected from $n = 353$ students who met eligibility criteria (i.e., four or more alcoholic drinks in the past two weeks, between the ages of 18 and 24, and completed the baseline assessment), representing typical college drinkers. After completing the baseline assessment, participants were randomized by gender into one of two conditions:

1) an intervention-only group, or 2) an intervention-plus-booster group. Of the participants who completed baseline, $n = 213$ (60.3%) completed the 2-week follow-up, and $n = 115$ (32.6%) completed the 4-week follow-up. Participants who did not complete any follow-up surveys ($n = 140$; 39.7%) were eliminated from the analysis, resulting in a final sample of $n = 213$. Because participation in the two-week follow-up was necessary to generate the content of the booster, participants who did not complete the first follow-up were unable to receive the booster. However, these participants were still included in all analyses, following an intent-to-treat model. The final sample was mostly female ($n = 140$; 65.7%) and largely Caucasian or White ($n = 132$; 62.0%) or African-American or Black ($n = 47$; 22.1%). The study was conducted in compliance with APA ethical standards and was approved by the institution's Internal Review Board.

Materials

Alcohol 101 Plus™—All participants received Alcohol 101 Plus™, an intervention developed by the Century Council.[50] This is an online intervention designed to be implemented to a large number of students (e.g., all incoming students, all athletes, all students associated with Greek organizations). The intervention is a combination of several intervention approaches including alcohol education, personalized feedback, attitude-focused strategies, and skills training. Alcohol 101 Plus™ depicts a virtual campus where students can select various locations that contain relevant information. Mode of information dissemination varies throughout the intervention, but modules contain written text, photos, videos of public service announcements, fictional video vignettes with decision points that can be revisited, and personal testimonials by real people. Finally, there is a virtual bar that provides updated BAC information based on participant information and choices.

Alcohol use—Participants' alcohol use was assessed using a modified version of the Daily Drinking Questionnaire.[51] Participants completed a grid indicating how many standard drinks they consumed on each day over the past 2 weeks. Participants also indicated how many hours passed during each drinking occasion. A total alcohol quantity score was created by summing drinks reported across the grid, and a frequency score was created by summing number of drinking days. Additionally, participants described their drinking in the past 2 weeks, including how many days they drank to the point of being intoxicated and on how many days they engaged in heavy drinking (i.e., five plus drinks for men and four plus drinks for women).[52] BAC was estimated using a formula which takes into account number of drinks, hours over which the drinks were consumed, weight, and gender.[53]

Alcohol-related problems—Alcohol-related problems were assessed using the Brief Young Adult Alcohol Consequences Questionnaire (B-YAACQ).[54] The B-YAACQ consists of 24 items assessing a single dimension of negative consequences, and respondents indicate with a dichotomous response whether they experienced each consequence within the past two weeks. The consequences listed range from mild (e.g., did embarrassing things or had a hangover) to more severe (e.g., had problems with interpersonal relationships or neglected obligations). The previous two weeks were assessed to be consistent with the assessment of other alcohol constructs. Internal consistency was adequate across all three timepoints: $\alpha = .82$, $\alpha = .87$, and $\alpha = .85$ for baseline, week 2, and week 4, respectively.

Protective behavioral strategies—PBS use during the past two weeks was assessed using a modified version of the Strategy Questionnaire (SQ).[43] Participants responded to 21 items using a modified 12-point count rating scale indicating the frequency of strategy use for the past two weeks (i.e., *None, 1 time, 2 times, …, 10 times, more than 10 times*). This allowed for a more sensitive assessment than the original grouped frequency rating scale. The scale consists of 3 dimensions: selective avoidance of risky drinking practices (e.g., not participating in drinking games); strategies while drinking (e.g., eating before and while drinking); and alternatives to drinking (e.g., finding other ways besides drinking to reduce stress). As demonstrated in previous research,[45] raw frequency is the most appropriate metric for alternatives to drinking, whereas contingent frequency (divided by number of drinking days) is the most appropriate metric for the dimensions of selective avoidance and strategies while drinking because these items are only possible in drinking contexts. Using this modified response option and scoring adjustment results in consistent, linear relationships with alcohol outcomes across subscales,[45] therefore the total score was used for the current study. Internal consistency was good (α = .92).

Boosters—Booster emails consisted of three pieces of intervention-related content. First, students were given descriptive normative feedback that described the proportion of students of the same gender from the same institution who drink less than the participant based on their own average weekly quantity that they reported. Normative data were collected campus-wide from the same institution as part of a separate study to generate the tailored feedback. Second, the booster congratulated the participant for the PBS that the participant reported using. Last, the booster provided reminders of unused PBS that the participant can use to protect themselves from alcohol-related problems. Additionally, boosters included feedback based upon a comparison of number of drinks consumed and alcohol-related problems for the week two assessment to baseline. If participants reduced their drinking and/or related problems at the later assessment, the feedback was congratulatory in nature (congratulating them on their reductions). If participants failed to reduce their drinking or problems, the feedback was encouraging in nature (urging them to try harder to reduce their drinking and/or alcohol-related problems). The sender of the email was gender-matched to the participant and was consistent across the entire study.

Procedure

Initial assessment—Participants came into the research lab and completed a computerized assessment at the beginning of their appointment that assessed alcohol use, alcohol-related problems, PBS, and demographics measures. Upon completion of the survey, participants were randomly assigned by gender to one of two possible conditions: an intervention-only condition that received the Alcohol 101 Plus™ intervention, or an intervention-plus-booster condition that received the Alcohol 101 Plus™ intervention plus a personalized booster email after their week two assessment. Because Alcohol 101 Plus™ has already been shown to be efficacious at reducing drinking,[6,14,15,16] the current study explored if an emailed booster could improve these effects; therefore, a control group was not necessary. After completing the initial assessment, participants were directed to navigate through their assigned program for 60 minutes. After completing the intervention, participants were reminded that they would receive further correspondence from researchers.

Baseline data were collected in both fall and spring semesters across two academic years. Initial assessments were conducted across multiple weeks throughout each semester.

Subsequent assessments—Approximately two and four weeks after the initial assessment, participants received an email informing them that they are eligible for follow-up surveys. This email included a link to an online survey that assessed alcohol use and related problems for the past two weeks. Two days after the original email, a second email was sent reminding participants to complete the survey if they have not yet done so. At that time, participants were also contacted by any secondary means of communication that they had the option to provide in the initial survey (i.e., alternate email address or text message).

Boosters—Approximately one to two days after the second assessment (i.e., two weeks after the intervention), participants in the experimental booster group received an additional email that served as a booster to the original intervention. To standardize amount of contact, participants who did not receive a booster email received a neutral email thanking them for their participation in the study and reminding them that there would be another follow-up assessment in approximately two weeks.

Analysis Strategy

Data were analyzed using piecewise latent growth models conducted within the larger framework of structural equation modeling (SEM) using maximum likelihood estimation within Mplus (version 6.1).[55] To assess piecewise latent growth, the intercept loadings were fixed to 1 for all timepoints; slope 1 captures growth from baseline to week two with loadings set to 0 (baseline), 1 (week two), and 1 (for week four), and slope 2 captures growth from week two to week four with loadings set to 0 (baseline), 0 (week two) and 1 (week four). This allowed for drinking and problem trajectories that were not strictly linear across time, and non-linear trajectories were expected if boosters result in further reductions for only one group.

As shown in Figure 1, a curve-of-factors model[56] was used to represent overall alcohol consumption. A latent variable was constructed for each timepoint, with each alcohol consumption variable at that timepoint as an indicator of the factor. The factor loadings were fixed to 1 for the alcohol quantity indicators, and the factor loadings and intercepts for each of the other outcomes (i.e., drinking frequency, heavy drinking days, days intoxicated, highest number of drinks, and peak BAC) were constrained to equality across timepoints. The constrained factor loadings are indicated with “a” through “e” in the figure. Estimated model parameters are interpreted in the number of drinks (quantity) metric. All analyses were bootstrapped with n = 1,000 replications and bias-corrected confidence intervals were used for significance testing due to the non-normality of alcohol use data. Gender was controlled for in all models.

To assess the moderating effect of PBS, multigroup models were conducted with PBS use determining group membership (high = above the PBS median; low = below the PBS median). Consistent with multigroup analysis, a single model was run with measurement parameters (i.e., factor loadings and item intercepts) constrained to equality, but structural parameters were free to vary across group. A second model was run where both

measurement and structural parameters were constrained to equality across groups. Model fit was compared to determine if constraining the structural parameters to equality across groups introduced significant misfit to the model.

Results

Preliminary Analyses

Survey items from baseline regarding age and number of drinks consumed for the past two weeks were used to exclude non-eligible students ($n = 245$) and to verify eligibility for the final sample ($n = 353$). As seen in Table 1, the "Missingness" column provides *t* test results comparing participants who remained in the study versus those who dropped out after baseline. Missingness (39.7% for week two and 67.4% for week four) was not significantly related to any baseline drinking behaviors. Across all alcohol outcomes, 15 outliers were reduced to a less extreme value, bivariate normality was assessed, and absence of multicollinearity was confirmed. Means and standard deviations for alcohol-related measures can be seen across time and by assignment in Table 1.

Baseline equivalence in outcomes across conditions was examined. A series of *t* tests revealed that group assignment (i.e., *intervention-only* or *intervention-plus-booster*) was significantly related to the outcomes at baseline of alcohol quantity, $t(211) = 2.996$, $p = .004$, number of drinking days, $t(211) = 2.50$, $p = .013$, alcohol-related problems, $t(211) = 3.51$, $p = .001$, number of days intoxicated, $t(211) = 2.67$, $p = .008$, and number of heavy drinking days, $t(211) = 2.28$, $p = .024$. It was not related to highest number of drinks or BAC on highest drinking day. Therefore, baseline differences were controlled for by including the effect of group assignment on intercepts for the outcomes and allowing these intercepts to correlate with growth.

As expected, there was a sharp decrease in many drinking behaviors immediately following the intervention. The intercept for slope 1 (growth from baseline to week two) for overall consumption indicated significant reductions for the intervention-only group, $b = -9.07$, $\beta = -0.827$, 95% CI [−11.98, −6.40]. As expected, the growth slope for the intervention-plus-booster group did not significantly differ from that reduction, $b = 1.96$, $\beta = 0.088$, 95% CI [−1.49, 5.65], because they had not yet received the booster at that time. Similarly, the alcohol-related problems intercept for slope 1 indicated significant reductions for the intervention-only group, $b = -1.98$, $\beta = -0.552$, 95% CI [−2.87, −1.13]. As expected, the growth slope for the intervention-plus-booster group did not significantly differ from that reduction, $b = 0.12$, $\beta = 0.016$, 95% CI [−1.00, 1.39]. The results suggest the intervention was effective at reducing drinking and related problems by week two.

Booster Effect

Booster receipt was coded as 1 = *received a booster*, 0 = *did not receive a booster*. As seen in Table 2, the booster did not significantly impact slope 2 growth trajectories (from week two to week four) for alcohol consumption, $b = -3.75$, $\beta = -0.174$, or alcohol-related problems, $b = 0.20$, $\beta = 0.029$, indicating that receiving the booster after the week two assessment did not significantly influence subsequent growth for consumption or problems through week

four. Significant effects are denoted by a 95% confidence interval that does not include 0. However, the trend for overall alcohol consumption demonstrated marginal significance ($p < .10$; 90% CI [−7.97, −0.43]).

To explore this demonstrated trend, the curve-of-factors model was followed by a subsequent model with each alcohol consumption variable modeled separately (i.e., an intercept, slope 1, and slope 2 for quantity; an intercept, slope 1, and slope 2 for frequency, etc.) but simultaneously as parallel processes to allow for natural relationships among the constructs. Residuals were allowed to correlate within timepoint across constructs (e.g., baseline quantity with baseline frequency), and within construct across timepoints (e.g., baseline quantity with week two quantity). As seen in Table 2, booster receipt was associated with significant reductions in drinking frequency, $b = -0.91$, $\beta = -0.215$, number of heavy drinking days, $b = -0.87$, $\beta = -0.240$, number if drinks on heaviest day, $b = -2.04$, $\beta = -0.254$, and BAC on that heaviest drinking day, $b = -0.06$, $\beta = -0.282$. It did not significantly influence quantity or number of days intoxicated.

The Moderating Effect of PBS

We also explored PBS as a moderator using a multi-group analysis. The sample was median-split into high PBS use (> 28.12 at baseline) or low PBS use (< 28.12 at baseline). Measurement estimates were constrained to equality across both groups for consistent representation of consumption scores, but structural paths were estimated separately for each. As seen in Table 3, receiving the booster was associated with further significant reductions for overall alcohol consumption from week two to week four for students who were low in PBS use at baseline, $b = -4.36$, $\beta = -0.190$, but not for students who were high in PBS use at baseline, $b = -1.01$, $\beta = -0.051$.

As seen in Figure 2, the trajectories for students low in PBS at baseline clearly demonstrate reduced consumption for both conditions to week two, then further declines to week four only for the booster condition, whereas slope 2 growth for the intervention-only condition is stagnant. Growth among students high in PBS at baseline is more consistent across condition, indicating no booster influence. For alcohol-related problems, receiving the booster did not significantly impact the growth trajectory for overall alcohol consumption from week two to week four for students who were low in PBS at baseline, $b = 0.44$, $\beta = 0.061$, nor for students who were high in PBS at baseline, $b = 0.37$, $\beta = 0.051$. To test overall moderation, a second model was run with structural parameters also constrained to equality across groups. A chi-square difference test indicated significant fit decrement when paths were constrained to equality, $\chi^2(8) = 18.60$, $p = .017$, indicating that the influence of the booster effect differed significantly for those low versus high in PBS at baseline.

Comment

The purpose of the current study was to assess the efficacy of a new booster technique of sending personalized feedback to students via email after receiving an online intervention targeting alcohol use and related problems. The personalized feedback booster was delivered via email, contained tailored normative information and reminders of individual PBS, and exhibited a non-significant trend for reducing overall alcohol use as examined using a latent

variable representing multiple drinking indicators, but not alcohol-related problems. A subsequent analysis examining individual consumption indicators indicated significant reductions in drinking frequency, number of heavy drinking days, number of drinks on highest drinking day, and BAC on highest drinking day after booster receipt. Multigroup analyses revealed that the booster was effective in reducing consumption for students who were low in PBS at baseline, but not for students who were already engaging in relatively high PBS use. Alcohol-related problems were not influenced by booster receipt for either group.

The trajectory for participants who received the booster email was reduced by over four drinks in overall consumption for students who were low in PBS use at baseline, whereas students who were already engaging in relatively high PBS use were reducing consumption by only one drink. The finding that the effect was significantly stronger for those low in PBS at baseline was not surprising given that the booster specifically addressed PBS strategies, which as previously been shown to be responsive to targeted directions encouraging their use.[48,49] It may be that only students who were not already engaged in harm reduction were the only ones who would benefit from such directions.

The findings of the current study are consistent with previous research. Multiple reviews of the literature conclude that personalized feedback provided to college students has generally been effective at reducing alcohol use and related problems.[12,57–59] The feedback is often combined with other forms of intervention (e.g., motivational interviewing), but is still effective when delivered as a stand-alone procedure.[37] The significant findings of the current study combined with the easy dissemination and cost effectiveness of emailed feedback has promising clinical implications. The ease of use and low cost may be popular among academic institutions currently employing the use of computerized interventions targeting drinking, including over 3,500 institutions using either Alcohol 101 Plus™, e-CHUG, or AlcoholEdu® for College, three of the most popular computerized interventions.[8–11] However, more temporally distant follow-up assessments are needed to evaluate the longer-term impact of the feedback.

Limitations

Although the current study had promising findings, including the ability of personalized feedback boosters to reduce drinking, there were also several limitations that should be addressed. Although there were a total of three assessments, each assessment was very temporally close to the others (i.e., only two weeks apart). The effects observed were only verified for the short-term (up to four weeks), and we do not know the duration of the effects. It is possible that the observed effects will not last much longer than the assessment period, and could erode fairly quickly. Consistent with typical intervention research, future studies should expand on the current study by assessing intermediate (i.e., 1–3 month) and longer-term (6+ months) effects as well. A second limitation of the current study was the use of self-reported retrospective data for the past two weeks, which may have been susceptible to recall bias. Future research incorporating a shorter period of recall (i.e., one week or daily assessment) could minimize potential biases associated with retrospective reporting.

Another limitation of the current study was the sample size as well as the rate of attrition (39.7% for week two and 67.4% for week four). These factors negatively impact external validity. The current study relied on course credit and raffles for compensation, reducing both participation rates as well as retention. Additionally, although the computerized nature of the intervention and survey is considered a benefit to the institution due to the comparatively low strain on resources, the computerized nature of the study may have weakened participants' perceived connection to the research, reducing follow-up rates compared to studies with in-person interventions.

Moreover, response rates for emailed survey invitations are often very low. A recent study found a range from 5.4% (with no compelling elements to the email) to 12.8% (with several compelling elements to the email).[60] The rates of the current study were much improved over these, likely due to fact that participants were already enrolled in the study and only the follow-up survey was emailed. In addition, although the demographics of the sample reflected the demographics of the institution, generalizations should be made with caution. Although the current study had a slightly higher representation of minorities compared to national averages (38% as compared to 28%),[61] the fact that the current sample had a high proportion of female and White participants combined with the relatively low sample size is a limitation. Results should be replicated in larger samples across multiple institutions.

Clinical Implications

The findings from the current study have a number of clinical implications for college drinking and related problems. The observed efficacy of the personalized booster delivered via email has positive clinical implications. This booster design has less cost to the institution, has a minimal time burden on both staff and students, could be automated, and can reach more students than in-person visits. It is a very efficient way to potentially reduce alcohol consumption among the student body. Although a reduction in alcohol-related problems was not observed in the current data, it is possible there is a delayed impact on problems after continued reduced consumption.

Future Directions

The findings of the current study are very promising, but future research should expand on this topic before widespread adoption of the procedure. Replicating the study with a longer timeline, increased retention, and assessment-only control is an important first step. Additionally, the eligibility criteria for the current study required only four or more alcoholic drinks within the past two weeks. This resulted in a sample of college student drinkers, not necessarily heavy drinkers. Future research should assess efficacy among students who engage in heavy, episodic drinking and students who experience moderate alcohol-related problems. Finally, future research may want to explore automating the booster generation process, which would further reduce costs for academic administrators and health officials.

Conclusions

Data from the current study indicate that an easily generated booster email providing personalized feedback was related to drinking reductions across multiple alcohol outcomes. Further exploration revealed that the booster was most efficacious for individuals not already

engaged in using many harm reduction behaviors. The implications of this finding are far-reaching, given the prevalence of online interventions targeting college student drinking, and the ability of easily-disseminated, cost-effective emails to boost efficacy. Although there were several limitations to the current study, the findings are nonetheless promising. Future research should attempt to replicate the current findings with longer-term follow-ups and more persistent procedures for maintaining participation rates.

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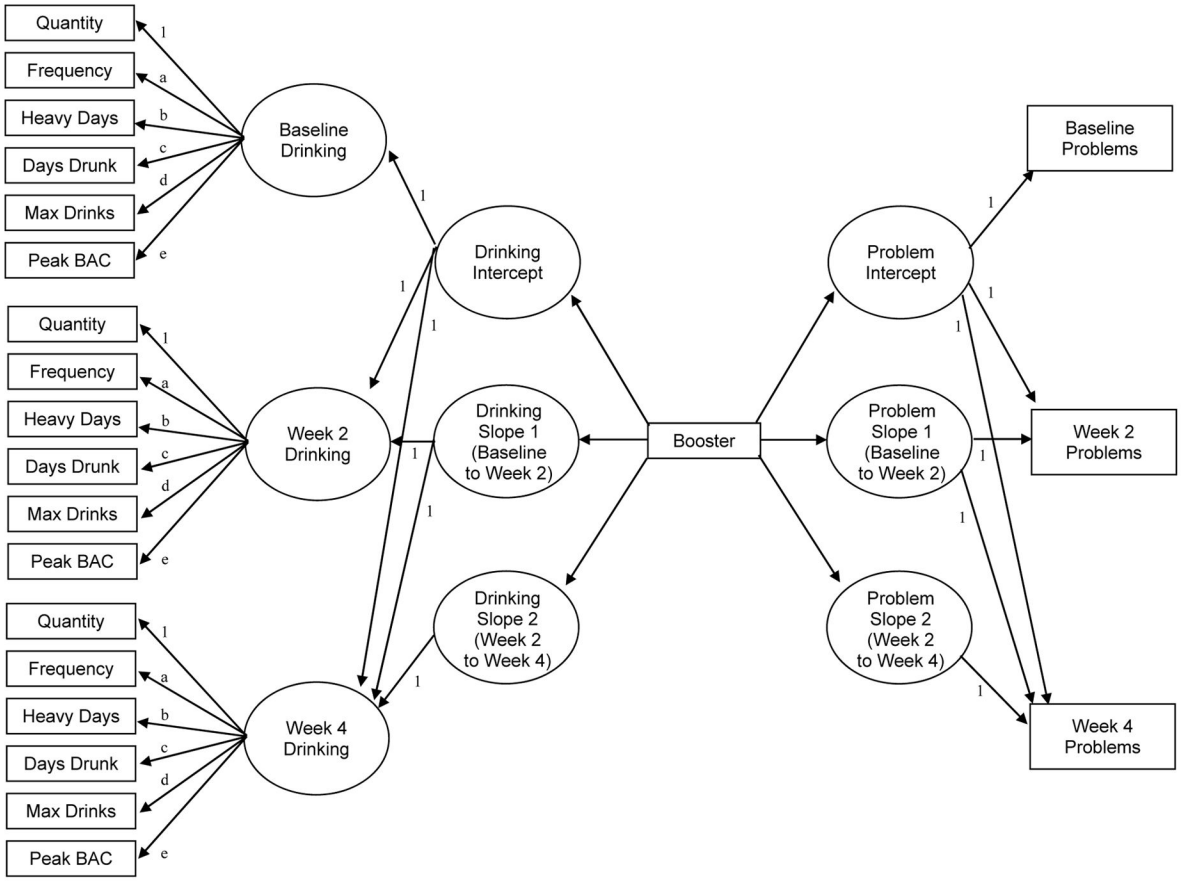
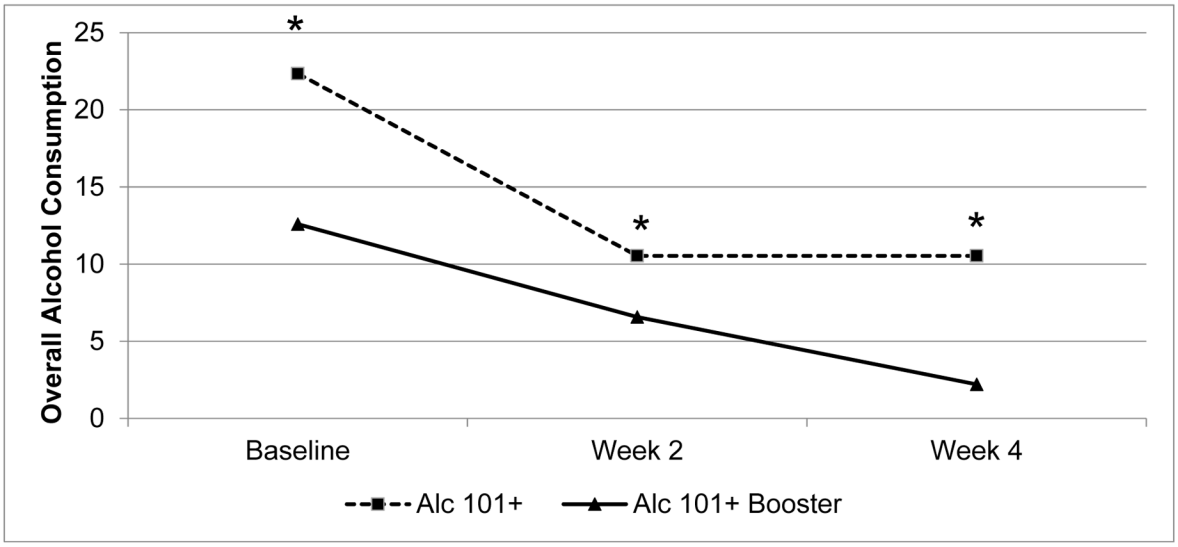


Figure 1.

Piecewise latent growth models testing the booster effect for overall consumption (a curve-of-factors model) and alcohol-related problems. Booster was coded as *0 = No booster*, *1 = Booster*. Factor loadings with matching letters (i.e., matching outcome indicators) were constrained to equality. BAC = Blood alcohol concentration.

(a)



(b)

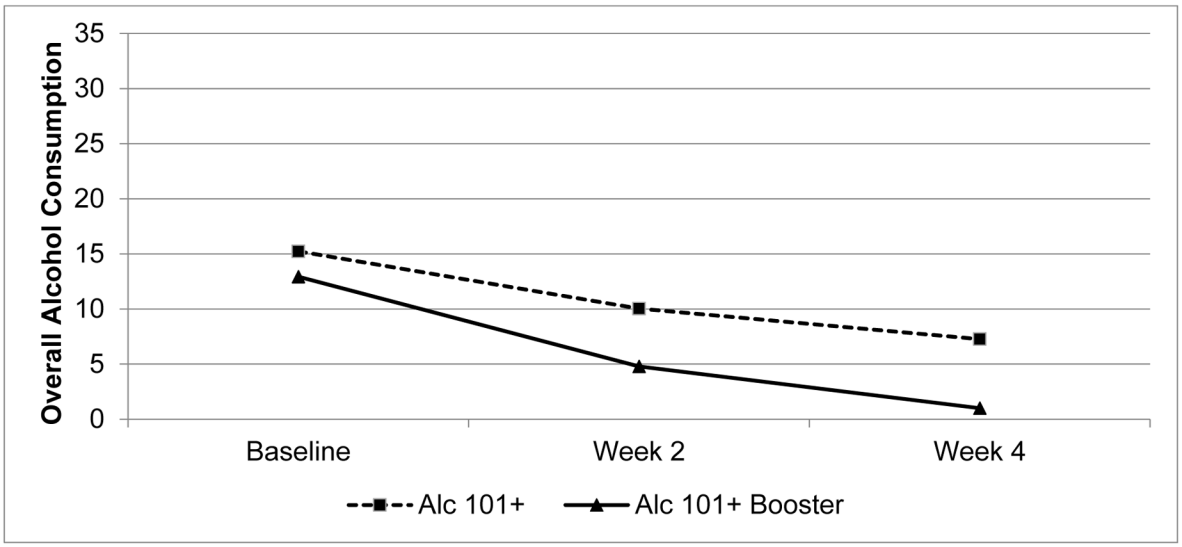


Figure 2.

Modeled trajectories for overall alcohol consumption for (a) individuals *low* in PBS at baseline (n = 107), and (b) individuals *high* in PBS at baseline (n = 106) based on a median split. Note that "Alc 101+" represents Alcohol 101 Plus™, and PBS = protective behavioral strategies. Asterisks denote a significant booster effect on the latent growth slopes/intercept based on 95% bootstrap confidence intervals.

Table 1

Means and Standard Deviations for Alcohol-Related Measures by Assignment

			Baseline		Week 2		Week 4		Missingness	
Measure	**Min**	**Max**	***M***	***SD***	***M***	***SD***	***M***	***SD***	***t***	***P***
Alcohol Quantity*									−0.20	.844
Alc101 only	0.0	86.60	25.79	21.65	18.61	18.09	17.18	15.18		
Alc101+bstr	0.0	86.20	19.75	15.84	13.18	13.81	10.26	13.13		
Number of Drinking Days*									−1.17	.245
Alc101 only	0.0	14.00	4.71	2.32	3.28	2.31	3.63	2.95		
Alc101+bstr	0.0	14.00	4.09	2.30	2.77	1.99	2.09	2.17		
Days Intoxicated*									−0.62	.534
Alc101 only	0.0	9.00	2.41	2.02	1.78	1.81	1.42	1.37		
Alc101+bstr	0.0	8.50	1.97	1.74	1.23	1.40	1.11	1.52		
Heavy Drinking Days*									0.53	.597
Alc101 only	0.0	11.00	3.02	2.38	2.14	2.15	2.37	2.17		
Alc101+bstr	0.0	11.00	2.50	2.13	1.67	1.91	1.22	1.77		
Number of Drinks on Highest Drinking Day									0.86	.389
Alc101 only	0.0	27.00	7.85	4.70	6.14	4.75	6.26	4.81		
Alc101+bstr	0.0	28.00	6.94	4.03	5.40	3.88	3.81	4.09		
BAC on Highest Drinking Day									1.85	.065
Alc101 only	0.0	0.51	0.15	0.11	0.11	0.10	0.13	0.12		
Alc101+bstr	0.0	0.58	0.14	0.11	0.10	0.09	0.07	0.09		
Alcohol-Related Problems*									−0.01	.990
Alc101 only	0.0	21.00	6.09	4.29	4.56	4.98	3.45	3.73		
Alc101+bstr	0.0	21.00	4.69	3.79	2.77	3.09	1.99	3.01		

Note. Alc101 = Alcohol 101 Plus™; bstr = personalized booster email; BAC = blood alcohol concentration. Asterisks indicate measures that were significantly different at baseline by assignment. Missingness provides *t* test results for whether each baseline drinking behavior was significantly different for participants who provided any follow-up data (n=213) versus were missing for both follow-ups (n=140).

Table 2

The Influence of the Booster Effect on Consumption and Problems

Outcome	*b*	β	95% CI
Model 1: Curve of Factors			
Intercept			
Overall Consumption	−6.77*	−0.204	[−11.78, −1.59]
Alcohol-Related Problems	−1.90*	−0.234	[−3.01, −0.74]
Growth from Baseline to Week 2			
Overall Consumption	1.96	0.088	[−1.49, 5.65]
Alcohol-Related Problems	0.12	0.016	[−0.94, 1.27]
Growth from Week 2 to Week 4			
Overall Consumption	−3.75	−0.174	[−8.67, 0.14]
Alcohol-Related Problems	0.20	0.029	[−1.00, 1.39]
Model 2: Parallel Processes			
Intercept			
Quantity	−8.30*	−0.233	[−13.84 −2.42]
Frequency	−0.70*	−0.139	[−1.33 −0.08]
Heavy Days	−0.78*	−0.167	[−1.44 −0.09]
Days Intoxicated	−0.71*	−0.197	[−1.24 −0.20]
Max Drinks	−1.17	−0.128	[−2.53 0.06]
Peak BAC	−0.01	−0.062	[−0.05 0.02]
Growth from Baseline to Week 2			
Quantity	2.79	0.105	[−1.32 6.53]
Frequency	−0.06	−0.013	[−0.66 0.63]
Heavy Days	0.31	0.069	[−0.30 0.96]
Days Intoxicated	0.16	0.052	[−0.27 0.61]
Max Drinks	0.40	0.049	[−0.72 1.53]
Peak BAC	0.01	0.039	[−0.02 0.04]
Growth from Week 2 to Week 4			
Quantity	−3.27	−0.137	[−8.04 0.68]
Frequency	−0.91*	−0.215	[−1.77 −0.10]
Heavy Days	−0.87*	−0.240	[−1.74 −0.29]
Days Intoxicated	0.04	0.014	[−0.42 0.54]
Max Drinks	−2.04*	−0.254	[−3.60 −0.61]
Peak BAC	−0.06*	−0.282	[−0.10 −0.02]

Note. 95% CI = 95% bias-corrected bootstrapped confidence intervals with n = 10,000.

Table 3

Influence of Booster Effects on Consumption and Related Problems by PBS Group

	Low PBS			High PBS		
	b	**β**	**95% CI**	***b***	**β**	**95% CI**
Overall Consumption						
Intercept	−9.76*	−0.280	[−16.38 −3.81]	−2.30	−0.072	[−9.35 4.51]
Growth to Week 2	5.79*	0.238	[1.09 11.05]	−2.96	−0.142	[−6.89 1.10]
Growth to Week 4	−4.36*	−0.190	[−8.13 −0.83]	−1.01	−0.051	[−6.65 4.18]
Alcohol-Related Problems						
Intercept	−2.12*	−0.246	[−39.69 −0.69]	−1.45*	−0.195	[−3.05 −0.03]
Growth to Week 2	−0.42	−0.054	[−1.89 1.21]	0.71	0.106	[−0.71 2.25]
Growth to Week 4	0.44	0.061	[−0.97 2.01]	0.37	0.051	[−1.17 1.94]

Note. 95% CI = 95% bias-corrected bootstrap confidence intervals with $n = 1{,}000$.