Randomized Controlled Trial of a Web-Delivered Personalized Normative Feedback Intervention to Reduce Alcohol-Related Risky Sexual Behavior among College Students

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Abstract

Objective—The purpose of this study was to evaluate the efficacy of personalized normative feedback (PNF) on college student alcohol-related risky sexual behavior (RSB).

Method—In a randomized controlled trial, 480 (57.6% female) sexually-active college students were stratified by gender and level of drinking and randomly assigned to an alcohol only intervention, an alcohol-related RSB only intervention, a combined alcohol and alcohol-related RSB intervention, or control. All assessment and intervention procedures were web-based.

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Results—Results indicated a significant reduction in drinking outcomes for the alcohol only and the combined alcohol and alcohol-related RSB interventions relative to control. Findings further demonstrated a significant reduction in alcohol-related RSB outcomes for the alcohol-related RSB only and the combined alcohol and alcohol-related RSB interventions relative to control. There were no significant intervention effects on alcohol-related negative consequences. These findings demonstrate that the combined alcohol and alcohol-related RSB intervention was the only intervention successful at reducing both drinking and alcohol-related RSB outcomes relative to control. There were no significant differences when comparing the combined alcohol and alcohol-related RSB intervention to the alcohol only intervention or the alcohol-related RSB only intervention. Finally, results suggested that the intervention effects on high-risk behaviors were mediated by reductions in descriptive normative perceptions.

Conclusions—These findings demonstrate that PNF specific to drinking in sexual situations was needed to reduce alcohol-related RSB. Furthermore, this study highlights the potential utility of a brief intervention that can be delivered via the Internet to reduce high-risk drinking and alcohol-related RSB among college students.

Keywords

alcohol; risky sexual behavior; descriptive norms; personalized normative feedback

While prior research has shown personalized normative feedback (PNF) interventions are efficacious at reducing high-risk drinking behavior and are mediated by reductions in normative perceptions, little research has examined PNF interventions aiming to reduce alcohol-related risky sexual behavior (RSB). Moreover, although web-based interventions have the potential to reach a large number of students at relatively low cost, there have been very few web-based interventions targeting alcohol-related RSB among college students. The present study was designed to evaluate the efficacy of a web-based PNF intervention in reducing alcohol-related RSB among college students.

Alcohol Use and Risky Sexual Behavior

Alcohol use among college students can lead to negative consequences for individuals and campus communities (Hingson, Edwards, Heeren, & Rosenbloom, 2009; Perkins, 2002). Alcohol use is associated with RSB, which is often defined as multiple or casual partners and unprotected sexual activity. On a global level, young adults who drink heavily are more likely to engage in greater levels of RSB (e.g., Patrick, O'Malley, Johnston, Terry-McElrtah, & Schulenberg, 2012; Rehm, Shield, Joharchi, & Shuper, 2012). On a situational level, there is some evidence that on days college students drink, they are more likely to engage in a greater number of sexual behaviors and are less likely to use condoms, especially with casual partners (e.g., Kiene, Barta, Tennen, & Armeli, 2009; Patrick & Maggs, 2009). College students often use condoms inconsistently, contributing to sexually transmitted infections in this population (American College Health Association, 2009). As a result, interventions aiming to reduce heavy alcohol use and related RSB among college students are needed.

Interventions for College Student Alcohol Use

Reviews of the college alcohol literature (e.g., Carey, Scott-Sheldon, Elliott, Bolles, & Carey, 2009; Cronce & Larimer, 2011) show that efficacious interventions aimed at reducing alcohol use often include some form of personalized drinking feedback and that changes in perceived normative perceptions are a primary mediator for personalized feedback intervention (PFI) efficacy (e.g., Carey, Henson, Carey, & Maisto, 2010; Doumas, McKinley, & Book, 2009). A subset of PFIs aimed at reducing descriptive normative perceptions is often referred to as personalized normative feedback (PNF) interventions (Lewis & Neighbors, 2006). Perceived descriptive norms refer to the perceived prevalence of a behavior (e.g., the perceived number of drinks per week or the perceived frequency of drinking prior to sex). PNF interventions highlight how the participant's own drinking behavior and drinking perceptions differ from the normative referent's actual drinking behavior. PNF has been shown to reduce heavy drinking and consequences as a standalone intervention (e.g., Lewis & Neighbors, 2007; Lewis, Neighbors, Oster-Aaland, Kirkeby, & Larimer, 2007; Neighbors, Larimer, & Lewis, 2004; Neighbors et al., 2010).

Interventions for College Student Alcohol-Related RSB

Although research evaluating social norms and normative misperceptions has primarily focused on alcohol use, this approach has more recently been applied to RSB. College students routinely overestimate the prevalence of peer RSB and alcohol-related RSB (Lewis, Lee, Patrick, & Fossos, 2007; Lewis, Litt, Cronce, Blayney, & Gilmore, 2012). Furthermore, both misperceptions of descriptive norms for RSB and alcohol-related RSB are positively associated with actual RSB and alcohol-related RSB (Lewis et al., 2007, 2012). Because college students overestimate the quantity and frequency of risky sexual behavior of the typical student, PNF may be an effective intervention strategy to reduce normative perceptions and therefore reduce RSB.

Few interventions have evaluated PNF as a means to reduce RSB. Chernoff and Davison (2005) used PNF in combination with goal setting in order to reduce HIV/AIDS risk behaviors among college students. The brief intervention resulted in a significant increase in condom use by men and a reduction in number of sexual partners for women. However, mediation analyses were not reported, and thus that study did not directly test the theoretical mechanism underlying the social norms approach. Moreover, it is unclear which intervention component(s) contributed to these outcomes. Specifically, it is unclear whether intervention effects were due to normative feedback, goal setting, or the combination of the two. The proposed research will address this issue by determining the unique effects of PNF on alcohol-related RSB.

Furthermore, few interventions have targeted both alcohol use and alcohol-related RSB, and even fewer have been web-based. Among college students, group, individual, and computer-delivered PFIs have been found to reduce RSB (Chernoff & Davison, 2005; Jaworski & Carey, 2001; Kiene & Barta, 2006). Ingersoll and colleagues (2005) evaluated an in-person PFI to reduce alcohol-related pregnancy risks among college women, which consisted of personalized feedback for drinking and contraception. At one month, women who received

the PFI were less likely to engage in heavy drinking, more likely to use effective contraception, and at lower risk for alcohol-related pregnancy. Findings further indicated that reducing heavy drinking mediated intervention efficacy on alcohol-related pregnancy risks. Thus, alcohol interventions shown to reduce drinking may hold particular promise in reducing alcohol-related RSB. In another study, an event-specific web-based intervention targeted heavy drinking and RSB during Spring Break. On days students were on Spring Break trips, they engaged in more sexual behavior, and this effect was lessened among those in the intervention group (Patrick & Lee, 2012). Results from the Spring Break intervention showed reductions in overestimated perceived norms for sexual behavior and alcohol use, although there were no differences in behavior (Patrick, Lee, & Neighbors, 2013). Finally, Dermen and Thomas (2011) evaluated a two-session, in-person PFI to reduce RSB among college students. Conditions included an alcohol risk reduction PFI, an HIV risk reduction PFI, and a combined alcohol and HIV risk reduction PFI. Findings indicated that the alcohol PFI reduced drinking but not RSB, and the HIV risk PFI reduced RSB. The combined PFI, however, did not reduce drinking or HIV risk behaviors.

Single-Risk versus Multiple-Risk Interventions

As demonstrated by Dermen and Thomas (2011), recent research has begun to examine if reducing alcohol use reduces RSB or if an intervention directly targeting alcohol-related RSB is necessary. It may also be that targeting both risky behaviors with a multiple-risk behavior PFI (i.e., combined PFI) could potentially be more efficacious than a single-risk behavior PFI as it conveys risk reduction messages for both behaviors. However, research has shown that longer PFIs are not always more efficacious than briefer PFIs (Kulesza, Apperson, Larimer, & Copeland, 2010). Because the question of parsimony of a single intervention to address multiple-risk behaviors versus the potential of diluting treatment effects with combined or integrated interventions has broad clinical implications, additional research aimed to examine the extent to which single-risk or multiple-risk interventions reduce alcohol-related RSB is needed.

Benefits of Web-Based Intervention

Although findings suggest weaker effects for computer-delivered PFIs than in person PFIs (Carey, Scott-Sheldon, Carey, DeMartini, 2007), research has demonstrated evidence for the efficacy of web-based PFIs, including PNF, in reducing alcohol consumption (e.g., Bewick et al., 2008; Doumas et al., 2009; Neighbors et al., 2010). While these studies have contributed to the understanding and advancement of web-based alcohol interventions, studies examining web-based interventions to reduce RSB are needed. The present study is a novel test of a web-based PNF intervention targeting alcohol use and alcohol-related RSB among college students.

Social Learning Theory and the Social Norms Approach

A number of theories provide rationale for the relationship between normative perceptions and personal behavior, although social learning theory is a commonly cited theoretical explanation (Bandura, 1977). Social learning theory, and its later extension social cognitive theory (Bandura, 1986), propose that the acquisition and maintenance of behaviors,

including but not limited to health and risk behaviors, can occur through observation of or by communication with others. Moreover, individuals' personal behaviors are influenced by their observations of the prevalence of risk behaviors, or perceptions of how common or uncommon a behavior is among others. These observations contribute to overestimated normative perceptions as most observations tend to be selective (i.e., focused on proximal peers who typically engage in similar risk or protective behaviors) and biased toward extreme cases (i.e., students who engage in high-risk behavior).

The Present Study

The purpose of the present study was to evaluate the efficacy of a PNF intervention in reducing descriptive drinking normative perceptions, descriptive alcohol-related RSB normative perceptions, drinking behavior, alcohol-related negative consequences, and alcohol-related RSB. For alcohol outcomes, we expected that experimental groups receiving the alcohol only PNF or combined alcohol and alcohol-related RSB PNF would show reduced drinking normative perceptions, drinking behavior, and alcohol-related negative consequences relative to the control group. With regard to alcohol-related RSB, we hypothesized that experimental groups receiving the alcohol only PNF, alcohol-related RSB only PNF, or combined alcohol and alcohol-related RSB PNF would show reduced alcohol-related RSB normative perceptions and alcohol-related RSB relative to the control group. We also expected that the experimental group receiving the combined alcohol and alcohol-related RSB PNF would show greater reductions in perceived drinking norms, perceived alcohol-related RSB norms, drinking behavior, alcohol-related negative consequences, and alcohol-related RSB relative to the other two PNF groups. The second aim of this study was to evaluate the potential theoretical mechanism (i.e., descriptive normative perceptions) underlying PNF intervention efficacy. We expected the efficacy of the alcohol only PNF and combined alcohol and alcohol-related RSB PNF on reducing alcohol consumption and negative consequences to be mediated by changes in perceived drinking normative perceptions. Finally, we expected the efficacy of the alcohol-related RSB only PNF and combined alcohol and alcohol-related RSB PNF on reducing alcohol-related RSB to be mediated by changes in perceived alcohol-related RSB normative perceptions.

Method

Participants

Participant flow throughout this study is presented in Figure 1. The invited sample consisted of 3,224 randomly selected undergraduate students aged 18 to 25 from a large public northwestern university. Of the invited sample, the mean age for participants was 20.38 years old ($SD = 1.56$). Gender and ethnic representation of the invited sample was 50.2% male, 54.7% White, 27.6% Asian, and 17.7% other ethnicities or not indicated. Of the invited participants, a total of 1,468 (45.5%) agreed to participate and 1,387 (94.5%) completed the screening survey. For those who participated in the screening survey, gender and ethnic representation was 43.6% male, 61.0% White, 23.2% Asian, and 15.8% other ethnicities or not indicated. The mean age for screening participants was 19.90 years old ($SD = 1.52$). Those who completed screening were younger than those who did not complete the

screening survey, t (3,223) = 2.23, p < .05. There were significant differences in ethnic representation (i.e., White, Asian, and other) based on whether students decided to participate or not, χ^2 (2, n = 4106) = 14.96, p < .001, Cramer's V = .060, p < .001, with Whites more likely and Asians less likely to participate in the screening survey. In regards to gender, women were more likely to participate in the screening survey than men, χ^2 (1, n = 4,659) =17.66, p < .001, Cramer's V = .062, p < .001.

Of the 1,387 students who completed the screening survey, 590 (56.4% female) met the study eligibility criteria. Eligible participants reported: 1) having at least 4/5 drinks on one occasion in the past month for women/men, respectively, 2) having oral, vaginal, or anal sex in the past 12 months, and 3) typically having sex with a member of the opposite sex. These selection criteria are similar to those used in previous indicated interventions for drinking (e.g., Lewis et al., 2007) and risky sexual behavior (e.g., Jawarski & Carey, 2001) and were expected to identify participants at elevated risk for negative consequences related to drinking or sexual behavior and therefore more suitable candidates for an alcohol and/or risky sexual behavior reduction intervention. Eligible participants were invited to the baseline survey for which 480 (81.4%) completed the survey and were included as participants in the longitudinal study. Recruitment for the longitudinal study was closed early after having exceeding the required sample size for the longitudinal study (N = 400). Those who completed the baseline survey and who were enrolled in the longitudinal study were 57.6% female, 70.0% White, 12.5% Asian, and 16.2% other or not indicated race/ethnicity. The mean age for those who completed the baseline survey and enrolled was 20.08 (SD = 1.48). Those who completed baseline and who were enrolled in the study were older than those who did not complete baseline or who declined longitudinal participation, t (572) = 3.69, p < .001. In regards to gender, women were more likely to complete the baseline survey than men, χ^2 (1, n = 574) =6.72, p < .001, Cramer's V = .110, p < .01. Those who completed baseline and who were enrolled did not differ from those who did not complete baseline or who declined longitudinal participation with respect to race/ethnicity.

About half of students in the longitudinal study (52.1%) reported not currently being in a monogamous relationship and 97.3% identified as heterosexual at Wave 1. Participants reported having an average of 1.32 (SD = 1.05) sexual partners in the last 3 months.

Procedures

A random sample of 3,224 undergraduate students ages 18 to 25 was requested from the University's Registrar Office. During the 2009 Fall Quarter, participants were invited to take a 20-minute web-based screening survey about alcohol use and sexual behavior. E-mail invitations were sent first, followed by an invitation letter in the U.S. mail two days later for those who had not yet completed the survey. Each invitation provided a brief description of the study and instructed interested participants to log on to the URL provided and enter their personal identification number (PIN). E-mail invitations included two e-mails, one containing the survey link and the second containing the participant's PIN. In both invitations, participants were informed that in addition to the survey payment, those who completed within the first two weeks would be entered for a drawing to win $100. Those who completed the survey before the deadline would also be entered to win an additional

$100. The drawing for two $100 checks was done at screening, baseline, 3-month, and 6-month follow-up. Participants who did not respond received a series of e-mail and phone call reminders. Once a participant logged into the screening survey, they were presented an information statement and those who agreed to participate were routed to the screening assessment. Participants were informed that if the study was right for them, they would be invited to complete a 30-minute survey immediately following the 20-minute screening survey and two additional 50-minute surveys at 3 month intervals (i.e., 3-month follow-up, 6-month follow-up). Participants were notified that after completing the baseline survey they would be randomly assigned to receive or not receive information comparing their drinking and/or sexual behavior with other students' drinking and/or sexual behavior at their university. A Federal Certificate of Confidentiality was obtained to help ensure privacy of research participants. All study procedures were approved by the University's Institutional Review Board and no adverse events were reported.

A priori power analyses indicated 400 participants would provide adequate power for detecting effect sizes in the small to medium range. Thus, we aimed to invite 3,224 students with the expectation that 50% would complete screening ($n = 1,612$), and approximately 25% of those would meet the eligibility criteria and complete baseline ($n = 400$).

Students who met screening criteria were given the option to complete the baseline survey immediately or to return to complete it within two weeks. Those who chose to complete the baseline survey immediately were seamlessly routed to the baseline assessment. Those who elected not to complete the baseline survey immediately were sent up to five e-mail reminders and received a phone call reminder before being removed from the invitation list.

All participants were randomly assigned to one of four conditions immediately after completing the baseline assessment. All measures and interventions were completed entirely via the Internet. Incentives for participation were $10 for completing the screening survey, $15 for the baseline survey, $25 for the 3-month follow-up assessment, and $30 for the 6-month follow-up assessment. Participants were carefully monitored at each assessment point for consumption of potentially lethal amounts of alcohol (BAC of .35 or greater). Those reporting consumption at this potentially lethal level (baseline $n = 28$, 3-month $n = 15$, 6-month $n = 17$) were sent information regarding the risks of drinking at their reported level, regardless of intervention condition. The proportion of participants with BAC of .35 or greater did not vary by condition at any assessment point (see Figure 1).

Randomization

A 6-month longitudinal randomized 2 (alcohol PNF vs. no alcohol PNF) x 2 (sex PNF vs. no sex PNF) experimental design was used in the present study. Participants were randomized into one of four conditions using stratified random assignment based on typical weekly drinking (less than 10 drinks per week vs. 10 or more drinks per week) and gender. The intervention conditions included: 1) alcohol only PNF, 2) alcohol-related RSB only PNF, 3) combined PNF, and 4) attention control. Random assignment was administered automatically using a computer algorithm and occurred in blocks of four to keep cell sizes equal.

Intervention

At the end of the baseline survey, participants were presented a link that routed them to view their PNF. Participants were also sent an e-mail inviting them to view their personalized feedback at any time. Those who did not view their PNF received up to four e-mail reminders to do so. The majority of participants (97.5%) viewed their feedback at least once. Participants who viewed their feedback did so from one to five times with an average of 2.18 views ($SD = .97$). On the first viewing of the feedback, participant time viewing the feedback ranged from five seconds to fifteen minutes with an average of 1.27 minutes ($SD = 2.10$). Of those who viewed their feedback, only 3.4% of participants printed their feedback.

The PNF interventions were modeled after previously found efficacious PNF interventions for high-risk drinking (Lewis & Neighbors, 2007; Neighbors et al., 2004, 2010). These interventions were developed based on the normative feedback component of the Brief Alcohol Screening and Intervention for College Students (BASICS) intervention (Dimeff, Baer, Kivlahan, & Marlatt, 1999). Following the conceptualization of PNF as personalized information designed to reduce descriptive normative perceptions, this intervention was extremely brief. All pages contained a banner with the study logo that read "How do you compare to other male/female [University Name] students?" The PNF included information regarding 1) one's own behavior, 2) one's perceptions of the typical same-sex students' behavior, and 3) the typical same-sex students' actual behavior (i.e., the campus norm). This information was presented in text and bar graph format. Together, these three pieces of information aimed to explicitly illustrate to the participant that: 1) he/she overestimated the prevalence of drinking and/or sexual behavior among his/her same-sex peers and 2) he/she reported more heavy drinking and RSB than the typical same-sex student. Participants randomized into the feedback conditions were given feedback regardless of whether or not they overestimated the campus norm.

The structures of the bar graphs were individually tailored to the participants' data so that, for each graph, the scale on the y-axis was dependent on the maximum of these three values for each participant. Participants were also provided with their percentile rank comparing them with other students' drinking behavior (e.g., "Your percentile rank is 96%, which suggests that you drink more than 96% of other male/female [University Name] students"). Percentiles were not provided for sexual behavior. Participants were notified that the information contained in the feedback came from a random sample of 1,002 students at their university. Screen formatting was identical across conditions; only the information and number of screens in the intervention varied. Intervention feedback material contained four screens for the alcohol only condition, four screens for the alcohol-related RSB only condition, and eight screens for the combined alcohol and alcohol-related RSB condition. The control condition was three screens. Participants navigated through the feedback by clicking the 'next' button but were able to review previous pages by clicking the 'previous' button. On the last screen of their feedback, participants were given the option to print their feedback.

Alcohol only PNF (alcohol only)—Drinking behaviors in the past 3 months included: 1) number of times spent drinking during the typical week, 2) average number of drinks

consumed per typical drinking occasion, and 3) number of drinks consumed per typical week. Each screen presented one graph and related feedback content. The final screen of the feedback provided a percentile rank for comparison between the participants' reported drinking and that of their same-sex peers.

Alcohol-related RSB only PNF (alcohol-related RSB only)—The RSB covered in the feedback included: 1) number of sexual partners in the past 3 months, 2) number of occasions of sex with a casual partner in the past 3 months, 3) number of occasions drank alcohol before having sex, and 4) number of drinks consumed before sex. Each screen presented one graph and related feedback content. In addition to the information presented within the text and graphically, relevant social norms on the safe sex and contraceptive practices for their same-sex peers were presented on each screen.

Combined alcohol and alcohol-related RSB PNF (combined)—Participants randomized into this condition were shown information on both drinking and RSB (i.e., the exact PNF from the alcohol only and the exact PNF from the alcohol-related RSB only conditions). The alcohol PNF was presented prior to the alcohol-related RSB PNF.

Attention control feedback (control)—Control participants were shown information related to use of technology. Technology use was broken down into three topics: 1) texting, 2) downloading music, and 3) playing video games. Each screen presented one graph and related feedback content. For each screen of the feedback, participants were provided their percentile rank for the specific technology uses. Actual technology use was collected from a 2007 survey of undergraduate students from the same university.

Measures

Measures provided for the current study included questionnaires regarding alcohol consumption, sexual behaviors, and descriptive normative perceptions of alcohol use and sexual behaviors in same-sex peers.

Drinking behavior—The Daily Drinking Questionnaire (DDQ; Collins, Parks, & Marlatt, 1985) was used to assess number of typical drinks per week. Participants were asked to "Consider a typical week in the past 3 months. How much alcohol, on average (measured in number of drinks), do you drink on each day of a typical week?" Weekly drinking was computed by summing the standard number of drinks for each day of the week. Typical drinking frequency and typical drinks per occasion were assessed with items from the Quantity/Frequency/Peak Alcohol Use Index (Dimeff et al., 1999). Typical drinking frequency was assessed by the question "On average, during the last 3 months, how often have you consumed alcohol?" Response options ranged from 0 = *never* to 30 = *every day*. To assess typical drinks per occasion, participants were asked to report the number of typical drinks per drinking occasion in the last 3 months. Response options ranged from 0 = *0 drinks* to 25 = *25+ drinks*. Alcohol-related negative consequences were assessed using the Brief Young Adult Alcohol Consequences Questionnaire (BYAACQ; Kahler, Strong, & Read, 2005). Participants indicated which items on a list of 24 potential problems they

experienced as a result of their drinking in the past 3 months. Internal consistency for the BYAACQ at baseline and follow-ups was excellent (.88 – .91).

Alcohol-related RSB—Items assessing sexual behaviors and normative misperceptions were adapted from those used by Lewis et al. (2007). Alcohol use in conjunction with oral, vaginal, or anal sex was measured by the question, "You said you had sex ___ time(s) in the past 3 months. Of the ___ time(s), how many times did you consume alcohol before or during the sexual encounter?" Response options ranged from 0 = *none* to 25 = *25+ times.* The number of drinks consumed prior to sex was examined using the question, "You said you had consumed alcohol before or during sex ___ time(s) in the past 3 months. During the ___ time(s), how many drinks on average did you consume?" Response options ranged from *none* (0) to *25+ drinks* (25).

Normative perceptions—Measures for perceived descriptive drinking (Baer et al., 1991) and sexual behavior (Lewis et al., 2007) were identical to measures for respondent drinking and sexual behavior (i.e., oral, vaginal, or anal) with modified stem questions to refer to the typical same-sex student at their university. For example, to assess perceived drinks per week, participants were asked to "Consider a typical week in the past 3 months. How much alcohol, on average (measured in standard number of drinks), does the typical male/female [University Name] drink on each day of a typical week?" Perceived weekly drinking was computed by summing the number of drinks estimated for each day of the week.

Data Analyses

The focus of the present study was to assess treatment effects on drinking behavior and alcohol-related RSB. We examined treatment differences between intervention groups for six outcomes at 3 months and 6 months: number of typical drinks per week, frequency of drinking per month, number of typical drinks per drinking occasion, alcohol-related consequences, frequency of drinking prior to sex, and number of typical drinks consumed prior to sex.

All outcomes were types of count variables (i.e., total number of drinks, days drinking, etc.) and as is common with count outcomes, all six were highly skewed and bounded at zero. Because of these qualities, count regression methods were used as the primary data analytic approach (see Atkins & Gallop, 2007). Another key analytic consideration was that outcomes were assessed at three time points, but the change across time was not linear. Most outcomes revealed a notable change from baseline to 3 months, with limited or no change between 3 and 6 months. Therefore, it was most straightforward to analyze 3 and 6 month outcomes in separate models, controlling for the baseline level of the outcome.

To appropriately model the non-normal outcome data, negative binomial regression models were used for frequency of drinking per month, number of typical drinks per drinking occasion, alcohol-related negative consequences, and the frequency of drinking prior to sex. However, two of the outcomes (typical drinks per week and the number of typical drinks consumed prior to sex) contained notable stacks of zeroes that were better fit by hurdle models. Similar to zero-inflated models, hurdle models have two sub-models: a logistic regression predicts zero or not-zero, and a truncated count regression predicts non-zero

counts (truncated because it does not include zero; Hilbe, 2011).[1] All count regression methods use a log link function, much as logistic regression uses a logit link function. To interpret coefficients, raw coefficients are exponentiated (raised to the base *e*) and are referred to as rate ratios.

The following model represents the basic model for analyzing treatment differences at 3 and 6 months:

$$E[\text{Outcome}] = b_0 + b_1 * \text{AlcoholPNF}_i + b_2 * \text{SexPNF}_i + b_3 * \text{CombinedPNF}_i + b_4 * \text{Gender}_i + b_5 * \text{Outcome}_{\text{Baseline},i} \quad (1)$$

where *i* indexes participants. Each model includes treatment contrasts (with attention control as the reference category) and includes gender and the baseline value of the outcome as covariates. For outcomes that were fit using hurdle models, the same set of covariates was used in both the logistic and count regression portions of the model.

In addition to estimating treatment differences, the second aim of this study was to evaluate the potential theoretical mechanism (i.e., descriptive normative perceptions) underlying PNF intervention efficacy. Mediation analyses were used to explore whether observed treatment effects were mediated through changes in perceived descriptive norms. To examine mediation, an extension of the Baron and Kenny (1986) procedures was used. Specifically, Equation 1 above defines the total effect of treatment (Pathway 'c' in the mediation literature). Next, mediators were regressed on the same set of covariates as shown in Equation 1 (Pathway 'a'), and finally, the direct and mediator effects were estimated using:

$$E[\text{Outcome}] = b_0 + b_1 * \text{AcoholPNF}_i + b_2 * \text{SexPNF}_i + b_3 * \text{CombinedPNF}_i + b_4 * \text{Gender}_i + b_5 * \text{Outcome}_{1i} + b_6 * \text{Norms}_i \quad (2)$$

For assessing mediation, the significance of the mediator coefficient, b_6, was examined, and the reduction or increase of the treatment effects was estimated from Equation 1 to Equation 2 (i.e., change in coefficients b_1, b_2, and b_3) for the five outcomes. Although it is common in psychological research to include an estimate of the indirect effect (i.e., product of pathways a and b), mediation analysis with over-dispersed count outcomes generally, and with zero-altered outcomes specifically, is an active area of statistical research (Wang & Albert, 2012).[2]

Analyses were done according to the intent-to-treat principle, in which participants were analyzed as randomized regardless of whether they viewed the intervention or not. Finally, a series of sensitivity analyses were conducted to examine whether results might vary due to gender, monogamous relationship status at baseline, and number of sex partners since previous assessment. All analyses were done in R v2.12.2 (R Development Core Team,

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[1] Zero-inflated models are a type of mixture model, in which the distribution of zeroes is a mixture of zeroes from the count regression model and the logit model. See Hilbe (2011) for further details.
[2] In addition, we note that the utility of estimating and testing the indirect effect is questionable outside of OLS regression. With non-identity link functions, the indirect effect no longer estimates the reduction of c (total) to c' (direct), and some writers have questioned whether the test of an indirect adds information over and above the classic, causal steps: "...we know of no evidence demonstrating the logical superiority of an a*b test over the joint test of a and b in demonstrating the plausibility of a mediation model: the null hypothesis of both approaches are consistent with the presence of a purported indirect effect" (p. 159, Gelfand, Mensinger, & Ten Have, 2009).

2011) using the MASS (Venables & Ripley, 2002) and pscl (Zeileis, Kleiber, & Jackman, 2008) packages for negative binomial regression and hurdle models, respectively.

Results

Means and standard deviations for behavior outcomes by treatment group are shown in Table 1. When examining means, regardless of what treatment the student received, means appear to decline over the three time points. Descriptive statistics of means and standard deviations for normative perceptions by treatment group are shown in Table 2. As with behavior, regardless of what treatment the student received, means in normative perceptions appear to decline over the three time points. Spearman's rho correlations indicated that, overall, drinking behavior (i.e., drinks per week, drinks per occasion, drinking frequency, alcohol-related negative consequences) was significantly associated with alcohol-related risky sexual behavior (i.e., frequency of drinking prior to sex, drinks consumed prior to sex) at all time points, ranging from .22 to .49, $ps < .05$. The one exception was that drinks per occasion was not correlated with drinks consumed prior to sex at any time point.

Models for Main Effects

Figure 2 (left) presents rate ratios (RRs) and 95% confidence intervals for the three active treatments relative to control, for each of the outcomes at 3 months and 6 months, controlling for gender and baseline outcome behavior. CIs that do not cross 1 are significant at the $p < .05$ level. When hurdle models were used, RRs are presented for the count regression portion, which is where notable treatment differences were found. All baseline outcomes (i.e., drinks per week, frequency of drinking per month, drinks per occasion, alcohol-related consequences, frequency of drinking prior to sex, and drinks consumed prior to sex) were significantly associated with corresponding 3 month and 6 month outcomes. In addition, men reported significantly higher: drinks per week (at 3 months only), frequency of drinking per month (at 3 months only), drinks per occasion (at 3 and 6 months), alcohol-related consequences (at 3 months only), and drinks consumed prior to sex (at 3 and 6 months).

In examining Figure 2, several broad patterns appear. First, there were stronger treatment effects on alcohol outcomes than on alcohol-related RSB outcomes. Second, interventions including alcohol content (alcohol only PNF, combined PNF) had significant reductions on drinking outcomes, whereas the alcohol-related RSB only PNF did not. Note also that the rate ratios of 0.80 to 0.90 signify a 20% to 10% reduction, respectively, in drinking outcomes for treatment group relative to control. Most intervention effects on drinking outcomes remained significant at the 6 month assessment. Alcohol-related RSB outcomes showed less movement and more variability relative to alcohol outcomes. Findings indicated significant treatment effects for alcohol-related RSB only PNF and combined PNF on frequency of drinking prior to sex at 3 months. However, there were no significant treatment effects for either alcohol-related negative consequences or drinks prior to sex. There were no significant differences when comparing the combined PNF intervention to alcohol only PNF or alcohol-related RSB only PNF interventions on all behavior outcomes.

Figure 2 (right) shows treatment effects on perceived descriptive normative perceptions for each outcome. Results indicated that treatment effects were stronger for descriptive normative perceptions than for behavior with almost all treatment effects, relative to control, on normative perceptions significantly lower at both 3 and 6 months. There were no significant differences when comparing the combined PNF intervention to alcohol only PNF or alcohol-related RSB only PNF interventions on all normative perception outcomes. Of importance, findings indicated that there were cross-over effects such that the alcohol only PNF had significant reductions on alcohol-related RSB normative perceptions and that the alcohol-related RSB only PNF had significant reductions on drinking normative perceptions.

Finally, when evaluating the second aim of this study (i.e., the theoretical mechanism underlying PNF intervention efficacy), results indicated evidence of mediation for four of the six outcomes, although the significance varied by treatment condition and by wave. For number of typical drinks per week, there was significant evidence of mediation at 3 (a change of nearly 20%) and 6 months (a change of about 6%) for the alcohol only PNF and the combined PNF. Thus, participants who received alcohol-specific PNF reduced their normative perceptions of the number of typical drinks per week, which in turn reduced their typical number of drinks per week at the 3 and 6 month follow-up. The frequency of drinking per month had significant evidence of mediation at 3 months for the combined PNF (a 10% change) and at 6 months for the alcohol PNF (3% change). The number of typical drinks per drinking occasion had significant evidence of normative perceptions mediation at 3 months for the alcohol PNF (8% change) and at 6 months for the alcohol PNF and combined PNF (5% and 2% change). For the alcohol-related RSB behaviors, the evidence of mediation was weaker, but as shown in Figure 2 (left), the treatment conditions did not reduce those outcomes as much as the drinking behavior outcomes. Frequency of drinking prior to sex had evidence of mediation; the alcohol PNF had a significantly protective effect at 3 months (1% change).

As noted previously, gender was included as a covariate in all analyses. However, it is possible that gender could have a differential influence on treatment effects; to examine this, gender was included as a moderator of treatment effects. Because models controlled for baseline values of the outcome, main effect gender differences in outcomes were largely accounted for. In examining treatment by gender interactions, there was no evidence for significant moderation by gender for any of the outcomes. In addition to gender, we considered two sex-specific sensitivity analyses. First, some participants reported no sexual partners since the previous assessment at either 3 month ($n = 50$, 12.3%) or 6 month ($n = 69$, 17.7%) assessments. Substantive results and conclusions were identical when analyses were restricted to participants reporting one or more partners at each follow-up assessment. A second sex-related sensitivity analysis considered those participants who reported being in a monogamous relationship at the baseline assessment ($n = 250$, 52.1%). Omnibus comparisons of main effect models versus moderation models for both risky sex outcomes again revealed no significant differences.

Discussion

This study evaluated PNF interventions that aimed to reduce alcohol use and alcohol-related RSB among college students. Specifically, this study compared alcohol only, alcohol-related RSB only, and combined alcohol and alcohol-related RSB PNF interventions. Overall, when compared to control, PNF interventions that included alcohol content (alcohol only PNF, combined PNF) had significant reductions on drinking quantity and frequency outcomes and that PNF interventions that included sex content (alcohol-related RSB only, combined PNF) had significant reductions on alcohol-related RSB outcomes. There were no significant intervention effects on alcohol-related negative consequences. These findings demonstrate that the combined PNF was the only intervention successful at reducing both drinking and alcohol-related RSB outcomes. Effects were stronger and longer lasting for drinking outcomes than for alcohol-related RSB outcomes. Of importance, it should be noted that the intervention was associated with reductions in frequency of drinking prior to sex but not reductions in quantity of consumption prior to sex. Not consuming alcohol prior to sex eliminates the impact of alcohol on judgment and decision making in sexual situations and reducing the quantity of consumption prior to sex would likely exert a strong effect on judgment and decision making in sexual situations. Findings further indicated that all three PNF conditions were efficacious at reducing normative perceptions for both drinking and alcohol-related RSB outcomes. Finally, for outcomes with significant reductions, there was evidence of mediation such that reducing descriptive normative perceptions led to changes in behavior.

Although expected, we did not find that the combined PNF condition was more efficacious than either the drinking only or the alcohol-related RSB only conditions. This may be because we used an additive rather than integrated approach. We combined the two sets of feedback – i.e., alcohol only and alcohol-related RSB only. Combining PNF required participants to understand and recall information regarding two risk behaviors (i.e., drinking and alcohol-related RSB) and it is uncertain if one set of information overshadowed the other or increased difficulty with recall for both sets of information. This may be why we did not see significantly stronger effects for the combined condition when compared to the other two PNF conditions. However, although the combined PNF did not show stronger effects, if did have broader effects, impacting both alcohol and alcohol-related RSB behavior.

Clinical Implications

As found with previous research examining PNF as a standalone brief intervention to reduce alcohol use (e.g., Lewis et al., 2007; Neighbors et al., 2004, 2010), the present study demonstrates that a brief, web-based intervention with an alcohol focus (i.e., alcohol only PNF, combined PNF) is efficacious at reducing drinking behavior for up to 6 months. Furthermore, this is the first study to evaluate the use of PNF as a standalone intervention to reduce alcohol-related RSB. Previous multi-component interventions that have incorporated a PNF component (e.g., Chernoff & Davison, 2005) have been shown to reduce alcohol-related RSB but PNF has not previously been evaluated as a single component intervention. The present study demonstrated short-term effects (e.g., 3 months) for reducing frequency of

drinking prior to sex with interventions with a RSB focus (i.e., alcohol-related RSB only PNF, combined PNF). However, these effects were not evident at 6 months, and they were not evident for quantity of alcohol consumed prior to sex. Overall, these findings demonstrate that PNF specific to drinking in sexual situations was needed to reduce alcohol-related RSB as the alcohol only PNF intervention did not have an effect on alcohol-related RSB. Thus, findings suggest that in order to reduce alcohol-related RSB with PNF it is necessary to provide content on alcohol-related RSB or content on both risk behaviors. This finding is in line with previous research that suggests that the decision to use alcohol may be separate from the decision to engage in alcohol-related RSB among college students (e.g., Weinhardt & Carey, 2000).

PNF effects were larger for drinking outcomes than for alcohol-related RSB outcomes. Furthermore, effects on drinking behavior were sustained at 6 months whereas for alcohol-related RSB effects were no longer significant at the 6 month follow-up assessment. Thus, consistent with prior research (e.g., Lewis & Neighbors, 2007; Neighbors et al., 2004, 2010), PNF is efficacious at reducing alcohol consumption when presented as a standalone intervention with alcohol content alone or when alcohol content is presented with alcohol-related RSB content. The present results suggest that PNF may not be an efficacious approach to reduce alcohol-related RSB over the long-term, as intervention effects were no longer significant at 6 months. Alcohol-related RSB may be more difficult to reduce than drinking behavior with PNF for a number of reasons. One potential reason may be that the decision to drink is often made by the individual alone. However, the decision to have sex after drinking involves the decision of two people; thus it may take more than PNF to have a sustained impact on behavior change.

Future research should examine the efficacy of multi-component interventions aimed to reduce alcohol-related RSB that include a PNF component in addition to other feedback components, such as alcohol-related sex expectancies, condom negotiation skills, and protective behavioral strategies to use to reduce drinking in sexual contexts. This recommendation is in line with previous recommendations (Dermen & Thomas, 2011; Bryan, Schmiege, & Broaddus, 2009) that suggest the focus be on preparing young adults to reduce the risks of alcohol use in sexual situations and the perceived and actual effects that alcohol can have on sexual-decision making (Davis et al., 2009). However, future interventions should examine the benefits of a more integrated intervention, such that feedback could include information on alcohol use in sexual contexts, which would emphasize the importance of alcohol use as a setting characteristic related to risk as well as the role intoxication plays as a barrier to sexual risk reduction. This integrated intervention could be done in place of a combined intervention where information on two risk behaviors is presented separately (i.e., presenting alcohol feedback followed by sexual behavior feedback or vice versa). Thus, future research should examine if more fully integrating alcohol content into the RSB content yields effects on reducing alcohol-related RSB.

As found in previous research, the PNF interventions had stronger effects on normative perceptions than on either risk behavior (e.g., Lewis & Neighbors, 2007; Neighbors et al., 2004, 2010). This study provides a novel contribution to the social norms literature in that it demonstrates that PNF for one risk behavior can reduce normative perceptions for another

risk behavior. Findings indicated cross-over effects such that the alcohol-only PNF intervention reduced normative perceptions for alcohol-related RSB and the alcohol-related RSB only PNF intervention reduced normative perceptions for drinking behavior. Research is needed to determine if a common mechanism of reducing normative perceptions for related risk behaviors is efficacious in reducing risk irrespective of behavior specificity. Consistent with other PFIs that have shown normative misperceptions to mediate intervention efficacy (e.g., Carey et al., 2010; Doumas et al., 2009), the present study demonstrated that reductions in normative perceptions mediated PNF efficacy for both drinking and alcohol-related RSB outcomes.

Finally, this study is unique in that it is among the first PNF intervention aimed to reduce alcohol-related RSB among college students that is web-based. Although this study was conducted among college students, this web-based PNF intervention has potential to be expanded to include young adults who do not attend college. Brief web-based interventions may be more advantageous for young adults who do not attend college as they would have greater reach by reducing participant burden (i.e., not having to come to a clinic or lab, not having to attend multiple sessions) and thus make it more feasible to complete the intervention. Although it is important to note that web-based or computer-based PFIs are cost-effective, their effects can be modest relative to more intensive, in person interventions (Carey et al., 2007).

Limitations

The present study is not without limitations. One limitation is that we only collected data from students at one university, and as such, the results may not generalize to college students in different regions or other young adults who are not currently enrolled in college. Another limitation concerns the use of sexual identity inclusion criteria. Because the criteria required typically engaging in sex with a member of the opposite sex, it is unclear whether the PNF provided would apply to individuals who typically have sex with a member of the same gender. This study's eligibility criteria included a minimum level of drinking behavior and a minimum level of sexual activity but did not include a minimum level of alcohol-related sexual activity. Thus, findings for RSB outcomes may be weaker because the feedback was not applicable to some people (i.e., those who did not drink before sex). Furthermore, while drinking is usually a patterned activity among college students, sexual activity is not to the same degree. Although some students may have sex on a regular basis with regular partners (which has a weaker relationship to alcohol), other students may only have sex occasionally. Thus, results may have been weakened by the nature of the high-risk behavior being targeted. Another limitation is that frequency of drinking prior to oral, vaginal, or anal sex was assessed with one item. Future research may consider looked at intervention effects on these behaviors as separate outcomes. Finally, we only considered descriptive normative perceptions as a mediator of intervention efficacy. It could be that other related factors mediated intervention efficacy, such as injunctive normative perceptions, attitudes, or perceived risk.

Conclusions

The present study adds to the social norms literature supporting PNF as a standalone, brief, web-based intervention to reduce college student drinking and provides early support for the short-term effects of PNF to reduce alcohol-related RSB. However, additional research is needed to develop an efficacious web-based intervention to reduce alcohol-related RSB over the longer-term among college students.

Acknowledgments

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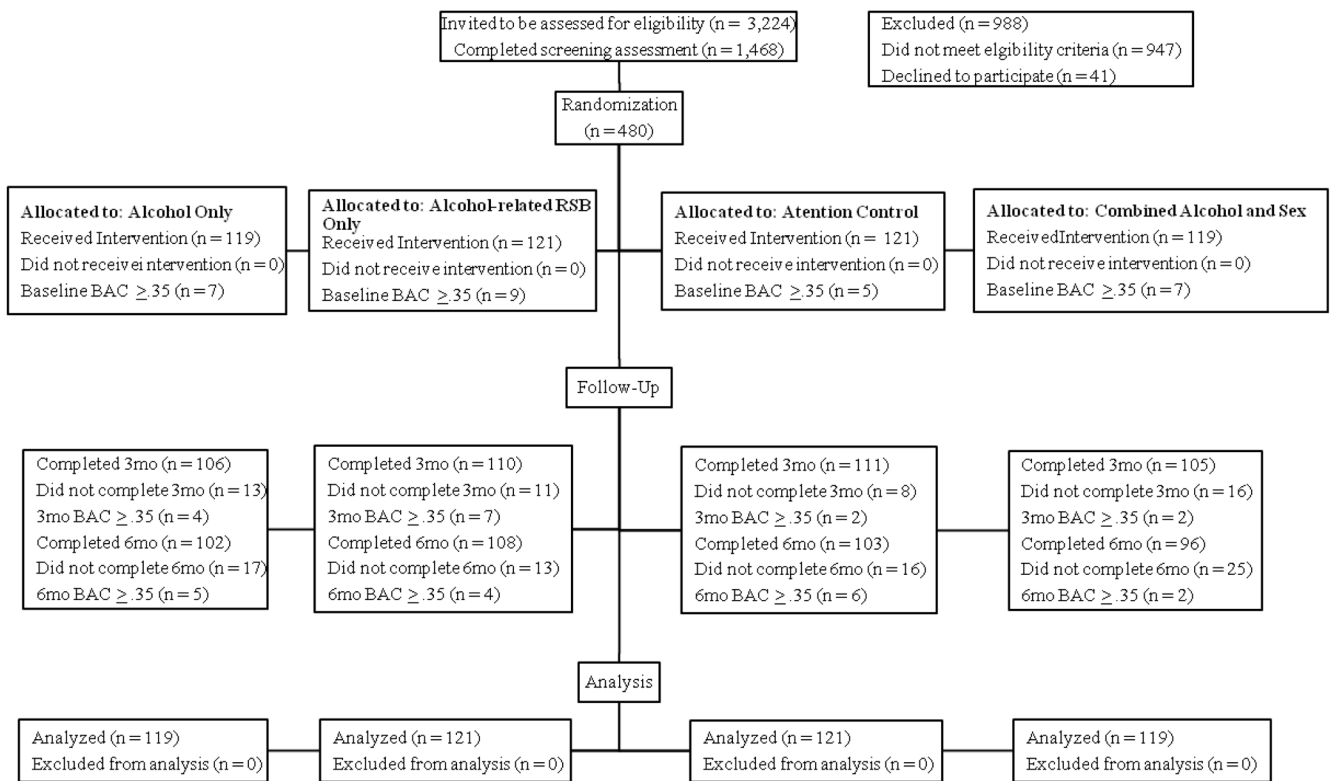Zeileis A, Kleiber C, Jackman S. Regression Models for Count Data in R. Journal of Statistical Software. 2008; 27(8) URL http://www.jstatsoft.org/v27/i08/.

Invited to be assessed for eligibility (n = 3,224)
Completed screening assessment (n = 1,468)

Excluded (n = 988)
Did not meet elgibility criteria (n = 947)
Declined to participate (n = 41)

Randomization
(n = 480)

Allocated to: Alcohol Only
Received Intervention (n = 119)
Did not receive intervention (n = 0)
Baseline BAC ≥ .35 (n = 7)

Allocated to: Alcohol-related RSB Only
Received Intervention (n = 121)
Did not receive intervention (n = 0)
Baseline BAC ≥ .35 (n = 9)

Allocated to: Atention Control
Received Intervention (n = 121)
Did not receive intervention (n = 0)
Baseline BAC ≥ .35 (n = 5)

Allocated to: Combined Alcohol and Sex
Received Intervention (n = 119)
Did not receive intervention (n = 0)
Baseline BAC ≥ .35 (n = 7)

Follow-Up

Completed 3mo (n = 106)
Did not complete 3mo (n = 13)
3mo BAC ≥ .35 (n = 4)
Completed 6mo (n = 102)
Did not complete 6mo (n = 17)
6mo BAC ≥ .35 (n = 5)

Completed 3mo (n = 110)
Did not complete 3mo (n = 11)
3mo BAC ≥ .35 (n = 7)
Completed 6mo (n = 108)
Did not complete 6mo (n = 13)
6mo BAC ≥ .35 (n = 4)

Completed 3mo (n = 111)
Did not complete 3mo (n = 8)
3mo BAC ≥ .35 (n = 2)
Completed 6mo (n = 103)
Did not complete 6mo (n = 16)
6mo BAC ≥ .35 (n = 6)

Completed 3mo (n = 105)
Did not complete 3mo (n = 16)
3mo BAC ≥ .35 (n = 2)
Completed 6mo (n = 96)
Did not complete 6mo (n = 25)
6mo BAC ≥ .35 (n = 2)

Analysis

Analyzed (n = 119)
Excluded from analysis (n = 0)

Analyzed (n = 121)
Excluded from analysis (n = 0)

Analyzed (n = 121)
Excluded from analysis (n = 0)

Analyzed (n = 119)
Excluded from analysis (n = 0)

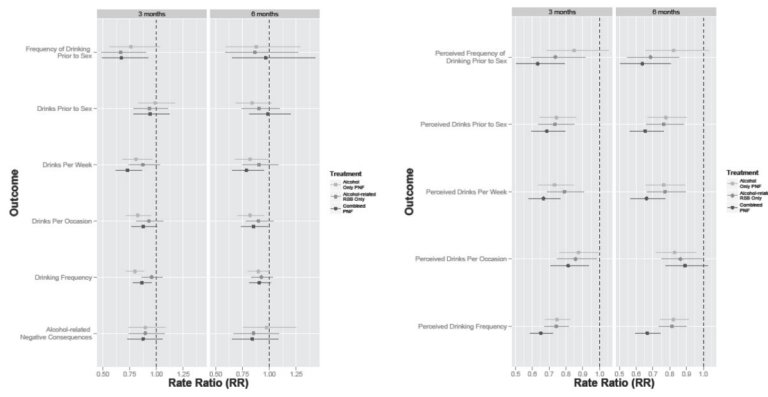**Figure 1.**
Participant flow throughout the study process.

Figure 2.
(Left) Rate Ratios (RR) and 95% CI for RRs comparing treatment conditions to control at 3 and 6 months post-intervention for behavioral outcomes. (Right) Rate Ratios (RR) and 95% CI for RRs comparing treatment conditions to control at 3 and 6 months post-intervention for normative perception outcomes.

Table 1

Means and Standard Deviations for Behavior Outcomes by Treatment Condition

Outcome	Assessment	Control		Alcohol		Alcohol-related RSB		Combined	
		M	SD	M	SD	M	SD	M	SD
Drinks per Week	T1	12.98	9.83	13.13	11.14	12.42	10.18	13.13	11.21
	T2	10.51	9.50	8.12	7.95	9.73	8.47	8.55	8.55
	T3	9.31	8.41	7.91	8.52	8.14	7.70	7.95	8.67
Drinks per Occasion	T1	4.43	2.03	4.97	3.28	4.44	2.56	4.51	2.84
	T2	4.24	2.50	3.70	2.08	4.05	2.27	3.79	2.06
	T3	3.95	2.25	3.63	2.34	3.68	2.21	3.51	2.25
Drinking Frequency	T1	2.19	1.54	2.18	1.54	2.15	1.52	2.22	1.66
	T2	1.83	1.33	1.42	1.12	1.69	1.23	1.52	1.22
	T3	1.61	1.34	1.42	1.21	1.50	1.25	1.44	1.24
Alcohol-related Negative Consequences	T1	8.26	5.49	7.65	4.73	8.23	4.95	8.49	5.34
	T2	7.64	5.38	6.31	5.38	6.69	5.41	6.82	5.91
	T3	6.53	5.35	6.14	5.36	5.55	5.08	6.04	5.90
Frequency of Drinking Prior to Sex	T1	3.73	4.43	3.62	4.23	3.73	4.13	3.21	3.54
	T2	3.88	4.69	3.66	4.85	2.96	3.68	2.56	3.43
	T3	2.37	3.55	2.56	4.48	2.33	3.51	2.22	2.99
Drinks Consumed Prior to Sex	T1	3.89	2.81	3.22	3.00	3.39	2.90	3.31	2.81
	T2	3.05	2.65	2.95	2.66	2.70	2.71	2.55	2.70
	T3	2.59	2.98	2.24	2.34	2.33	2.49	2.46	2.82

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Table 2

Means and Standard Deviations for Normative Perceptions by Treatment Condition

Outcome	Assessment	Control		Alcohol		Alcohol-related RSB		Combined	
		M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Perceived Drinks per Week	T1	16.18	9.11	16.50	8.94	14.74	9.01	15.52	8.28
	T2	14.42	8.75	10.65	6.56	11.01	6.84	9.21	5.68
	T3	13.38	7.58	10.78	7.80	9.87	6.90	8.62	6.67
Perceived Drinks per Occasion	T1	4.67	2.17	4.84	2.26	4.65	2.71	4.77	2.36
	T2	4.30	1.92	3.79	1.56	3.73	1.46	3.50	1.78
	T3	4.29	1.69	3.63	1.63	3.66	1.71	3.86	2.67
Perceived Drinking Frequency	T1	2.15	1.16	2.37	1.19	2.31	1.24	2.17	1.08
	T2	2.09	1.21	1.66	0.84	1.64	0.98	1.38	0.79
	T3	1.93	1.11	1.68	0.91	1.67	1.06	1.30	0.97
Perceived Frequency of Drinking Prior to Sex	T1	4.24	3.83	4.16	3.57	4.52	3.63	3.68	3.44
	T2	3.43	2.79	2.87	2.51	2.59	2.57	2.04	1.94
	T3	3.40	2.87	2.55	2.42	2.25	2.10	1.96	1.80
Perceived Drinks Consumed Prior to Sex	T1	4.68	2.00	4.68	2.14	4.43	1.90	4.33	2.02
	T2	4.36	2.37	3.33	1.76	3.20	1.79	2.97	1.86
	T3	4.39	2.05	3.55	1.93	3.32	1.82	2.86	2.29