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A Personalized Normative Feedback Text-Message Intervention to Reduce 21st Birthday Alcohol Use and Problems

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A PERSONALIZED NORMATIVE FEEDBACK TEXT-MESSAGE INTERVENTION TO REDUCE 21st BIRTHDAY ALCOHOL USE AND PROBLEMS

BY

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ABSTRACT

Objective: Twenty-first birthdays are associated with extreme levels of heavy drinking and alcohol-related harm. However, few 21st birthday preventive interventions have been tested, and even fewer have been supported as effective. The current study was designed to 1) test a text-message intervention to reduce 21st birthday estimated Blood Alcohol Content (eBAC) and alcohol problems, and 2) examine potential mediators and moderators.

Method: College students (*n*=200; 69% female, 87.5% White/Caucasian) with an upcoming 21st birthday completed a baseline assessment and were randomized to a text-message intervention or an assessment-only control condition. Participants in the intervention group were sent, and were asked to reply to, a text-message the day before and day of their planned 21st birthday celebration focusing on 21st birthday specific personalized normative feedback (PNF) and protective behavioral strategies (PBS), respectively. All participants were sent a follow-up assessment the day after their birthday celebration (92.9% retention rate).

Results: Among participants in the intervention group, 95.8% responded to text-message 1, and 95.8% responded to text-message 2. Regression analyses did not reveal an overall treatment effect for eBAC or alcohol problems. However, there were indirect effects with perceived norms as the mediator and eBAC (-.175 [*SE*=.060]; 95% CI [-.292, -.080]) and alcohol problems (-.124[*SE*=.044]; 95% CI [-.245, -.057]) as the outcome such that the intervention was associated with lower perceived norms, which was, in turn, related to less alcohol involvement.

Conclusions: Although no main effect of treatment was observed, this study provides further evidence that changing perceived norms is a promising strategy for preventive interventions with event-level alcohol use.

Key Words: Alcohol, twenty-first birthday, Personalized Normative Feedback, text-message

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PREFACE

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Evaluation of a Text Message Intervention for 21st Birthday Alcohol Involvement

This manuscript is formatted according to the guidelines of *Journal of Consulting and Clinical Psychology.*

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Introduction

Most research examining alcohol-related harms considers drinking patterns over a general time period (e.g. past month or past year). This approach, however, obscures the reality that acute problems are typically caused by a single occasion of heavy alcohol use. To address this disconnect, a small but emerging body of research focuses on specific events where drinkers are at an elevated risk of alcohol-related harms (Neighbors, Walters et al., 2007; Neighbors et al., 2012). These include spring break (Grekin, Sher, & Krull, 2007), bachelorette parties (Buettner & Khurana, 2014), tailgating (Glassman, Werch, Jobli, & Bian, 2007; Glassman et al., 2010), St. Patrick's Day (Henselee, Bucker, & Irons, 2015), Mardis Gras (Henselee et al., 2015), and of particular interest, 21st birthday celebrations.

Even among these very high-risk events, 21st birthday drinking stands out as especially risky. In one study, average Blood Alcohol Content (BAC) among college drinkers on their 21st birthday was .186, which was 116% higher than St. Patrick's Day, 74% higher than peak consumption over spring break, and 47% higher than New Year's Eve (Neighbors et al., 2011). In a large and rigorous descriptive study of 21st birthday celebratory drinking (*N*=2,518), 83% reported some alcohol consumption, with drinkers consuming an average of 12.65 (*SD*=8.5) alcoholic beverages (Rutledge, Park, & Sher, 2008). Nearly half (48%) of those who drank to celebrate consumed more alcohol that day than at *any* previous point in their life. Of particular concern, 34% of men and 24% of women who drank to celebrate reported consuming 21 or more alcoholic beverages, consistent with the "21run," or "21 for 21" ritual. Most people experience one or more alcohol-related problems as a result of 21st birthday

drinking (Neighbors et al., 2014), with 41% blacking out, 45% having a hangover, and 35% vomiting (Brister, Sher, & Fromme, 2011).

21st Birthday Preventive Interventions

Effective preventive interventions focusing on this event are needed. To date, only a few interventions have been evaluated, with generally modest results. A recent meta-analysis (Steinka-Fry, Tanner-Smith, & Grant, 2015) of 21st birthday interventions (10 studies total) observed no significant intervention effect for number of drinks consumed (g=.05, 95% CI [-.03, .13]), and a small effect in reducing estimated BAC (g=.20, 95% CI [.07, .33]). However, these findings are due at least in part to the evolving nature of programmatic research in this area. The early interventions consisted of nothing more than birthday cards with moderation messages and were not effective (Hembroff et al., 2007; Neighbors et al., 2005; Smith et al., 2006). More recent trials have included an array of empirically-based intervention approaches, with more promising results.

For example, Neighbors et al. (2009) assigned college students who intended to consume at least two drinks to celebrate their 21st birthday to an assessment only control group, or to an emailed intervention. The email contained a link to a 9-page personalized feedback report that was sent one and two days before their 21st birthday. The report consisted of a number of feedback and educational components based upon principles of Brief Motivational Interviewing, such as expected 21st birthday Blood Alcohol Content (BAC), expected alcohol-related consequences, standard drink information, alcohol expectancies, protective behavioral strategies (PBS), and 21st birthday-specific Personalized Normative Feedback (PNF). Relative to the

assessment-only control group, this intervention reduced 21st birthday estimated BAC (eBAC), *d*=. 33. Moderation analyses revealed that the intervention was efficacious for participants with a high *intended* eBAC (*d*=.42 at one *SD* above the mean), calculated as the estimated BAC participants thought they would achieve on their 21st birthday during a baseline assessment. The intervention was not efficacious for participants with a low intended eBAC (*d*=.04 at one *SD* below the mean). Mediation analyses showed that the intervention worked as a result of reducing perceived 21st birthday drinking norms. No indirect effect was observed through use of PBS. This study indicates that PNF is a promising intervention for 21st birthday drinking, although replication is needed, particularly across modalities that are used more frequently than email.

Text Message Interventions

One promising communication modality for disseminating alcohol prevention interventions with young adults is Text Messaging (TM) (Suffoletto, 2016). A 2011 Pew Research study (Smith, 2011) found that 92% of 18-24 year olds use TM and most receive/send 100+ texts per day. TM has advantages over other forms of intervention delivery, particularly with event-level alcohol use, since they are accessed regularly and quickly. In fact, 99% of all TMs are read, and the vast majority (90%) are read within three minutes of receipt (MobileSquare, 2010). Unlike emails, which require the user to actively check an account, TMs allow researchers to almost guarantee an intervention is seen, and provides great control on the exact day and time it is viewed. This makes text-messaging particularly suitable for event-level preventive interventions. College students spend an astounding 527 minutes on their cell phones

per day, with more time devoted to text-messaging (95 minutes) than any other activity (Roberts, Yaya, & Manolis, 2014). In a review of text-messaging as a means of delivering public health interventions, Hall, Cole-Lewis and Bernhardt (2015) argued that "mobile phones have become the most accessible form of mediated communication in world history, and text messaging has become one of the most frequently used forms of mobile communication" (p. 415).

Text messaging interventions have been successfully used for physical activity (O'Reilly & Spruijtz-Metz, 2013), diabetes management (Cole-Lewis & Kershaw, 2010) weight loss (Bacigalupo et al., 2013), low-density lipoprotein (LDL) cholesterol reduction (Chow et al., 2015), and smoking cessation (Whittaker et al., 2012). In spite of the general popularity for using TM to manage health behaviors, alcohol researchers are only beginning to utilize the technology as an intervention modality. For instance, Mason et al. (2015) conducted a meta-analysis of RCTs examining the efficacy of a TM intervention for adolescent or young adult substance use. Overall, they observed a weighted effect size of d=.25. Eleven of these trials used TM for tobacco prevention, whereas only three focused on alcohol.

TM interventions for health promotion are more effective when they are tailored to the recipient (Head et al., 2013). For example, in one study (N=765), young adults being discharged from an Emergency Department who received TMs that included feedback on willingness to set drinking moderation goals reported less alcohol use and fewer alcohol-related injuries than participants in control groups up to nine-months post-intervention (Suffoletto et al, 2015). The current study will also tailor TM to recipients in an effort to reduce heavy drinking.

Current Study Overview

The goal of the current study was to test a 21st birthday intervention delivered through text-messaging. Since individual texts can only be 160 characters, the intervention needed to be brief. Therefore, PNF was initially chosen as the basis for the intervention and subsequently shaped through a pilot study to include PBS (see below). A large body of research indicates that PNF is associated with reductions in alcohol consumption in stand-alone interventions (Dotson, Dunn, & Bowers, 2015), and Neighbors et al (2009) demonstrated its effects as part of a larger treatment package to reduce alcohol use via e-mail delivery.

Hypothesis one was that a TM intervention for 21st birthday drinking, relative to an assessment-only control group, would be associated with a reduction in estimated Blood Alcohol Content (eBAC) and alcohol-related problems for 21st birthdays. Hypothesis two was that this main effect would be moderated by 21st birthday drinking intentions, such that the treatment effect would be greater for participants who anticipated a high (versus low) 21st birthday eBAC. Hypothesis three was that perceived 21st birthday drinking norms would mediate this association. Specifically, it was hypothesized that a) the intervention (relative to control) would be associated with a reduction in perceived 21st birthday drinking norms, and b) lower drinking norms would be related to less alcohol involvement. Protective behavioral strategies (PBS) was also examined as a potential mediator, although no *a priori* hypothesis was established because it did not mediate intervention effects in the Neighbors et al. (2009) study.

Method

Participants & Recruitment

Participants were recruited on a rolling basis between May 2016 and November 2016. In the approximately 7 days prior to their 21st birthday, students (*n*=1,283) received up to three recruitment emails for a study that ostensibly examined how young adults celebrate their birthday. Those who were interested completed a very brief online questionnaire to verify eligibility (*n* =280). Students were eligible if they a) intended to consume at least two standard drinks to celebrate their 21st birthday, and b) had a mobile phone from which they could send and receive text messages. Of people who took the eligibility survey, 85.0% were eligible. Sample characteristics at baseline are presented in Table 1, and recruitment is depicted in Figure 1. The racial composition of this sample is similar to the racial composition at the University of Rhode Island (http://web.uri.edu/ir/files/RIBOE-Official-Enrollment-Reports-2002-2016.pdf, accessed Jan 24, 2017), and the sample is diverse with respect to gender.

Procedure

Upon completing the eligibility survey, eligible participants were presented with an informed consent document. Those who consented were asked to immediately complete a short baseline survey. Next, participants were urn randomized by gender and drinking intentions (strata of standard drinks: 2-5, 6-10, 11-15, 16-20, 21+) to the intervention or control condition (Stout, Wirtz, Carbonari, & Del Boca, 1994). As discussed below, those assigned to the intervention condition were texted the day

before and the day of their anticipated birthday celebration.[1] Participants assigned to the control condition were not contacted during this period. At 4 PM the day after their anticipated celebration, participants received a link via email for an online follow-up questionnaire. Non-responders received up to four reminders (one by email, two by text message, and one by phone call, in that order). Participants were entered into a raffle for an iPad mini for completion of the baseline survey, and received $10 in cash or towards an Amazon Gift card for completion of the follow-up survey. All policies and procedures were approved by the University of Rhode Island Institutional Review Board (IRB).

Intervention Development

Focus Groups. To refine the wording and delivery of text messages (described below), six 30-60 min. focus groups were conducted with drinkers 19-20 years old (*n*=23). To start, general feedback was solicited about information that may be helpful for students to receive proximal to their 21st birthday; next, structured questions were asked to elicit specific information. In the structured question portion of the focus groups, participants were asked their opinion of receiving two nearly identical text messages presenting PNF. Of *n*=13 responses[2], 69% thought the texts should be

[1] To check accuracy of the anticipated birthday celebration date, which was assessed at baseline, participants were also asked to indicate the date of their birthday celebration at follow-up (henceforth called actual birthday celebration date). Since the date TMs were sent occurred according to the planned birthday celebration, it was possible that participants in the intervention condition would receive the first TM the day of their actual birthday celebration, and receive the second TM the day after their actual birthday celebration (if the actual birthday celebration date was exactly one day before the planned birthday celebration date). It was also possible that participants could receive no TM prior to their actual birthday celebration (if the actual birthday celebration date was two or more days before their planned celebration date). Among those in the intervention condition, participants who received one TM (n=5) were retained but participants who received no TM (*n*=1) prior to their actual birthday celebration were excluded.
Other than one participant who was erroneously sent the follow-up too early and therefore excluded from the study, no one indicated their birthday celebration occurred after completing the follow-up assessment.

[2] Due to the nature of the focus groups, not every participant answered each question, and *n*=10 did not reply to this particular question.

different and 31% liked the redundancy. In the unstructured portion of the focus group, when participants were asked what information might be helpful to receive on a 21st birthday, responses almost exclusively entailed reminders about Protective Behavioral Strategies (PBS; e.g. "drinking slowly" *n*=3; "drink water" *n*=5; "eat beforehand" *n*=5; "arrange a safe ride" *n*=4). Given these focus group results, the intervention was modified such that PBS was included to complement the PNF.

Intervention. At 4 PM the day before their planned birthday celebration, participants assigned to the intervention group were sent the following (text message one):

> Hi [participant name]. Happy almost birthday from the URI Young Adult Birthday Study! Earlier, you said you would have *W* drinks on your 21st birthday celebration[3]. This is more than what *X*% of URI [males/females] drink on their 21st birthday. If you drink this much over *Y* hours, you will have a blood alcohol content of *Z*. This may result in [effect from Table 2] PLEASE RESPOND "OK" so we know you got our message.

The number of anticipated drinks (*W*), time spent drinking (*Y*), and gender were taken from participants' replies on the baseline survey, and used to calculate Blood Alcohol Content (*Z*). The normative feedback component (*X*) was based on gender-specific 21st birthday drinking data collected from 961 undergraduate students 21 years or older in April 2015 at the same study site.

At 4PM the day of their planned birthday celebration, intervention participants were sent the following (text message two):

> Hi [participant name]. Here are some tips to stay safe from the URI Young Adult Birthday Study: Keep track of how many drinks you have and space them out with water, eat beforehand, and have a sober driver ready. Enjoy your time with friends and make it a night to remember! PLEASE RESPOND "OK" so we know you got this.

[3] The word "celebration" was added after the first 42 participants. This was considered potentially important since some celebrations were planned on days other than their actual birthday.

For both text messages, participants who did not reply received up to two follow-ups at 5PM and 6PM. The 5PM follow-up to text message one was: "We missed your response. Did you see our earlier message? If so, reply 'OK'." The 6PM follow-up to text message one was: "Just checking in again. PLEASE RESPOND 'OK' if you got our earlier message." The 5PM follow-up to text message two was: "We missed your response. Please respond 'OK' if you got today's message." The 6PM follow-up to text message two was: "Because we did not hear back from you, we assume you did not get our message. PLEASE RESPOND 'OK' so we know you got it." Participants who replied to text message one by 7 PM immediately received: "Thanks! We will check in tomorrow." Participants who replied to text message two by 7 PM immediately received: "OK thanks! We'll be emailing you in the next day or two." Although a reply of "OK" was requested at both time points, any response (e.g. "yes," "sounds good," etc.) was treated as indicative of compliance. All text messages were sent from a secure program built for this study at the University of Pittsburgh.

Measures

Eligibility Survey. This survey consisted of two items: 1) "Do you have a mobile phone that you use to send and receive text messages?" 2) "How many standard alcoholic drinks do you intend to consume on your 21st birthday celebration?" Standard drink definitions were given.

Demographics. At baseline, participants were asked their gender, weight, ethnicity, and race. Greek status was assessed with one item adopted from Capone, Wood, Borsari, and Laird (2007).

Intended Birthday Celebration Day. At baseline, participants were shown a calendar and asked to "Indicate the day you intend to celebrate your 21st birthday. If you plan on celebrating two or more days, please choose the day that you anticipate will be the 'largest' or 'primary' celebration."

Intended/Actual 21st Birthday BAC. At baseline and follow-up, participants were asked: 1) "In total, how many standard drinks do you plan on consuming/did you consume during your 21st birthday celebration?" and 2) "Over how long a period of time do you plan on drinking/were you drinking?" Standard drink estimates were provided. Intended/actual 21st birthday BAC were calculated using these data, as well as gender and weight (from the demographics survey) with the formula provided by Matthews and Miller (1979).

21st Birthday Alcohol Problems. At follow-up, participants completed a 17-item version of the 24-item Brief Young Adult Alcohol Consequences Questionnaire (B-YAACQ; Kahler, Strong, & Read, 2005). Directions were modified to only assess problems the day of or day after their 21st birthday celebration, and items only applicable to drinking over a long time period were deleted (e.g. weight gain). Alpha in this study was 0.76.

Normative 21st Birthday Alcohol Use. At baseline and follow-up, we used the following item adapted from Neighbors et al. (2009) "How many drinks do you think a typical University of Rhode Island student of your gender consumes on his/her 21st birthday?"

Protective Behavioral Strategies. At follow-up, we used a 15-item survey from Neighbors et al. (2009) (adapted from Martens et al., 2005) to assess the number

of protective behavioral strategies used on the participant's 21st birthday in a yes/no format (e.g. "use a designated driver"). We observed a co-efficient alpha of .77.

Intervention Satisfaction. At follow-up, participants in the intervention condition were asked the following questions on a 5-point Likert Scale from 1 (not at all) to 5 (extremely): "The feedback was useful to me," "I thought about this information over the course of my birthday celebration," "I would have preferred receiving this information through other means, such as email."

Power

The one intervention most similar to the present study observed an effect size (ES) of d=.33 (Neighbors et al., 2009). Since the current study includes fewer intervention components than did Neighbors et al., a lower ES might be anticipated. On the other hand, by using TM to deliver the intervention, participants may read the information more carefully and/or be more receptive to it. Therefore, d=.33 was utilized to develop an adjusted ES (ES_{adj}) based on controlling for intended eBAC as a covariate. Using the formula provided by Rossi (2013), ES_{adj} of d=.42 was calculated, conservatively assuming the covariate and outcome are associated at r=.59 (these were correlated at r=.69 in Neighbors et al., 2009). According to G*Power (Faul, Erdfelder, Buchner, & Lang, 2009), power of 0.80 with that effect size is established with n=181, which served as our targeted follow-up sample size. Ultimately, a sample size of n=182 was retained at follow-up.

Analytic Plan

Assumption Testing and Data Cleaning. For anticipated and actual 21st birthday eBAC variables, scores greater than .50, which were considered likely

impossible, were recoded to .50[4] as done in Neighbors et al. (2009). Data checking revealed that 21st birthday eBAC, and 21st birthday alcohol consequences were over-dispersed and non-normal. Therefore, primary analyses utilized a negative binomial distribution where standard general linear model assumptions do not apply.

Preliminary Analyses. A series of comparisons between groups were run to look at differential participation, eligibility, and attrition. Chi-squared tests were calculated for categorical dependent variables (gender, treatment condition), and independent samples *t*-tests were calculated for continuous dependent variables (BAC intentions). Descriptive statistics were examined, including for the intervention satisfaction items.

Regression Analyses. To examine intervention efficacy, two regression models were run where treatment condition, anticipated 21st birthday eBAC, and the condition by anticipated 21st birthday eBAC interaction were entered as independent variables. Dependent variables were actual 21st birthday eBAC, and 21st birthday alcohol consequences. Regression analyses assumed a negative binominal distribution with the GENLIN command in SPSS v. 24. For these analyses, results from the Wald χ^2 test were reported, which accounts for the log-transformations used in negative binomial tests.

Mediation. To examine mediation, four models with bootstrapping were run in MPlus version 7also assuming a negative binomial distribution for the outcomes. Specifically, mediation models were run with actual eBAC and alcohol consequences as the outcome, and T2 Norms and PBS as the mediator. In all models, intended 21st

[4] This adjusted value was used for the regression and mediation analyses. For "Descriptive Analyses," (see below) the median of the unadjusted value is reported.

Birthday eBAC was included as a covariate for the outcome. In models with T2 Norms as the mediator, T1 Norms was included as a covariate for the mediator. Indirect effects were computed as the *a* path (independent variable to mediator) multiplied by the *b* path (mediator to dependent variable). A significant indirect effect indicates mediation.

Results

Attrition and Comparison Analyses

Among students who were sent recruitment emails, females were more likely to complete the screening survey than males, χ^2 (1, N=1283)=29.69, p<.001 (28.0% v. 15.3%). Among students who took the screening survey, those who were eligibile were more likely to be female than those who were not eligible χ^2 (1, N=242)=5.561, p=.018 (69.0% female among eligible students; 50.0% female among ineligible students). Among participants retained at baseline, there was no difference between those who completed the follow-up versus those who did not complete the follow-up with respect to gender: χ^2 (1, N=196)=0.969, p=.325, treatment condition: χ^2 (1, N=196)=0.226, p=.634, and BAC intentions, t(194)=.04, p=.968.

Descriptive Analyses

At baseline, participants reported a median anticipated 21st birthday eBAC of .0827. At follow-up, participants reported a median actual 21st birthday eBAC of .0858, and a mean of 2.220 consequences. Among participants retained in the intervention condition, 95.8% responded to the first text message, and 95.8% responded to the second text message. Mean values of perceived 21st birthday drinking norms are presented in Table 3. No change was observed for participants in the control

group, $t_{paired}(91)=0.43$, $p=.667$. Norms decreased among participants in the intervention group $t_{paired}(89)=3.70$, $p<.001$, $d=0.43$[5].

Intervention Satisfaction

Mean values for intervention satisfaction were as follows: "Feedback was useful," *M*=3.13, *SD*=.985; "Thought about information", *M*=2.86, *SD*=1.181; "Would have preferred receiving feedback through other means", *M*=2.19, *SD*=1.280.

Intervention Efficacy

Results from the negative binomial regressions suggest actual 21st birthday eBAC and 21st birthday alcohol consequences were not significantly different between the treatment and control condition. The Treatment by Anticipated 21st Birthday eBAC interactions were also not significant. Full results are presented in Table 4.

Mediation

Full mediation results are presented in Figure 2 (T2 Norms as the mediator) and Figure 3 (with PBS as the mediator). For each model, the *a* (Independent Variable to Mediator), *b* (Mediator to Dependent Variable), and *c'* (Direct Effect) paths are reported in the diagram, and the *c* (Total effect) and *a*b* (Indirect effect; also equivalent to *c*-*c*') paths are reported in the Figure note. For example, in Figure 2a, the *a* path equals -2.256, the *b* path equals 0.078, the *c*' path equals 0.130, the *c* path equals -0.045 and the *a*b* (or indirect effect) equals -.175. For the purpose of establishing mediation, it is the indirect effect that is most important. A significant indirect effect through T2 Norms was observed with both actual 21st birthday eBAC and alcohol problems as the outcome (-.175[*SE*=.060], 95% CI [-.292, -.080] and -

[5] The effect size was calculated according to Morris and DeShon (2002), who recommend accounting for the correlation between Time 1 and Time 2 variables in within-subjects comparisons.

.124[*SE*=.044], 95% CI [-.245, -.057], respectively). An indirect effect through Protective Behavioral Strategies was not observed for either outcome.

Discussion

The current study was designed to test the efficacy and mechanisms of a TM intervention for 21st birthday drinking. Counter to expectations that participants receiving the intervention would exhibit less 21st birthday alcohol involvement than those in a control group, no direct intervention effects were observed for either eBAC or alcohol-related consequences. There was also no interaction between eBAC intentions and treatment (hypothesis two), failing to replicate findings in Neighbors et al. (2009). However, in support of hypothesis three, perceived drinking norms (but not PBS) functioned as a mediator for both 21st birthday eBAC and 21st birthday alcohol consequences. Specifically, participants in the intervention condition had lower drinking norms at follow-up (after controlling for baseline drinking norms), and follow-up drinking norms were positively associated with 21st birthday eBAC and 21st birthday alcohol consequences. Furthermore, the magnitude of these effects was rather large. For example, after accounting for baseline norms, the intervention (relative to control) was associated with a 2.256 unit reduction in the perceived number of 21st birthday drinks consumed by a same-sex University of Rhode Island student. Then, for every one unit decrease in perceived norms, there was an 8% decrease in 21st birthday eBAC.[6]

[6] The 2.256 reduction is readily interpretable based on the *a* path shown in Figure 2A. The 8% decrease is established because exponentiating .078 (the *b* path value) in base *e* equals 1.081, which is a value that can be treated as similar to an odds ratio. Exponentiating .078 is required since negative binomial models automatically create a log-link value, which is inversely related to an exponentiated value.

Counter to early theorists (i.e. Baron & Kenny, 1986) who argued that a total effect (i.e. *X* and *Y* are associated) is a necessary prerequisite for an indirect effect, recent experts have argued otherwise (e.g. Hayes, 2013; MaKinnon, 2008). As discussed by Hayes (2009), a total effect can be conceptualized as the sum of all indirect effects and a direct effect. Then, "two or more indirect effects with opposite signs can cancel each other out, producing a total effect… that is not detectably different from zero, in spite of the existence of specific indirect effects that are not zero" (Hayes, 2009; p. 414). Although many indirect effects *might* exist, there are limitations to what data can be reasonably collected, and then tested statistically. It is very possible that the intervention exerted additional effects on the outcome through one or more unknown mediators that went in the opposite direction of the Treatment -> Norms -> alcohol involvement indirect effect. One potential factor is enhanced recall of alcohol consumed on 21st birthdays. In other words, it is possible that the intervention led participants to have a more accurate memory of how much they drank, which was then associated with the number of drinks and/or consequences reported. If true, the intervention may actually be efficacious, but we observed null results due to differential reporting bias in the intervention versus control condition. However, this is just one of several possibilities. That the indirect effect may have been "cancelled out" by some other unknown effect should be treated as preliminary since this is a relatively new area of study and findings should be replicated elsewhere.

Although a main effect of treatment was not observed, the existence of an indirect effect through drinking norms is promising and consistent with two recent reports. A systematic review by Reid and Carey (2015), which included 61 trials

where a mediator was tested for intervention effects in college student samples, identified descriptive norms as the most widely supported mediator. In another review of mediators for technology-delivered psychosocial treatments for substance use, seven studies tested perceptions of peer drinking as a mediator, and it was supported in six (87.5%) trials (Dallery, Jarvis, Marsch, & Xie, 2015). The current study provides further evidence that changing perceptions of drinking norms is a promising tool for preventive interventions, and likely applicable to event-level drinking in addition to typical patterns of alcohol use (e.g. Rodriguez et al., 2015).

Strengths

The major strength of the present experiment is that a high level of study integrity was achieved. Among the 196 participants who were randomized and not excluded, 92.9% were retained at follow-up, with no evidence of differential attrition. Furthermore, nearly all participants assigned to the treatment group responded to the text messages (95.8% for TM 1 and 95.8% for TM 2), which suggests they received and read the information. This finding points to the general promise for using text-messaging as a means of intervening with young adults, consistent with recent reviews (Orr & King, 2015; Suffoletto, 2016). Although no total intervention effect was observed, another strength of the current study is that the text-messages were carefully created based on focus group pilot testing, and on PNF, which is widely supported in the literature. Based on the descriptive results, participants reported moderate satisfaction with the intervention.

Limitations, and Future Directions

One limitation of the present study is use of an assessment-only control condition. Although this was considered appropriate given the preliminary nature of work in this area, a more suitable test of whether the exact **content** of the text-message reduced 21st birthday alcohol involvement would have entailed an attention-matched control condition. Future research may consider sending a neutral text-message to participants in the control group. Such a design would allow the researcher to determine the efficacy of receiving a particular intervention beyond a general TM. An additional weakness is related to the manner in which eBAC is calculated. The formula used estimated BAC at the **end** of the 21st birthday drinking episode, but consider the following: A 150 pound female who has eight standard drinks between 6:00pm and 7:00 pm, then one standard drink at 2:00 am will report consuming nine drinks over seven hours with an eBAC of .134. However, at 7:00pm, her eBAC will be 66% higher at .223. In reality, a greater concern is reducing peak eBAC as compared to eBAC at the end of a 21st birthday celebration, and the extent to which these values differ is unknown but could be high in some cases. Future research aimed at describing or preventing event-level alcohol use would benefit using from Ecological Momentary Assessment or, even more promising, a wearable bio-sensor (e.g. Kim et al., 2016). This would also negate or minimize issues of inaccurate reporting, which as noted above, may be more likely to occur among participants in the control condition.

Researchers interested in refining the approach discussed here to enhance the efficacy of a text-message intervention for event level alcohol consumption may consider certain modifications to this study design. Treatment dosage could be

increased by sending several messages over the course of a night or intervening on friends with whom participants plan to celebrate. Also, it might be beneficial to send initial messages 1-2 weeks prior to an event to capture the period of time when students are likely planning the night's activities.

Finally, since perceived norms, but not PBS, mediated the treatment -> alcohol outcomes path, future studies might benefit from removing PBS and further focusing on norms. One possibility would be correcting both descriptive (quantity of actual behaviors, as addressed in this study) and injunctive (approval of certain behaviors) norms. As discussed by Krieger et al. (2016), injunctive norms are more strongly associated with behavior when the two are closely connected. Perhaps the total intervention effect could be enhanced by including the following feedback: "The average student at [study site] believes XX drinks is the maximum one should consume on a 21st birthday." Another option might be adopting injunctive norms for Protective Behavioral Strategies (e.g. "X% of students at [school/university] think people should adopt strategy A on their 21st birthday)[7].

Conclusion

The efficacy of a PNF and PBS text-message intervention for 21st birthday drinking. Nearly all students assigned to the treatment condition received and read the intervention, and participants were reasonably satisfied with the messages. In spite of this, there was no main effect of treatment on eBAC or alcohol problems. There were, however, indirect effects through perceived 21st birthday drinking norms. Future

[7] I thank Dr. John Stevenson for this suggestion.

event-level preventive intervention studies could further refine the normative feedback component of this treatment to potentially enhance the overall intervention effect.

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TABLES & FIGURES

Table 1. Sample Characteristics

Variables	Percent of Sample
Condition	
Treatment	49.0
Control	51.0
Gender	
Female	69.0
Male	31.0
Race	
White/Caucasian	87.5
Black/African American	3.0
Asian	4.5
Native American/American Indian	0.5
Other	4.5
Ethnicity	
Hispanic/Latino	10.5
Not Hispanic/Latino	89.5
Greek Involvement	
Member/Pledge	35.5
Non-member, regularly attend activities	6.0
Non-member, do not regularly attend activities	58.5
Drinks/Week (*M*=9.87, *SD*=10.04)	
0	12.0
1-5	30.9
6-10	21.5
11-15	14.1
16-20	9.9
21+	11.5

Note. Based on the *n*=200 who were enrolled in the study.

Table 2. *Effects Reported to Participants in Text-Messages*

Expected BAC	Effect
<.06	relaxation and low inhibitions
.06-.09	impaired judgment and decision making
.10-.15	clear deterioration of judgment and coordination
.16-.19	nausea and vomiting
.20-.24	Confusion, difficulty walking, and blacking out
.25-.29	Becoming very ill, blacking out, and having severe impairments of basic bodily functions
.30-.34	Passing out and having difficulty waking up
.35+	Going into a coma or even dying from excessive

Note. BAC=Blood Alcohol Content. The effects listed here were based upon ones used by Neighbors et al. (2009).

Table 3. Perceived 21st Birthday Drinking Norms

	Control Group	**Intervention Group**
Baseline Norms	10.21(6.38)	10.89(8.54)
Follow-up Norms	9.93(5.03)	7.86(4.54)

Note. Values outside of paranetheses reflect mean number of drinks respondents thought that same-gender URI students drank on their 21st birthday. Parenthetical values represent standard deviations.

Table 4. Effect of Treatment and Anticipated 21st Birthday eBAC on Actual 21st Birthday eBAC and Alcohol Consequences

	eBAC	Alcohol Consequences
Intercept	432.91***	72.91***
Main Effects		
Anticipated 21 Birthday eBAC	9.60**	7.00**
Condition[a]	0.46	0.98
Interaction		
Anticipated 21st Birthday eBAC by Condition	0.43	0.87

Note: Wald χ^2 for the Test of Model Effects are displayed. Degrees of freedom (*df*)=1 for all analyses. Anticipated 21st Birthday eBAC and Actual 21st Birthday BAC were calculated according to Matthews and Miller (1979) and Rutledge et al. (2008). BAC=Blood Alcohol Content, [a] 0=Control Condition, 1=Intervention Condition. Results for the main effects were not substantially changed when separate models were run without the interaction term

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Figure 1. *Procedural Flowchart*

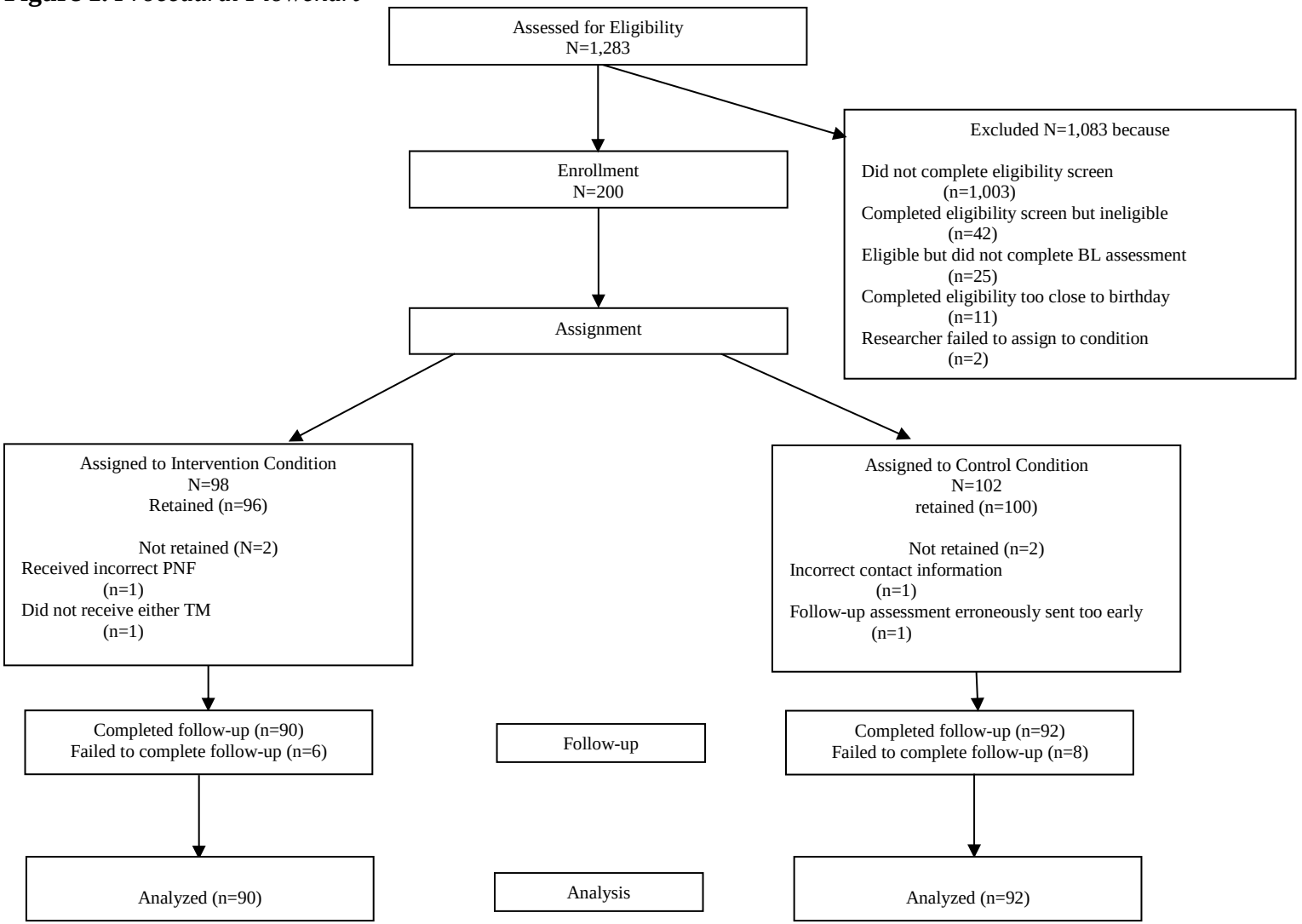

Figure 2. *Mediation Models with Perceived Drinking Norms*

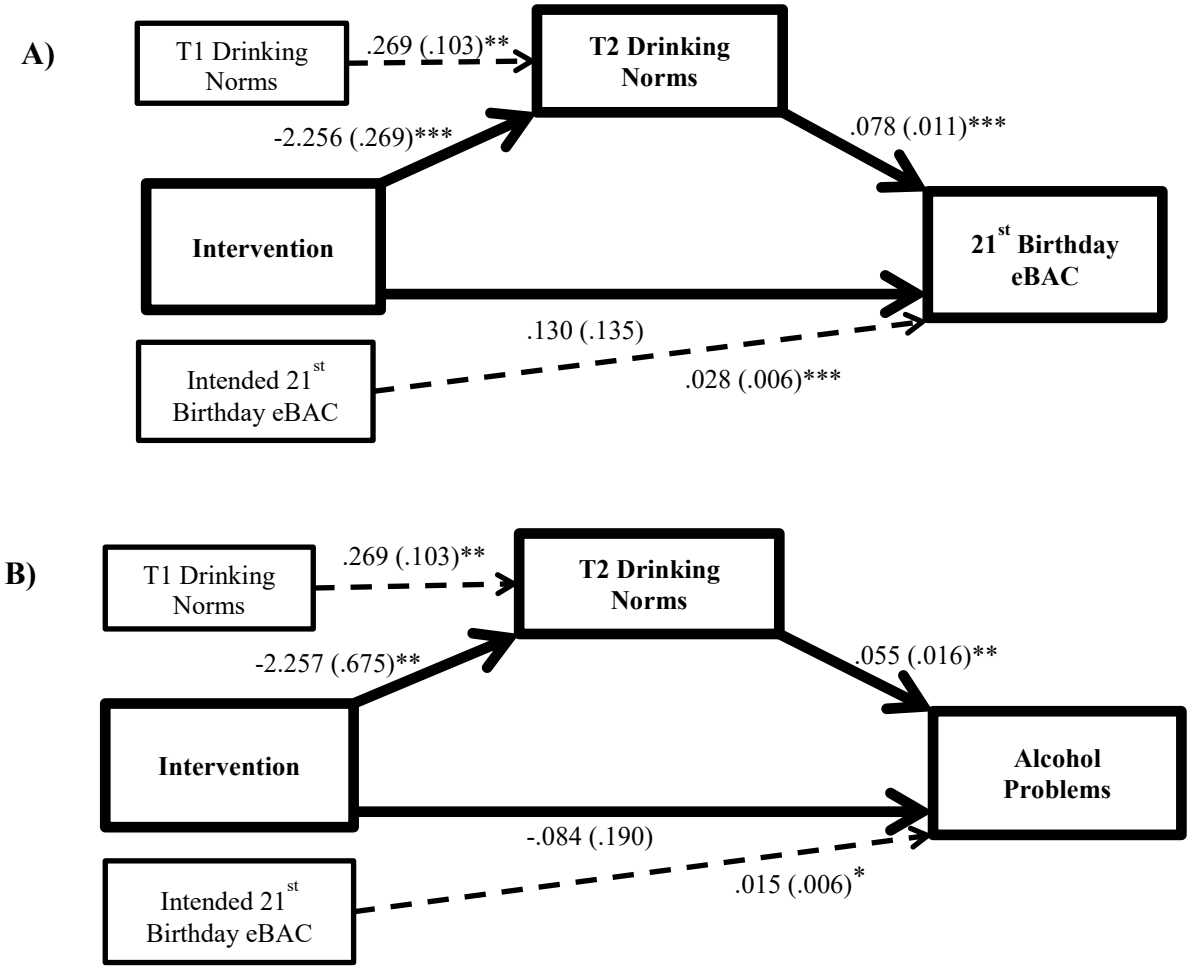

Figure 3. *Mediation Models with Protective Behavioral Strategies*

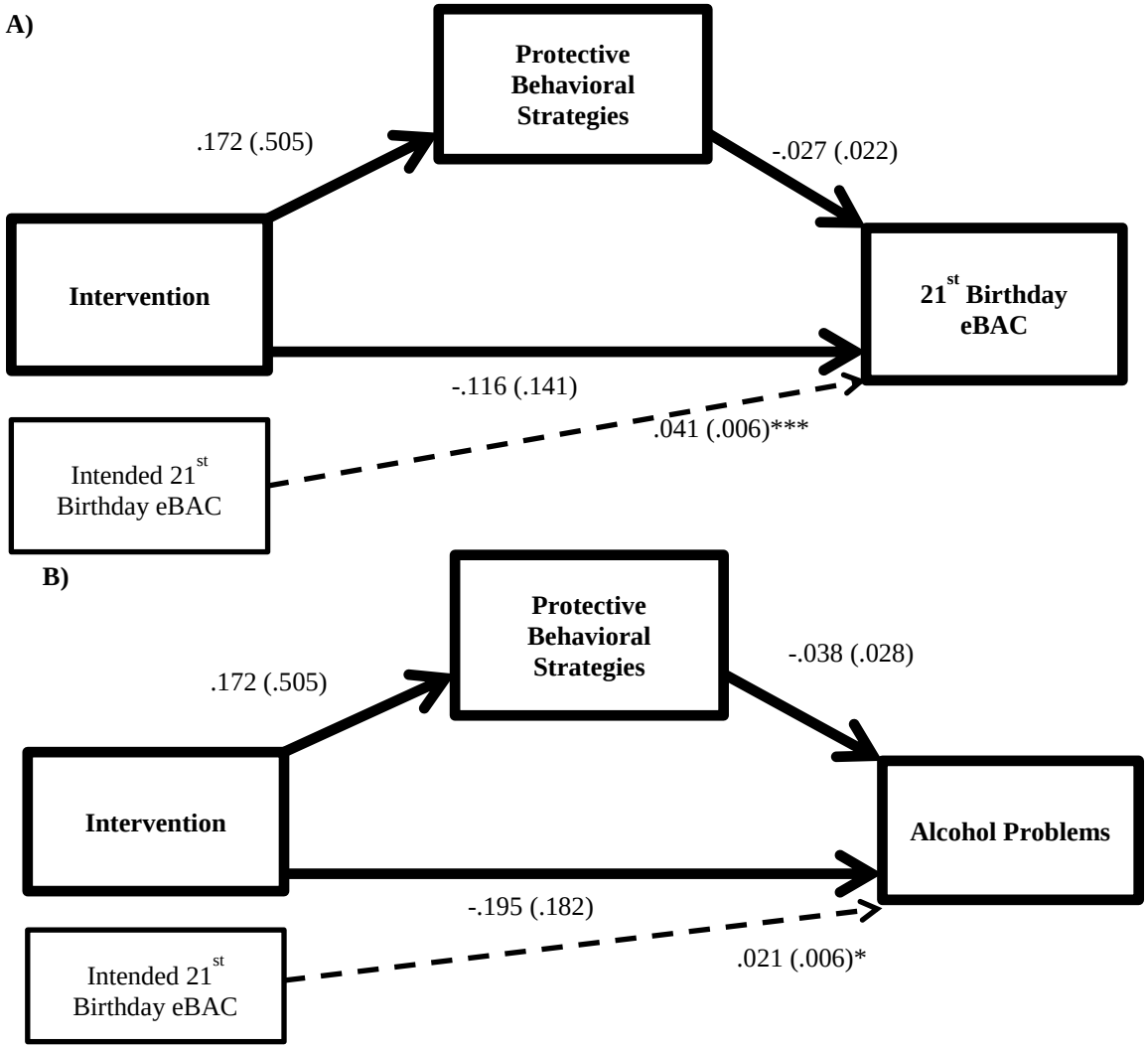

Figure Notes

Figure 2.

Note. Two separate mediation models are presented. Values not in parantheses represent unstandardized coefficients and values in parentheses represent standard errors. Intervention was coded as 0=control, 1=treatment. eBAC=Estimated Blood Alcohol Content. Lighter boxes and dashed arrows represent covariates. The total effect (path c) is -.045(*SE*=.141), *p*=.748 for panel A, and -.208(.197), *p*=.290 for panel B. The indirect effect and 95% Confidence Intervals is -.175(*SE*=.059) [-.292, -.080], *p*=.003 for panel A, and -.124(*SE*=.044) [-.245, -.057], *p*=.005 for panel B. **p*<.01, two-tailed; ***p*<.001, two-tailed.

Figure 3.

Note. Two separate mediation models are presented. Values outside of parantheses represent unstandardized coefficients and values in parantheses represent standard errors. Intervention was coded as 0=control, 1=treatment. eBAC=Estimated Blood Alcohol Content. Lighter boxes and dashed arrows represent covariates The total effect (path c) is -.121*(SE*=.141), *p*=.393 for panel A, and -.201 (.185), *p*=.208 for panel B. The indirect effect and 95% Confidence Intervals is -.005(*SE*=.020) [-.053, .013], *p*=.814 for panel A, and -.007(*SE*=.025) [-.523, .172], *p*=.709 for panel B. **p*<.05, two-tailed; ***p*<.001, two-tailed.