Digital Commons @ LMU and LLS

Digital Commons@ Loyola Marymount University and Loyola Law School

Heads Up!

Psychology

4-1-2017

PNF 2.0? Initial evidence that gamification can increase the efficacy of brief, web-based personalized normative feedback alcohol interventions

Sarah C. Boyle
Loyola Marymount University, sarah.boyle@lmu.edu

Andrew M. Earle
Loyola Marymount University, Andrew.Earle@lmu.edu

Joseph W. LaBrie
Loyola Marymount University, jlabrie@lmu.edu

Daniel J. Smith
Loyola Marymount University, Daniel.Smith2@lmu.edu

Accepted Manuscript

PNF 2.0? Initial evidence that gamification can increase the efficacy of brief, web-based personalized normative feedback alcohol interventions

Sarah C. Boyle, Andrew M. Earle, Joseph W. LaBrie, Daniel J. Smith

Please cite this article as: Boyle, S.C., Earle, A.M., LaBrie, J.W. & Smith, D.J., PNF 2.0? Initial evidence that gamification can increase the efficacy of brief, web-based personalized normative feedback alcohol interventions, *Addictive Behaviors* (2016), doi:10.1016/j.addbeh.2016.11.024

Running Head: PNF GAMIFICATION

PNF 2.0? Initial Evidence that Gamification Can Increase the Efficacy of Brief, Web-based Personalized

Normative Feedback Alcohol Interventions

Sarah C. Boyle, Andrew M. Earle, Joseph W. LaBrie, & Daniel J. Smith

Loyola Marymount University

*Correspondence concerning this article should be addressed to: Joseph W. LaBrie, Ph.D., Department of Psychology, Loyola Marymount University, 1 LMU Drive, Suite 4700, Los Angeles, CA 90045; Phone: (310) 338-5238; Fax: (310) 338-7726; Email: jlabrie@lmu.edu

Abstract

Gamified interventions exploit the motivational characteristics of a game in order to provide prevention information and promote behavior change. Despite the modest effect sizes observed in increasingly popular web-based personalized normative feedback (PNF) alcohol interventions for college students, previous research has yet to consider how gamification might be used to enhance efficacy. This study examines whether a novel, gamified PNF intervention format, which includes a point-based reward system, the element of chance, and personal icons to visually represent users, is more effective in reducing short-term alcohol use than the standard web-based style of PNF currently used on college campuses. Two-hundred and thirty-seven college students were randomly assigned to receive either a standard brief, web-based PNF alcohol intervention or the same alcohol intervention components delivered within a Facebook-connected social game called CampusGANDR (Gamified Alcohol Norm Discovery and Readjustment). In both study conditions participants answered identical questions about their perceptions of peer drinking norms and own drinking and then received the same PNF slides. Two weeks following PNF delivery, participants again reported their perceptions of peers' alcohol use and own drinking. Students in the CampusGANDR condition reported significantly reduced peer drinking norms and alcohol use at the two-week follow-up relative to students who received identical PNF delivered by standard online survey. Further, a mediation model demonstrated that this effect was driven by larger reductions in perceived drinking norms among participants assigned to receive CampusGANDR, relative to control. As web-based PNF is becoming an increasingly universal prevention strategy, findings from this study suggest gamification may represent one method by which intervention efficacy could be substantially improved. The potential methodological and economic benefits associated with gamified PNF interventions are emphasized and directions for future research are discussed.

1. Introduction

College students tend to overestimate how much and how often their peers drink (Borsari & Carey, 2003; Larimer, Turner, Mallett, & Geisner, 2004; Lewis & Neighbors, 2004). This is a significant problem since perceptions of peer alcohol use norms are among the strongest known predictors of future drinking behavior (Neighbors, Lee, Lewis, Fossos, & Larimer, 2007; Perkins, 2003). To combat this issue, researchers have developed interventions to correct misperceptions of peer drinking norms. Personalized Normative Feedback (PNF) is one norms-based intervention strategy that has become a dominant approach for reducing problematic alcohol use on college campuses. Brief and cost-effective, PNF consists of an individualized report in which national or campus-wide drinking statistics are presented graphically alongside participants' estimates of peer drinking behaviors and their own self-reported drinking (Berkowitz, 2005;Lewis & Neighbors, 2007; Miller & Prentice, 2016). Both stand-alone and multicomponent interventions incorporating PNF have been found to reduce alcohol use in randomized clinical trials (Borsari & Carey, 2000; Doumas, Haustveit, & Coll, 2010; LaBrie, Lewis, Atkins, Neighbors, Zheng, Kenney, et al, 2013; Lewis et al., 2007; Martens, Smith, & Murphy, 2013; Neighbors, Larimer, & Lewis, 2004; Neighbors, Lewis, Atkins, Jensen, Walter, Fossos et al., 2010). However, PNF has consistently demonstrated only small to moderate reductions in students' drinking (Dotson, Dunn, & Bowers, 2015; Walters & Neighbors, 2005) and researchers have identified several issues which may limit the effectiveness of this approach. If these limitations are remedied the public health benefits associated with this cost-effective intervention strategy could be substantial.

In order for PNF to successfully correct normative perceptions and induce reductions in alcohol use, participants' attention must be captured and they must accept the presented normative data as both believable and credible (Perkins, 2003; Berkowitz, 2005; Perkins & Berkowitz, 1986). Researchers have, therefore, speculated that doubts about the credibility of drinking statistics presented (LaBrie, Hummer, Neighbors, & Larimer, 2010; Hummer & Davison, 2016), defensive reactions among heavy drinkers (Granfield, 2005; Steers, Coffman, Wickham, Bryan, Caraway, et al., 2016), and general inattention to feedback (Lewis & Neighbors, 2015) may be responsible for the modest effects observed. Surprisingly,

although approximately 100 published studies during the past two decades have evaluated PNF

components (Larimer & Cronce, 2002; Cronce & Larimer, 2011; Dotson et al., 2015); innovation seeking

to rectify these limitations has been slow to emerge. In fact, aside from advances in delivery modalities

(e.g., in-person, mail-based, web-based, etc.) and reference group specificity (e.g., general student, same-

sex student, same-sex and ethnicity student; LaBrie et al., 2013; Lewis et al., 2007), the format has

remained essentially unchanged since the first PNF studies were published over 20 years ago (Agostinelli,

Brown, & Miller, 1995). However, because web-based PNF is one of the most economical and scalable

alcohol intervention formats, there is growing interest in how its efficacy can be improved. In the service

of this interest, the current study presents preliminary data supporting a novel stand-alone, web-based

PNF intervention, "CampusGANDR" (*Gamified Alcohol Norm Discovery and Readjustment*), which

departs radically from standard PNF in that it is packaged not as a program to reduce risky drinking but as

a Facebook-connected game about college life.

1.1 Intervention Gamification

Gamified interventions, also known in the literature as *Serious Games*, exploit the motivational

characteristics of a game in order to provide prevention information or engage behavior change (Cook,

Brennan, Gray, & Kennard, 2015; Cugelman, 2013). *Serious Games* have shown initial promise as a

method for motivating audiences to engage in healthy behaviors and decrease unhealthy behaviors,

including alcohol use (Cook et al., 2015). In a recent analysis of gamification features, the presence of

certain elements within a software app (e.g., point-based reward systems, chance, progressing difficulty

levels, etc.) were associated with favorable reviews by users and increased app success (Bharathi, Singh,

Tucker, & Nembhard, 2016). Informed by both gamification and alcohol intervention research, three of

these elements were selected to improve the effectiveness of PNF delivered by CampusGANDR:

personal icons, chance, and points.

1.2.1 Personal Icons. The graphical representation of self and others via personal icons or avatars

is an essential element of many online games. This feature induces self-awareness and virtual co-

presence, the sense of being together with others online (Campos-Castillo, 2012; Lee, 2004). Personal

icons leverage co-presence in CampusGANDR to combat a lingering problem associated with social norms interventions; the fact that heavy drinkers are likely to question, dismiss, and derogate normative statistics from national and campus-wide surveys (Campo & Cameron, 2006; Granfield, 2005; Polonec, Major, & Atwood, 2006). One potential solution to this problem is suggested by LaBrie and colleagues' (2008; 2009; 2010) live, interactive, group-based normative feedback intervention format. This approach involves groups of students using clickers to answer questions about normative perceptions and their own behaviors in real time, generating live norms for the group. The success of these interventions suggests that the ability to visualize the other college students whose behavioral reports create the normative statistics may increase the credibility of the feedback.

CampusGANDR was designed to simulate this generation of norms among visible peers by borrowing the concept of co-presence from the gamification literature and harnessing the popularity of social media. Facebook integration allows CampusGANDR users to view the thumbnail profile photos of peers contributing to the norms, creating a sense of shared experience and a feeling of inhabiting the same online environment. As Facebook is now used by over 95% of undergraduates (Boyle, LaBrie, Froidevaux, & Witkovic, 2016; Ridout & Campbell, 2014) many external applications and websites popular among college students now employ a Facebook login, which requires users to sign in with their Facebook credentials. This action both verifies the user's identity and allows the application to access to his or her Facebook information and profile picture. Facebook profile pictures are commonly used within external applications to personalize users' experiences and represent them socially. Thus, in CampusGANDR, Facebook login allows users to become members of a virtual group of students, all identified by their Facebook thumbnail photos, who participate collectively in the generation of normative statistics.

1.2.2 Chance. Most PNF alcohol interventions for college students have been transparent in their alcohol focus. That is, it has been abundantly clear to participants that researchers are interested in their alcohol use and are providing feedback in an effort to decrease their drinking. Problematically, research suggests awareness that the goal of an intervention is to modify behavior may trigger psychological

reactance, undermining efficacy (Brehm & Brehm, 1981; 2013). Due in parts to such reactance, dogmatic alcohol prevention messages have actually been found to *increase* alcohol use among heavy drinking college students (Bensely & Wu, 1991). In an effort to decrease potential reactance to alcohol PNF, CampusGANDR is presented as social game that tests perceptions and reveals truths about *multiple* aspects of college life including studying, hooking up, drug use, television watching, social media use, alcohol use, and exercising. To enhance belief in this cover story the app features a spinner, styled to look like a slot machine which selects three topics, ostensibly at random, at the start of each session. Participants then answer questions about their own behaviors and perceptions of peer behaviors in these three domains. Later, a second spinner selects one of the three topics, again ostensibly at random, on which the user will receive feedback. Thus, when this spinner is programmed to select alcohol as the feedback topic, CampusGANDR users receive the same alcohol PNF they would receive in a typical PNF intervention but the illusion of chance is employed to make it less obvious that this feedback is designed to alter drinking behavior.

1.2.3 Points. One of the earliest and most pervasive theories of learning is operant conditioning (Skinner, 1948), which holds that behavior can be shaped through the manipulation of consequences. In gamified learning paradigms this is generally manifested in the form of conditioned reinforcements such as points, badges, or tokens (Antin & Churchill, 2011, Evans, Jennings, & Andreen, 2012; Nagel, Wolf, Reiner, & Novak, 2014). Use of these elements to reward desired behaviors and responses in educational games has been found to increase motivation and strengthen the learning of facts, procedures, and strategies (Kap, 2012; Johnson, Deterding, Kuhn, Staneva, Stoyanov, et al., 2016). Further, a recent review of gamified interventions identified point-based rewards systems, in particular, to be a foundational component of games seeking to change behavior (Lewis, Schwartz, Lyons, 2016). Because the ultimate goal of PNF interventions is to induce behavior change by helping participants learn facts about the true prevalence of various behaviors among their peers, CampusGANDR was designed to reward participants for accurate perceptions of peers' behaviors using a system of points. Specifically, users wager points on the likelihood that their perceptions of typical student behavior will match the

answers provided by other Facebook-connected students. Accurate perceptions result in a gain equal to the number of points wagered while inaccurate perceptions result in a loss of the wagered points.

1.3 The Current Study

This initial study evaluates the ability of alcohol PNF delivered by a pilot version of CampusGANDR, which includes points, chance, and simulates the generation of norms by visible, Facebook-connected peers, to correct drinking norms and reduce alcohol use relative to PNF delivered by the standard online survey format currently used on college campuses. Due to CampusGANDR's constellation of gamified elements, we expected PNF on alcohol use delivered by this application to lead to larger reductions in perceived peer drinking norms (Hypothesis 1) and alcohol use (Hypothesis 2) two weeks later, relative to identical PNF delivered by standard survey. In addition, perceived drinking norms were predicted to mediate the relationship between condition assignment (i.e., CampusGANDR vs. Standard PNF) and alcohol use at follow-up. That is, we anticipated that PNF delivered by CampusGANDR would better reduce peer drinking norms than PNF delivered by standard survey, thereby more substantially impacting alcohol use (Hypothesis 3).

2. Method

2.1 Participants

Undergraduate students (N=273) at a mid-sized private university on the west coast were recruited from the psychology department's human subject pool to participate in a 2-session study, with sessions 1 and 2 of the study to take place two weeks apart. To be eligible for participation, students had to be between 18 and 24 years old, have a valid Facebook account, and be available during two specific 72 hour periods to complete sessions 1 and 2 of the study on a computer connected to the internet. All aspects of the study (e.g., design, measures, procedures, etc.) were approved by the Institutional Review Board at Loyola Marymount University and all participants consented prior to participation. The majority of participants completed both parts of the study (N=252; 92.3%). As presented in Table 1, the sample was predominantly Caucasian (49.5%), in their first year of study (50.9%), and female (77.1%), with no

significant between-group differences on any demographic variables. Participants were compensated with partial credit in an introductory psychology course.

2.2 Procedure

Recruitment materials invited potential participants to be "beta testers" for a new Facebook application, called CampusGANDR. The app was described as a game about college life ostensibly designed by university psychologists to test the accuracy of users' social perceptions. Students were led to believe that the app was being simultaneously tested at various universities across the country and that they would be connected live with a group of 100-200 other students of their same sex and class year. To increase the believability of this story, the study was conducted during two 3-day periods, referred to as "national beta test periods." Students were informed that they would receive 1 participation credit for using the CampusGANDR app during one of the beta periods, and 1 participation credit for completing an online survey during the other.

At the start of the first beta period (i.e., session 1) all participants were emailed links to a brief pre-survey, which collected basic demographic information. Following completion of the pre-survey, participants were directed to the app website where they logged in to the app using their Facebook credentials. After logging in, participants were randomly assigned to the treatment (CampusGANDR) or control (standard PNF) condition. For those assigned to the treatment condition, a CampusGANDR session began immediately following login. Those assigned to the control condition received a message informing them that the CampusGANDR sessions were full, so they would complete the online survey portion of the study during the first beta period and would test CampusGANDR during the second beta period. Two weeks later, participants received a follow-up email reminding them to participate in the second beta period (i.e., session 2). During the second session, treatment participants completed the survey and control participants used the app. Because identical alcohol use norm and behavioral questions were asked in both CampusGANDR and the survey, session 2 served as a two-week follow-up assessment to measure the short-term effects of group assignment on alcohol use and normative perceptions.

2.2.1 Standard PNF Condition. The survey was modeled on standard web-based PNF (Lewis & Neighbors, 2015; Neighbors et al., 2004). Participants answered questions about their perceptions of the drinking behaviors of the typical student of their same sex and class year and then reported their own alcohol use. Next, bar graphs were immediately presented highlighting (a) the extent to which participants misperceived the norms and (b) how participants' own drinking compared to the drinking of the typical student of their same sex. The normative statistics presented in the PNF graphs came from a previous large-scale survey of the alcohol use behaviors of undergraduates at our university. However, participants were told statistics were based on a national survey of 132 college students of their same sex and class year. Example feedback slides used in both study conditions are presented in Figure 1.

2.2.2 CampusGANDR Condition. CampusGANDR was designed to ask the exact same questions as typical PNF and to present the exact same feedback but to do so in a more engaging and believable way. After logging in to the app, participants waited on an animated landing page for 13 seconds before being told that the app was matching them with students similar to them. To increase believability that they were truly being connected with other students, the app displayed the criteria it was ostensibly using to filter users (sex and class year) and Facebook-style thumbnail images for 132 students of the same sex and class year appeared one at a time as each new student apparently joined the session (See Figure 2 for a screenshot). Next, participants were informed that 132 students from across the country were participating in the current session and that topics for the session were being randomly selected. To represent this visually, a slot machine-style spinner with three slots appeared on screen and various topics whirled by before three were "chosen at random" (the topics were always alcohol, social media, and TV). Figure 3 provides screenshots of the spinners as they appeared to participants.

To begin the first topic, *alcohol*, participants answered six items assessing their normative perceptions and own drinking behaviors (See Figure 4 for sample items). Next, participants were informed that they would be placing bets on the accuracy of their perceptions and that they would win points for a correct response and lose points for an incorrect response. Each participant began with 250 points and was asked to place a bet (between 5-35 points) on the accuracy of each of their three

perceptions (maximum number of drinks consumed on a single occasion, average number of drinks consumed per occasion, and number of binge drinking episodes during the past two weeks) one at a time. For a correct answer the number of points won immediately appeared in green, while for an incorrect answer the number of points lost appeared in red. A running tally of each participant's score was displayed before each bet was made. After placing a bet on each of their three alcohol perceptions and finding out their score, participants began round 2 (social media), followed by round 3 (TV). These rounds proceeded in precisely the same way as the first, with parallel questions assessing, for instance, perceptions of the maximum number of hours a typical student spent watching TV, the length of an average TV watching session, and the frequency of "binge watching" during the previous two weeks. Points were lost and accumulated across all three rounds, resulting in a final score.

At the end of the session participants were informed that they would receive feedback on one of the three topics from the session and that the feedback was a feature of the app which would help them to score better during session 2. As shown in Figure 3, a colorful spinner with icons representing the three topics from the session ostensibly stopped on a randomly-chosen topic for feedback (alcohol was always selected). Finally, participants viewed feedback slides highlighting (a) the extent to which they misperceived the norms and (b) how their own use compared to the use of the typical student. Importantly, these slides were identical to the feedback presented in the standard PNF condition.

2.2.3 Debriefing

Upon completion of the study, all participants were thanked for their time and debriefed via email regarding deceptive study elements. The debriefing page disclosed that while logged into CampusGANDR, participants were not actually connected to 132 other students. Further, the thumbnail profile pictures of other students displayed to represent other connected users were in fact the same for all students of each sex. It was explained that the full version of CampusGANDR, currently in development, will likely feature such "live" Facebook-connected sessions. They were told that in this study we simulated this "live" feature in order to determine its value. Finally, in an effort to maintain the benefits associated with receipt of normative feedback, participants were informed that the normative statistics

about use of alcohol and social media presented in the feedback delivered by both CampusGANDR and the online survey were, in fact, real. It was explained that both the distributions of question responses and normative statistics came from a large sample of college students from the students' university who answered identical questions in a survey earlier in the year. Participants were also informed that alcohol use norms at their university are highly consistent with national norms for students at colleges and universities in the U.S.

2.3 Measures

2.3.1 Demographics. During the pre-survey participants answered questions assessing their sex, class year, and race/ethnicity.

2.3.2 Drinking Norms. Both CampusGANDR and the online survey required participants to answer identical questions about their perceptions of the alcohol use of a typical student of their same sex and class year during the previous two weeks. Thus, during the first session (i.e., baseline) and second session (i.e., follow-up), questions assessed participants' perceptions of the typical student's (1) maximum number of drinks consumed on a single occasion, (2) average number of drinks consumed per occasion, and (3) frequency of binge drinking (4+ drinks on an occasion for females or 5+ drinks for males) during the previous two weeks. The three alcohol use perception items were highly correlated at baseline (all >.66) and follow-up (all >.75). Items were first standardized and then averaged at each time-point in order to create composite measures of drinking norms at baseline (session 1) and follow-up (session 2).

2.3.3 Alcohol Consumption. Identical questions in CampusGANDR and the online survey also assessed participants' own alcohol consumption during the previous 2 weeks. Alcohol consumption questions paralleled the three normative perception questions assessing participants' (1) maximum number of drinks consumed on a single occasion, (2) average number of drinks consumed per occasion, and (3) frequency of binge drinking during the previous two weeks. Alcohol consumption items were highly correlated at baseline (all >.70) and follow-up (all >.88). Overall alcohol consumption scores were

computed by standardizing and then averaging the alcohol consumption items assessed at baseline (session 1) and follow-up (session 2).

2.4 Data Analytic Plan

Tests of hypotheses first sought to determine whether condition assignment was significantly associated with the composite measures of drinking norms (H1) and alcohol consumption (H2) at follow-up. Composite drinking norm and consumption variables were normally distributed and, thus, respective hierarchical linear regression models examined the variability in perceptions of drinking norms (H1) and alcohol consumption (H2) associated with condition assignment after controlling for participants' sex, class year, and the baseline composite measure of the outcome. Because composite norm and alcohol consumption variables at baseline and follow-up were computed from the averages of three standardized variables, we elected to standardize all predictor variables in these models to enhance interpretation.

In the presence of significant condition effects on both perceived drinking norms and alcohol consumption, a mediation model examined whether perceived alcohol use norms mediated the relationship between condition assignment and alcohol use at follow-up (H3). Mediation analyses were performed by the PROCESS bootstrap test in SPSS (Preacher & Hayes, 2008). Recommended guidelines for testing mediation using the Preacher and Hayes method were followed (e.g., 5,000 bootstrap samples and bias corrected confidence intervals; Hayes, 2009; Preacher and Hayes, 2004; Zhao, Lynch, & Chen, 2010). Condition assignment was specified as the independent variable (0 = Standard PNF, 1=CampusGANDR), perceived norms at follow-up as the mediator, and alcohol consumption at follow-up as the outcome. The mediation model also controlled for participant's age, sex, race, baseline norms, and baseline alcohol consumption in both M and Y paths.

3. Results

3.1. Missing Data & Preliminary Analyses

As shown in Figure 4, of the participants assessed at baseline ($N = 273$), 92.3% were re-assessed 2 weeks later at follow-up ($N = 252$). The 21 students not assessed at follow-up were evenly distributed among CampusGANDR (N=120 followed out of 134) and standard PNF (N=130 followed out of 139)

conditions, χ^2=.024, p = .88. Further, no differences were observed on any study or demographic variables between the students who dropped out and those who remained in the study (all ps > .05). Beyond attrition, missing data affected less than 6% of cases and were determined to be missing at random. List-wise deletion resulted in the sample size of 237 reflected across analyses. Table 1 provides descriptive information for demographic covariates as well as for baseline and follow-up measures of all outcome variables in the overall sample and by study condition. Randomization resulted in equivalent groups assigned to CampusGANDR and standard PNF conditions for all demographic, baseline norm, and baseline alcohol consumption variables.

3.2 Effect of Condition Assignment on Perceived Drinking Norms (H1).

As presented in Table 2, the hierarchical linear regression model predicting perceived drinking norms at follow-up indicated a significant effect for condition assignment (B = -.14, p =.002) and support for Hypothesis 1. As shown in the bottom of Table 1, participants in both conditions demonstrated significant reductions in their perceptions of drinking norms from baseline to follow-up; however, PNF delivered by CampusGANDR was associated with a larger reduction in these norms than was standard PNF.

3.3 Effect of Condition Assignment on Alcohol Consumption (H2).

Similarly, in support of Hypothesis 2, the regression model predicting alcohol consumption at follow-up revealed a significant effect for condition assignment with CampusGANDR (B = -.10, p =.009), significantly reducing overall alcohol consumption relative to standard web-based PNF. While alcohol consumption was reduced significantly from baseline to follow-up in both conditions (Table 1) the reduction in drinking was more substantial in the CampusGANDR condition.

3.4 Norms Mediate the Relationship between Condition and Alcohol Consumption (H3).

Next, we tested participants' perceptions of drinking norms as a mediator of the relationship between condition assignment and alcohol consumption at follow-up (See Figure 5). Condition assignment (Standard PNF=0, CampusGANDR=1) significantly predicted perceptions of peer drinking norms (B = -.14, p = .002), and this mediator subsequently predicted alcohol consumption (B = .19, p =

.001). Supporting Hypothesis 3, there was a significant indirect effect from condition assignment to alcohol consumption via peer drinking norms, $B = -.03$, 95% CI [-.06, -.01]), and a non-significant direct effect from condition assignment to alcohol consumption, $B = -.07$, 95% CI [-.14, .01].

4. Discussion

This research provides proof of concept for CampusGANDR, a novel, gamified, Facebook-connected, software application that delivers PNF on alcohol use and other behaviors of interest to college students. CampusGANDR's ability to correct peer drinking norms and reduce alcohol use was tested against the standard web-based PNF alcohol format currently popular on college campuses. Although students assigned to both study conditions answered identical questions about peer alcohol use and their own drinking, and then received identical feedback charts, students in the CampusGANDR condition reported significantly reduced perceptions of peer drinking norms and alcohol use two weeks later relative to students in the standard web-based PNF condition. Support for the theorized mediation model also demonstrated that, relative to Standard PNF, CampusGANDR fostered larger reductions in alcohol consumed by more substantially decreasing perceived drinking norms.

To our knowledge, CampusGANDR is the first web-based PNF intervention format to introduce gamified elements including a point-based reward system, visual representation of other students via Facebook thumbnail photos, and elements of chance, in order to address the limitations associated with standard web-based PNF interventions for college students. Notably, the pilot version of CampusGANDR tested in this initial study only simulated the generation of norms by visible, Facebook-connected, peers yet was still substantially more effective than standard web-based PNF in reducing both college students' peer drinking norms and subsequent alcohol use. Given that recent meta-analyses have consistently found brief, stand-alone PNF interventions to significantly reduce students' drinking when compared to assessment only controls (Dotson et al., 2015), and the growing interest in how these interventions can be improved, these initial CampusGANDR results are suggestive of practical and economical methods for significantly increasing effect sizes associated with this intervention modality.

4.1 Implications

The GANDR PNF format takes the well-established core components of a social norms-based PNF alcohol intervention (providing feedback on the accuracy of one's peer alcohol use perceptions and how one's own drinking compares to peers') and delivers these components within the context of an inviting, Facebook-connected, social game. Given the widespread use of Facebook among adolescents and adults (Duggan, Ellison, Lampe, Lenhart, & Madden, 2015), a Facebook-connected game offering to test perceptions of peer's behaviors is likely to appeal to members of many young adult and adult groups known to over-estimate alcohol use norms. Thus, while this initial study examined a college life-themed version of GANDR, this gamified, Facebook-integrated PNF format has the potential to be culturally tailored to appeal to a number of different populations, including those traditionally considered to be "hidden" or hard to reach (e.g., sexual minority groups, young military veterans) as well as high-risk individuals who would be unlikely to self-select into a study that was more transparent about its focus on reducing alcohol use. At the discretion of the researchers additional behaviors for which feedback is provided may be of the purely fun nature, designed to increase the appeal of GANDR and recruit new users of the target population. Alternatively, other topics could target meaningful health behaviors, including the use of other substances (e.g., tobacco, marijuana, prescription drugs). In the event that these other norms are misperceived, GANDR-delivered PNF could also potentially increase participants' frequency of engaging in healthy behaviors while simultaneously decreasing the frequency of risky behaviors.

This gamified PNF format may also increase both the ecological validity and cost-effectiveness of intervention evaluation studies. Because most brief intervention studies are transparent in their goal to reduce participants' alcohol use, research participation effects may bias self-reported alcohol consumption (McCambridge, Butor-Bhavsar, Witton, & Elbourne, 2011; McCambridge, Kypri, & Elbourne, 2014). Uniquely, studies evaluating the GANDR PNF format have the potential to eliminate this source of reporting bias. Given the multiple college life topics and gamified elements, students may be unaware that they are participating in an alcohol intervention study. GANDR evaluation studies also have the potential to be more cost-effective than those evaluating standard web-based PNF interventions. Delivering a brief

alcohol intervention within the context of a gamified app allows the intervention to be disguised as something fun and interesting, which may reduce or even eliminate the need to provide compensation in order to attract and retain participants. As in the present study, later behavior can also be assessed within the app under the guise of future rounds of play, making follow-up data collection organic and inexpensive.

4.2 Limitations and Directions for Future Research

This initial test of the GANDR PNF format for college students is not without limitations. Foremost, because our goal was to determine whether feedback delivered by CampusGANDR was more effective than standard web-based PNF, participants were provided with identical normative statistics in both study conditions. To accomplish this, we had to limit CampusGANDR's Facebook integration and deceive participants with regard to the generation of live norms. Although students truly logged into CampusGANDR with their Facebook credentials, participants were not really connected to 132 other students of their same sex and class year as the app suggested. This deception allowed us to provide the same normative statistics for alcohol use (based on previously collected survey data) in both CampusGANDR and standard PNF conditions, which, in turn, allowed us to make clean between-group comparisons of norms and alcohol consumption at follow-up. Because these results suggest that visible peers connected via Facebook may indeed increase the credibility of normative statistics, this feature will be actualized in the full version of CampusGANDR and future evaluation studies will not require deception.

Additional limitations of this study include the composition of the participant sample, and the study design's 2 week follow-up assessment, which only allowed us to test a mediation model in which both the mediator (norms) and outcome (alcohol consumption) were assessed at the same point in time (follow-up). First, the sample was heavily female (70%), reflecting the demographics of psychology students at our university. As recent research finds undergraduate males and females to similarly engage in heavy drinking and experience negative consequences (White & Hingson, 2014), the extent to which CampusGANDR is effective among male students is in need of further investigation. Future tests of

CampusGANDR will also require longer-term follow-up assessments (e.g., 1 month, 6 months, 12 months), and more diverse samples of college students from multiple universities. Such longitudinal studies will also need to examine whether drinking norms assessed after the delivery of PNF, but prior to alcohol use outcomes, mediate the relationship between CampusGANDR PNF delivery and alcohol consumption, as would be expected based on this study's results. Further, because this study did not assess variables theorized to account for gamified elements' impacts on norms and behavior, additional research will be required to identify whether the CampusGANDR effects observed are driven by increased motivation, attention, believability, or unidentified variables.

A final direction for future research is suggested by the fact that this initial attempt to gamify PNF found success while utilizing only three elements of gamification (personal icons, points, and chance). The growing gamification literature is rife with additional features that could be used to further enhance PNF interventions. For instance, a leader board could allow students to see how their scores compare to their peers, providing further incentive to perform well. Additionally, progressing levels could be added so that players unlock new topics and challenges the more they use the app. It is our hope that the findings from this study will encourage other alcohol interventionists to explore different combinations of gamified elements that may further increase the effectiveness of web-based PNF interventions for college students and other populations.

Conclusion

This is the first PNF intervention to introduce gamified elements including a point-based reward system, visual representation of other users via Facebook, and elements of chance in order to address the limitations associated with standard web-based PNF interventions for college students. Results from this study suggest that PNF does not have to be explicitly aimed at reducing alcohol use to be effective. In fact, CampusGANDR, in which normative feedback on alcohol use was presented as part of a gamified app rather than as an overt intervention, was significantly more effective at reducing student drinking behavior than was standard PNF. As web-based PNF is increasingly considered a universal prevention strategy due to its brevity, low cost, and consistent ability to reduce high-risk drinking (Dotson et al.,

2015; Lewis & Neighbors, 2015), findings from this study suggest a novel approach by which PNF may

be significantly improved and encourage further innovation in the development of more effective web-

based PNF formats.

References

Agostinelli, G., Brown, J. M., & Miller, W. R. (1995). Effects of normative feedback on consumption among heavy drinking college students. *Journal of Drug Education, 25*(1), 31-40. doi: 10.2190/XD56-D6WR-7195-EAL3

Antin, J., & Churchill, E. F. (2011, May). *Badges in social media: A social psychological perspective.* Paper presented at the CHI 2011 Gamification Workshop Proceedings, Vancouver, BC, Canada.

Bensley, L. S., & Wu, R. (1991). The role of psychological reactance in drinking following alcohol prevention messages. *Journal of Applied Social Psychology, 21*, 1111-1124. doi:10.1111/j.1559-1816.1991.tb00461.x

Berkowitz, A. D. (2005). An overview of the social norms approach. In L.C. Lederman & L.P. Stewart (Eds.), *Changing the culture of college drinking: A socially situated health communication campaign* (193-214). Cresskill, NJ: Hampton Press.

Bharathi, A. K. B. G., Singh, A., Tucker, C. S., & Nembhard, H. B. (2016). Knowledge discovery of game design features by mining user-generated feedback. *Computers in Human Behavior, 60*, 361-371. doi:10.1016/j.chb.2016.02.076

Borsari, B., & Carey, K. B. (2000). Effects of a brief motivational intervention with college student drinkers. *Journal of Consulting and Clinical Psychology, 68*(4), 728-733. doi:10.1037/0022-006X.68.4.728

Borsari, B., & Carey, K. B. (2003). Descriptive and injunctive norms in college drinking: A meta-analytic integration. *Journal of Studies on Alcohol, 64*(3), 331-341. doi:10.15288/jsa.2003.64.331

Boyle, S. C., LaBrie, J. W., Froidevaux, N. M., & Witkovic, Y. D. (2016). Different digital paths to the keg? How exposure to peers' alcohol-related social media content influences drinking among male and female first-year college students. *Addictive Behaviors, 57*, 21-29. doi:10.1016/j.addbeh.2016.01.011

Brehm, S. S., & Brehm, J. W. (1981). *Psychological reaction: A theory of freedom and control.* Cambridge, MA: Academic Press.

Brehm, S. S., & Brehm, J. W. (2013). *Psychological reactance: A theory of freedom and control.* Cambridge, MA: Academic Press.

Campo, S., & Cameron, K. A. (2006). Differential effects of exposure to social norms campaigns: A cause for concern. *Health Communication, 19*(3), 209-219. doi:10.1207/s15327027hc1903_3.

Cook, K., Brennan, E., Gray, C., & Kennard, T. (2015). "Keep What You've Earned": Encouraging Sailors to Drink Responsibly. *Design, User Experience, and Usability: Interactive Experience Design* (pp. 575-586). New York, NY: Springer.

Cronce, J. M., & Larimer, M. E. (2011). Individual-focused approaches to the prevention of college student drinking. *Alcohol Research & Health: The Journal of the National Institute on Alcohol Abuse and Alcoholism, 34*(2), 210-221. doi:SPS-AR&H-33

Cugelman, B. (2013). Gamification: What it is and why it matters to digital health behavior change developers. *JMIR Serious Games, 1*(1). doi:10.2196/games.3139

Dotson, K. B., Dunn, M. E., & Bowers, C. A. (2015). Stand-alone personalized normative feedback for college student drinkers: A meta-analytic review, 2004 to 2014. *PloS One, 10*(10), e0139518. doi:10.1371/journal.pone.0139518

Doumas, D. M., Haustveit, T., & Coll, K. M. (2010). Reducing heavy drinking among first year intercollegiate athletes: A randomized controlled trial of web-based normative feedback. *Journal of Applied Sport Psychology, 22*(3), 247-261. doi:10.1080/10413201003666454

Duggan, M., Ellison, N. B., Lampe, C., Lenhart, A., & Madden, M. (2015, January). Social media update 2014. Pew Research Center. Retrieved from: http://www.pewinternet.org/2015/01/09/social-media-update-2014/.

Evans, M., Jennings, E., & Andreen, M. (2012). Assessment through achievement systems: A framework for educational game design. *Developments in Current Game-Based Learning Design and Deployment*, 302-311. doi:10.4018/978-1-4666-1864-0.ch022

Granfield, R. (2005). Alcohol use in college: Limitations on the transformation of social norms. *Addiction Research & Theory*, 13(3), 281-292.

Hayes, A. F. (2009). Beyond Baron and Kenny: Statistical mediation analysis in the new

millennium. *Communication Monographs, 76,* 408-420. doi: 10.1080/03637750903310360

Hummer, J. F., & Davison, G. C. (2016). Examining the role of source credibility and reference group

proximity on personalized normative feedback interventions for college student alcohol use: A

randomized laboratory experiment. *Substance Use & Misuse*, *51*(13), 1-15.

doi:10.1080/10826084.2016.1197258

Johnson, D., Deterding, S., Kuhn, K. A., Staneva, A., Stoyanov, S., & Hides, L. (2016). Gamification for

health and wellbeing: A systematic review of the literature. *Internet Interventions.* doi:

10.1016/j.invent.2016.10.002

Kapp, K. M. (2012). *The gamification of learning and instruction: game-based methods and strategies

for training and education*. Hobeken, NJ: John Wiley & Sons.

LaBrie, J. W., Hummer, J. F., Neighbors, C., & Pedersen, E. R. (2008). Live interactive group-specific

normative feedback reduces misperceptions and drinking in college students: A randomized

cluster trial. *Psychology of Addictive Behaviors, 22*(1), 141-148. doi:10.1037/0893-

164X.22.1.141

LaBrie, J. W., Hummer, J. F., Huchting, K. K., & Neighbors, C. (2009). A brief live interactive normative

group intervention using wireless keypads to reduce drinking and alcohol consequences in college

student athletes. *Drug and Alcohol Review, 28*(1), 40-47. doi:10.1111/j.1465-3362.2008.00012.x

LaBrie, J. W., Hummer, J. F., Neighbors, C., & Larimer, M. E. (2010). Whose opinion matters? The

relationship between injunctive norms and alcohol consequences in college students. *Addictive

Behaviors, 35*(4), 343-349. doi:10.1016/j.addbeh.2009.12.003

LaBrie, J. W., Lewis, M. A., Atkins, D. C., Neighbors, C., Zheng, C., Kenney, S. R., . . . Hummer, J. F.

(2013). RCT of web-based personalized normative feedback for college drinking prevention: Are

typical student norms good enough? *Journal of Consulting and Clinical Psychology, 81*(6), 1074-

1086. doi:10.1037/a0034087

Larimer, M. E., & Cronce, J. M. (2002). Identification, prevention and treatment: A review of individual-focused strategies to reduce problematic alcohol consumption by college students. *Journal of Studies on Alcohol, Supplement*(14), 148-163. doi:10.15288/jsas.2002.s14.148

Larimer, M. E., Turner, A. P., Mallett, K. A., & Geisner, I. M. (2004). Predicting drinking behavior and alcohol-related problems among fraternity and sorority members: Examining the role of descriptive and injunctive norms. *Psychology of Addictive Behaviors*, *18*(3), 203-212. doi: 10.1037/0893-164X.18.203.

Lee, K. M. (2004). Presence, explicated. *Communication Theory*, *14*(1), 27-50. doi: 10.1111/j.1468-2885.2004.tb00302.x

Lewis, M. A., & Neighbors, C. (2004). Gender-specific misperceptions of college student drinking norms. *Psychology of Addictive Behaviors, 18*(4), 334-339. doi:10.1037/0893-164X.18.4.334

Lewis, M. A., & Neighbors, C. (2007). Optimizing personalized normative feedback: The use of gender-specific referents. *Journal of Studies on Alcohol and Drugs, 68*(2), 228. doi:10.15288/jsad.2007.68.228

Lewis, M. A., & Neighbors, C. (2015). An examination of college student activities and attentiveness during a web-delivered personalized normative feedback intervention. *Psychology of Addictive Behaviors, 29*(1), 162-167. doi:10.1037/adb0000003

Lewis, Z. H., Swartz, M. C., & Lyons, E. J. (2016). What's the point?: A review of reward systems implemented in gamification interventions. *Games for Health Journal, 5*(2), 93-99. doi:10.1089/g4h.2015.0078

Martens, M. P., Smith, A. E., & Murphy, J. G. (2013). The efficacy of single-component brief motivational interventions among at-risk college drinkers. *Journal of Consulting and Clinical Psychology, 81*(4), 691-701. doi:10.1037/a0032235

McCambridge, J., Butor-Bhavsar, K., Witton, J., & Elbourne, D. (2011). Can research assessments themselves cause bias in behaviour change trials? A systematic review of evidence from Solomon 4-group studies. *PloS One, 6*(10), e25223. doi:10.1371/journal.pone.0025223

McCambridge, J., Kypri, K., & Elbourne, D. (2014). Research participation effects: A skeleton in the methodological cupboard. *Journal of Clinical Epidemiology, 67*(8), 845-849. doi:10.1016/j.jclinepi.2014.03.002

Miller, D. T., & Prentice, D. A. (2016). Changing norms to change behavior. *Annual Review of Psychology, 67*, 339-361. doi:10.1146/annurev-psych-010814-015013.

Nagle, A., Wolf, P., Riener, R., & Novak, D. (2014). The use of player-centered positive reinforcement to schedule in-game rewards increases enjoyment and performance in a serious game. *International Journal of Serious Games*, *1*, (4) 35-47. doi: 10.17083/ijsg.v1i4.47

Neighbors, C., Larimer, M. E., & Lewis, M. A. (2004). Targeting misperceptions of descriptive drinking norms: Efficacy of a computer-delivered personalized normative feedback intervention. *Journal of Consulting and Clinical Psychology, 72*(3), 434-447. doi:10.1037/0022-006X.72.3.434

Neighbors, C., Lee, C. M., Lewis, M. A., Fossos, N., & Larimer, M. E. (2007). Are social norms the best predictor of outcomes among heavy-drinking college students? *Journal of Studies on Alcohol and Drugs, 68*(4), 556. doi:10.15288/jsad.2007.68.556

Neighbors, C., Lewis, M. A., Atkins, D. C., Jensen, M. M., Walter, T., Fossos, N., . . . Larimer, M. E. (2010). Efficacy of web-based personalized normative feedback: A two-year randomized controlled trial. *Journal of Consulting and Clinical Psychology, 78*(6), 898-911. doi:10.1037/a0020766

Perkins, H. (2003). *The social norms approach to preventing school and college age substance abuse: A handbook for educators, counselors, and clinicians.* San Francisco, CA: Jossey-Bass.

Perkins, H. W., & Berkowitz, A. D. (1986). Perceiving the community norms of alcohol use among students: Some research implications for campus alcohol education programming. *International Journal of the Addictions, 21*(9-10), 961-976. doi:10.3109/10826088609077249

Polonec, L. D., Major, A. M., & Atwood, L. E. (2006). Evaluating the believability and effectiveness of the social norms message "most students drink 0 to 4 drinks when they party." *Health Communication, 20*(1), 23-34. doi:10.1207/s15327027hc2001_3

Preacher, K. J., & Hayes, A. F. (2004). SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behavior Research Methods, Instruments, & Computers, 36*, 717-731. doi: 10.3758/bf03206553

Preacher, K. J., & Hayes, A. F. (2008). Assessing mediation in communication research. *The Sage Sourcebook Of Advanced Data Analysis Methods For Communication Research.* Thousand Oaks, CA: Sage, 13-54.

Ridout, B., & Campbell, A. (2014). Using Facebook to deliver a social norm intervention to reduce problem drinking at university. *Drug and Alcohol Review, 33*(6), 667-673. doi:10.1111/dar.12141

Skinner, B. F. (1948). 'Superstition' in the pigeon. *Journal of Experimental Psychology, 38*(2), 168-172. doi:10.1037/h0055873

Walters, S. T., & Neighbors, C. (2005). Feedback interventions for college alcohol misuse: What, why and for whom? *Addictive Behaviors, 30*(6), 1168-1182. doi:10.1016/j.addbeh.2004.12.005

White, A., & Hingson, R. (2014). The burden of alcohol use: Excessive alcohol consumption and related consequences among college students. *Alcohol Research: Current Reviews*, *35*(2), 201.

Zhao, X., Lynch, J. G., & Chen, Q. (2010). Reconsidering baron and kenny: Myths and truths about mediation analysis. *Journal of Consumer Research, 37*, 197-206. doi: 10.1086/651257

Table 1

Descriptive statistics for demographic, normative perception and alcohol use variables.

	Overall (N = 237)		CampusGANDR (N = 113)		Standard PNF (N = 124)	
	% (N)	M (SD)	% (N)	M (SD)	% (N)	M (SD)
Class Year						
Freshman	51.1 (121)		49.6 (56)		52.4 (65)	
Sophomore	37.1 (88)		38.1 (43)		36.3 (45)	
Junior	6.8 (16)		7.1 (8)		6.5 (8)	
Senior	5.1 (12)		5.3 (6)		4.8 (6)	
Sex						
Male	24.5 (58)		23.0 (26)		25.8 (32)	
Female	75.5 (179)		77.0 (87)		74.2 (92)	
Race/Ethnicity						
Asian	18.5 (44)		18.6 (21)		18.5 (23)	
Black or African American	8.0 (19)		8.0 (9)		8.0 (10)	
White or Caucasian	48.1 (114)		48.6 (55)		47.5 (59)	
Hispanic/Latino	16.0 (38)		16.0 (18)		16.3 (20)	
Multiracial	5.1 (12)		4.4 (5)		5.6 (7)	
Other	4.2 (10)		4.4 (5)		4.0 (5)	
Baseline Norms						
Maximum Occasion		5.63 (1.99)		5.43 (1.97)		5.81 (2.00)
Average Occasion		3.75 (1.53)		3.88 (1.72)		3.64 (1.33)
Binge Episodes		2.15 (1.22)		2.09 (1.23)		2.21 (1.20)
Follow-up Norms						
Maximum Occasion		3.71 (1.27)[c]		3.60 (1.21)[c]		3.81 (1.32)[c]
Average Occasion		2.53 (1.05)[c]		2.23 (.87)[c]		2.79 (1.12)[c]
Binge Episodes		1.28 (.99)[c]		1.17 (.91)[c]		1.32 (.99)[c]
Baseline Drinking Outcomes						
Maximum Occasion		3.75 (3.41)		3.92 (3.44)		3.59 (3.37)
Average Occasion		2.38 (2.21)		2.46 (2.36)		2.30 (2.10)
Binge Episodes		1.03 (1.29)		1.00 (1.40)		1.05 (1.31)
Follow-up Drinking Outcomes						
Maximum Occasion		2.80 (3.00)[c]		2.55 (2.91)[c]		3.02 (3.08)[a]
Average Occasion		1.78 (1.94)[c]		1.63 (1.94)[c]		1.92 (1.94)[b]
Binge Episodes		0.78 (1.15)[c]		0.64 (1.04)[c]		0.89 (1.23)[b]

Note. Variables with significant between-condition differences are marked with asterisks in the "overall" column; **p<.001. Norms and behaviors that differed significantly from baseline to follow-up are flagged at follow-up; a: *p*<.05; b: *p*<.01: c: *p*<.001.

Table 2

Summary of regression results for condition assignment predicting perceived drinking norms and alcohol consumption variables at follow-up (N=237).

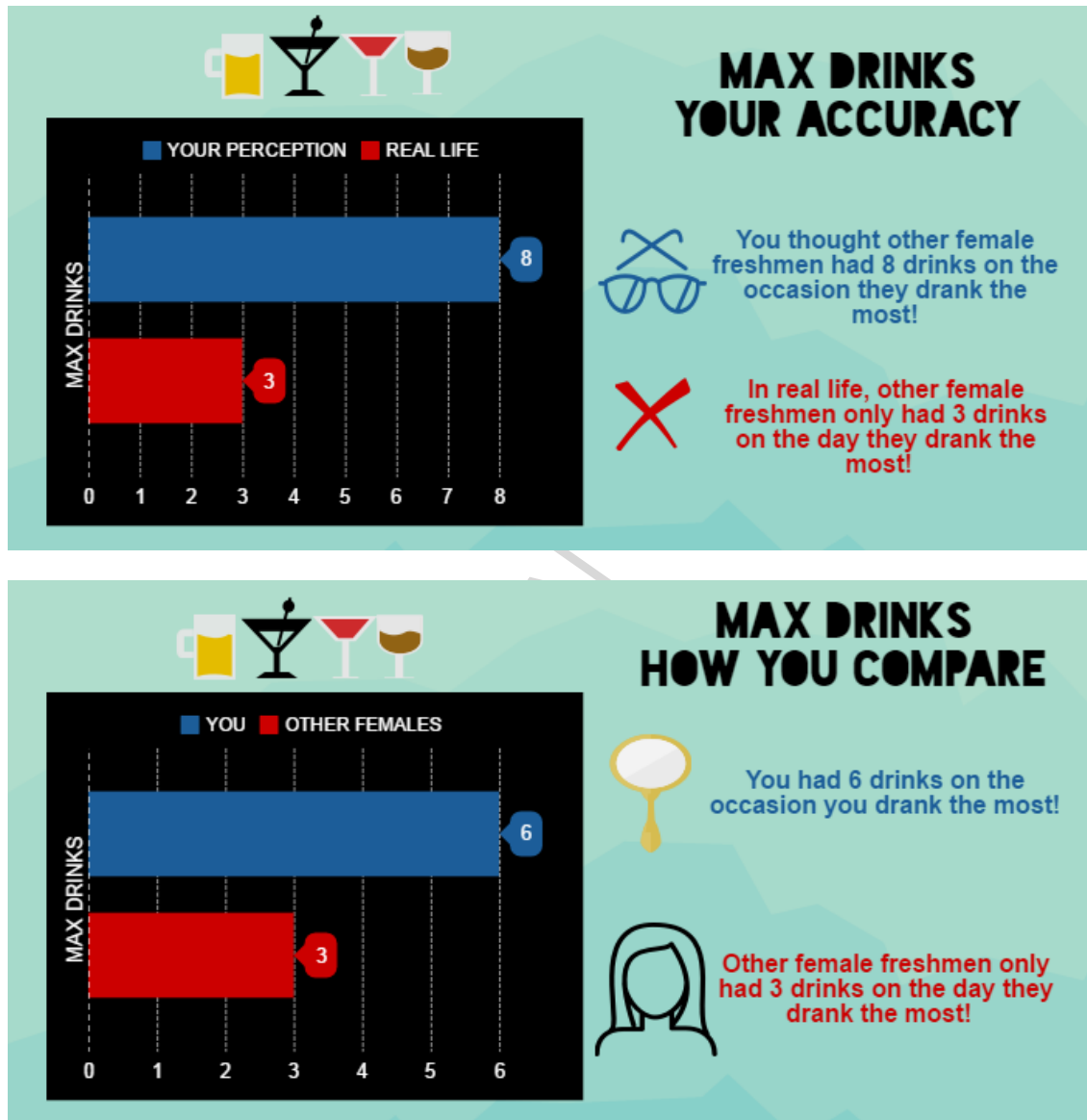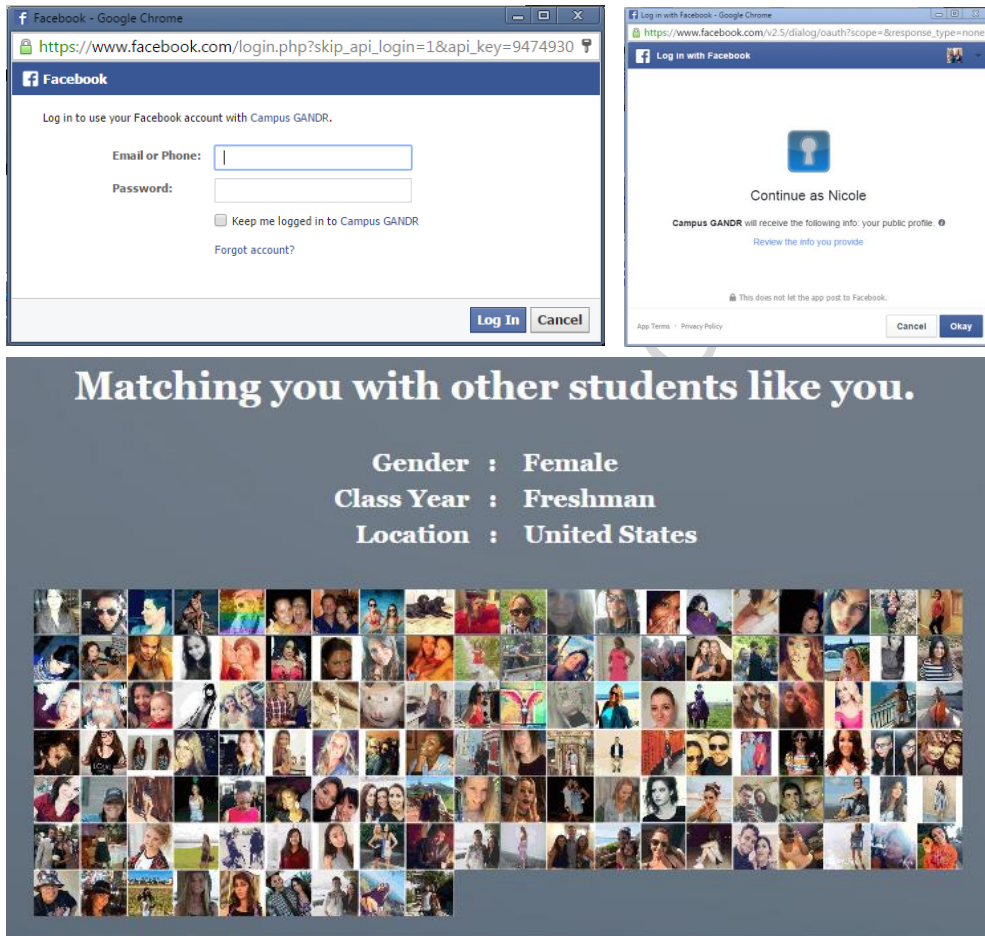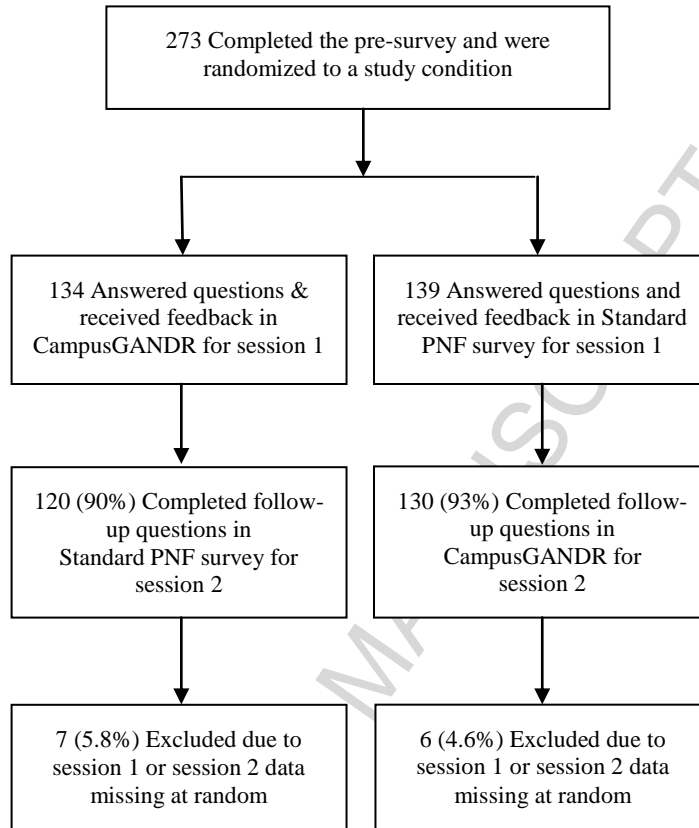|	*Overall Linear Regression Models*				
	Condition Assignment (Standard PNF = 0; CampusGANDR = 1)				
Outcome	*B*	*SE B*	t	F^{change}	$R^{2\ change}$
Z-Perceived norms composite	- .14**	.04	-3.11	9.71**	.027
Z-Alcohol use composite	-.10**	.03	-2.50	6.03**	.014

p < .05; **p* < .01.

Figure 1. Sample PNF slides delivered to participants in both study conditions.

Figure 2. Facebook integration and personal icons as they appeared in the pilot version of CampusGANDR.
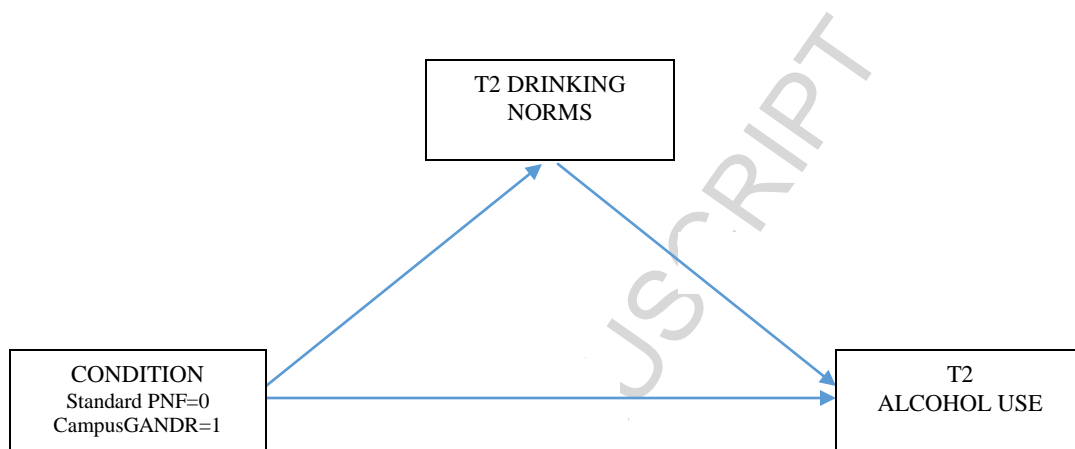
Figure 3. Topic selection and feedback selection spinners appearing in the pilot version of CampusGANDR.

```
┌─────────────────────────────────────────┐
│   273 Completed the pre-survey and were   │
│       randomized to a study condition     │
└─────────────────────────────────────────┘
```

```
┌──────────────────────────┐      ┌──────────────────────────┐
│ 134 Answered questions &  │      │ 139 Answered questions and │
│    received feedback in   │      │ received feedback in Standard│
│ CampusGANDR for session 1 │      │   PNF survey for session 1 │
└──────────────────────────┘      └──────────────────────────┘
```

```
┌──────────────────────────┐      ┌──────────────────────────┐
│ 120 (90%) Completed follow-│      │ 130 (93%) Completed follow-│
│      up questions in       │      │      up questions in       │
│  Standard PNF survey for   │      │     CampusGANDR for        │
│        session 2           │      │        session 2           │
└──────────────────────────┘      └──────────────────────────┘
```

```
┌──────────────────────────┐      ┌──────────────────────────┐
│  7 (5.8%) Excluded due to  │      │  6 (4.6%) Excluded due to  │
│ session 1 or session 2 data│      │ session 1 or session 2 data│
│    missing at random       │      │    missing at random       │
└──────────────────────────┘      └──────────────────────────┘
```

Figure 4. Participation flow diagram.

Figure 5. Supported mediation model with unstandardized regression coefficients for all paths including the (total effect) of *x* on *y*. *$p < .05$; **$p < .01$.

Highlights

- Students received either gamified or standard personalized normative feedback
- Peer drinking norms were corrected in both gamified and standard PNF conditions
- Reductions in norms and drinking were greater in the gamified PNF condition
- Gamified elements may increase the efficacy of web-based PNF interventions