

Official Title: Revolutionizing Normative Re-education: Delivering Enhanced PNF Within a Social Media Inspired Game About College Life

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Protocol with Statistical Analysis Plan

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Background

The transition into college is considered a critical period in which risky drinking patterns are often established (Arria et al., 2016; Derefinko et al., 2016), and serious negative consequences occur (Caamaño-Isorna et al., 2017; Hingson et al., 2009, 2016; Mallett et al., 2013). As perceptions of peers' drinking are among the strongest predictors of college students' future drinking (Borsari & Carey, 2003; Neighbors et al., 2007), but students tend to overestimate these norms (Larimer et al., 2004; Miller & Prentice, 2016), interventions designed to correct misperceived drinking norms have become popular strategies for reducing alcohol-related risks. One such strategy is Personalized Normative Feedback (PNF), wherein students are prompted to answer questions about their perceptions of peers' drinking, report their own drinking, and then receive an individualized report employing a combination of charts and text to highlight discrepancies between perceptions of peers' drinking, peers' actual drinking, and one's own drinking (Larimer & Cronce, 2007). Although studies have reliably found PNF interventions to be efficacious in reducing perceptions of drinking norms, typical weekly alcohol consumption, peak drinks consumed on one occasion (Berkowitz et al., 2005; Lewis & Neighbors, 2007; Miller & Prentice, 2016; NIAAA, 2019), and increasing the likelihood of continued abstinence among non-drinking students (e.g., Bernstein et al., 2018; Larimer et al., 2007; Larimer et al., 2023), the effect sizes associated with these intervention trials have been modest regardless of alcohol risk characteristics of the sample or length of follow-up period for web-based PNF, the most cost-effective and scalable modality (Dotson et al., 2014; Palfai et al., 2014; Rodriguez et al., 2015). Several issues may explain the relatively small effects observed. For example, students often question the credibility of the normative data (Hummer et al., 2016; LaBrie et al., 2010), the content fails to capture students' attention (Lewis & Neighbors, 2007), and heavy drinkers often react to the feedback defensively (Leffingwell et al., 2007; Miller & Leffingwell, 2013). These issues are not surprising as, unlike social media and digital gaming applications that capture and sustain young adults' attention, traditional PNF formats lack the sophisticated digital graphics, social interactivity, and other dynamic features to which students have become accustomed. Inspired by the digital formats and platforms popular among young people, the present study evaluates a modern gamified approach to delivering PNF on alcohol use and other topics of interest to students within a fun, social guessing game for Apple and Android smartphones called CampusGandr.

CampusGandr, a gamified app that delivers PNF to new college students

Gamification is the application of digital game mechanics, aesthetics, and thinking to engage, motivate action, and promote learning in non-game contexts (Cugelman, 2013; Kapp, 2013; Kawachi, 2017; Seaborn & Fels, 2015). Informed by Self-Determination Theory's basic human needs for relatedness, autonomy, and competence (SDT; Deci & Ryan, 2004; Ryan & Deci, 2000), popular game mechanics, including social media-inspired copresence, multiple question topics, chance-based uncertainty, and a point-based reward system are strategically leveraged in CampusGandr by camouflaging the alcohol intervention intention of PNF delivery, thereby decreasing defensiveness, while also bolstering motivation, attention, and feedback credibility.

Framed as a weekly social guessing game wherein new students can learn more about their classmates and campus life while competing for cash prizes, CampusGandr users create browsable, social media-like public profiles with usernames and avatars (see Figure 1a), and answer three perceived norm questions weekly about the behaviors and experiences of the

typical student of their same sex (e.g., How many times does the typical [INSERT UNIVERSITY NAME] guy party per week), which are accompanied by scrolling avatars representing the “typical students” as specified in the question (i.e., [INSERT UNIVERSITY NAME] males). To combat the defensiveness often experienced by students who drink in traditional alcohol-focused PNF interventions, questions about alcohol use are always presented alongside others focused on academics (i.e., How many hours does the typical [INSERT UNIVERSITY NAME] guy spend studying per week?), dorm life (i.e., How many times does the typical [INSERT UNIVERSITY NAME] guy shower per week?), relationships (What % of [INSERT UNIVERSITY NAME] guys have been in love), emotions (i.e., What % of [INSERT UNIVERSITY NAME] guys are feeling homesick), or beliefs (i.e., What % of [INSERT UNIVERSITY NAME] guys believe that aliens are real?).

After submitting each guess about the typical same-sex student, users are prompted to select points to wager on their guess being correct based on the responses of fellow same-sex users and answer the same question themselves (e.g., How many times do you party per week). The app’s social media-inspired copresence features aim to meet SDT’s needs for relatedness while also mitigating doubts about the credibility of normative data that is common in traditional PNF interventions that present actual norms derived from previously collected survey data (e.g., Borsari & Carey, 2003; Neighbors et al., 2014). That is, actual norms for alcohol use and other topics in CampusGandr are transparently derived from classmates’ answers to questions about their own behaviors and experiences (see Figure 1b-c).

At noon each Friday of the competition, the round closes, and the app’s backend calculates actual norms based on responses from all players, not just study participants. Personalized results screens are then rendered for each user, accompanied by a banner notification indicating that detailed results are ready to view. Tapping the notification opens the app to an initial screen on which an animated, slot-machine-like spinner determines the two questions from the round on which the user will receive detailed results (i.e., PNF) (see Figure 1d). Working alongside the game’s broad base of question topics, chance selection of the questions on which results are received is designed to further the game from being perceived as an alcohol intervention by users, thereby helping to satisfy SDT’s autonomy needs and reducing the psychological reactance and subsequent defensiveness experienced in the traditional alcohol intervention context by heavy drinkers (Bensley & Wu, 1991; Campo & Cameron, 2006; Jung et al., 2010; Werch et al., 2000).

Detailed results screens for the chance-selected questions follow with an initial screen for each question presenting an animated bar chart that contrasts the user’s guess (i.e., perceived norm) with the actual norm and communicates the number of points won or lost by the user based on the accuracy of their guess (see Figure 1e). A second results screen then contrasts the actual norm with the user’s own answer about their behavior, along with text communicating a fun fact related to the distribution of responses comprising the actual norm (see Figure 1f). It is important to note that the individual responses of other players are not visible within the game. Following results screens, users can toggle between viewing weekly and monthly leaderboards designed to meet SDT’s needs for competence (i.e., learning how their guessing game performance compares to others), submitting and voting on questions to be featured in future weeks of the game, and beginning the next weekly round. Each week, the game’s top scorer wins a small cash prize; each month, larger cash prizes are awarded to 1st, 2nd, and 3rd place scorers. The first weekly round of CampusGandr began in August before students arrived on campus, with 16 consecutive weekly rounds played over the fall semester.

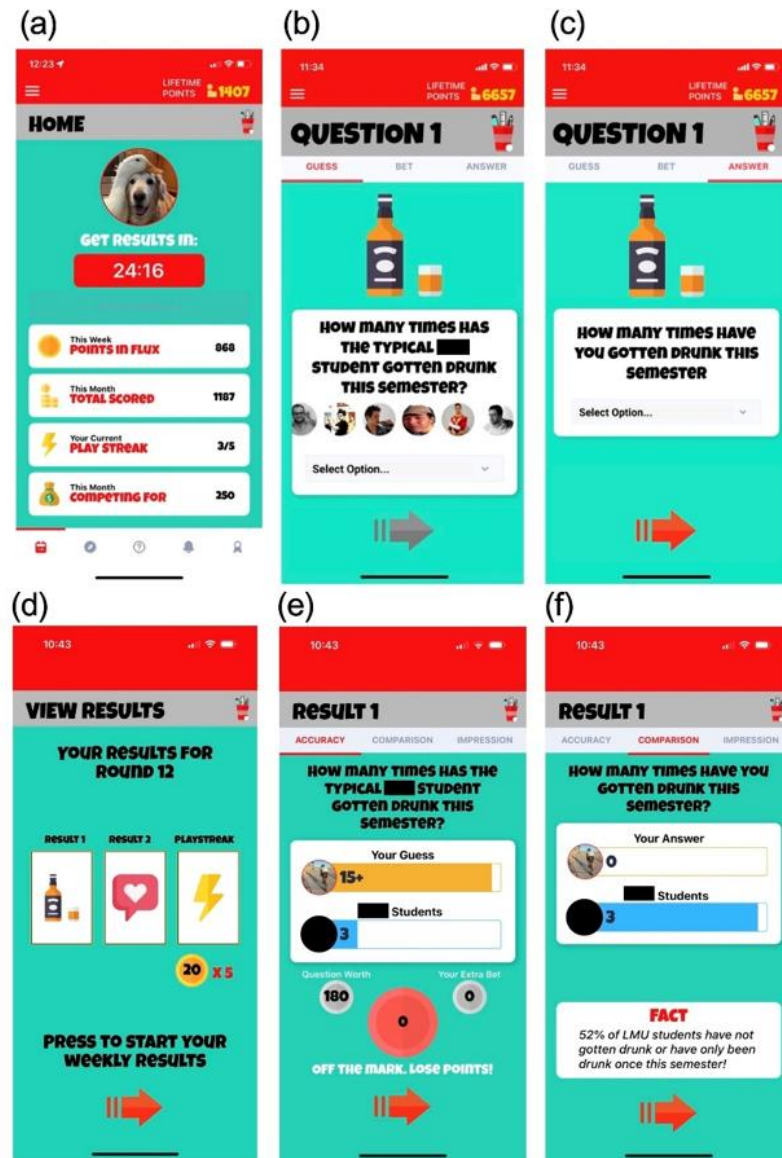


Figure 1. Screens shots from CampusGandr app: (a) the home screen of a player who completed a game round and is awaiting the results from that round/new round to begin; (b) sample alcohol question participants were asked to determine perceived norm; (c) sample alcohol questions participants were asked to determine their actual behavior; (d) a reminder screen provided before participants viewed their results from a round that showed the three categories of questions asked about during the round; (e) sample results screen for alcohol question showing the players perceived norm relative to actual norm in the game; and (f) sample results screen for alcohol question showing the players behavior relative to the actual norm in the game.

CampusGandr Pilot Findings and Unanswered Questions

Early CampusGandr pilot work demonstrated that gamified alcohol PNF, incorporating peer copresence, multiple topics, elements of chance, and a point system, was substantially more effective in reducing perceptions of peer drinking norms as well as weekly drinks, peak drinks consumed on one occasion, and heavy episodic drinking frequency than standard alcohol PNF when delivered in a single dose (Boyle et al., 2017). Subsequent studies separately manipulated the inclusion of specific game mechanics, such as multiple topics, chance-based uncertainty (Boyle et al., 2018), and social media-inspired copresence (LaBrie et al., 2019; Boyle et al., 2021) in web-based versions of CampusGandr, finding that the presence of these elements individually played roles in further reducing perceived drinking norms and alcohol consumption among moderate and heavy-drinking students. Additionally, the potential cost-effectiveness and scalability of this gamified PNF approach have been demonstrated, with nearly 60% of one first-year student cohort signing up to play in the absence of study framing or participation incentives (Earle et al., 2018). These published pilot studies provide very detailed overviews of CampusGandr's game mechanics, supporting literature, and feedback on early versions of the game from participants. However, pilots featured a low-cost web version of CampusGandr that was limited by unsophisticated graphics and deficits in backend functionality, all participants being students at a single private West Coast University, and most studies evaluating a single dose of feedback on drinking and other topics rather than delivery of both weekly over the course of a semester. As such, key questions that remain to be answered include whether CampusGandr's pilot effects can be generalized to larger and more diverse student samples, whether a polished native smartphone app would attract students outside of a paid study context, and, importantly, the number of weekly rounds in which alcohol feedback should be delivered over the course of a semester to best mitigate alcohol-related risks.

Goals of This Clinical Trial

Building on this work and in response to calls in the literature to explicitly examine changes in perceived drinking norms and alcohol outcomes in PNF intervention studies (e.g., Dempsey et al., 2018), this study employed a large and diverse sample of incoming college students attending universities in Texas and California to (1) examine the effectiveness of a fully featured CampusGandr smartphone app as an alcohol intervention strategy when advertised to students as a social game about college life free to play over their fall semester; and, (2) elucidate the optimal dosage of alcohol feedback to be delivered in the app to best reduce perceptions of drinking norms and alcohol consumption. First, using an intent-to-treat approach, we examine short and longer-term effects on alcohol use and perceptions of drinking norms associated with a CampusGandr intervention period in which student users were randomized to receive alcohol feedback in 0, 3, or 6 weeks of the game. Second, we take a closer look at the question of dosage by examining end-of-semester drinking and perceptions of norms as a function of the number of alcohol feedback results verifiably viewed by participants. Whereas a traditional alcohol intervention approach might assume that delivering alcohol feedback every week would be most protective, our pilot work (Boyle et al., 2018) and a large psychological reactance literature (e.g., Dillard et al., 2023; Jung et al., 2010; Reynolds-Tylus et al., 2022, 2024) suggest that too much feedback on alcohol relative to other topics in the game may reveal the drinking-reduction intention of the activity, eliciting reactance, and thereby undermining efficacy. As such, less frequent alcohol feedback balanced with feedback on other topics of interest to students was expected to be more efficacious in reducing perceived drinking norms, preventing alcohol

initiation, and reducing consumption than both no alcohol feedback and more frequent alcohol feedback.

Design

This study utilized a three-arm parallel-group randomized controlled trial to examine the efficacy of CampusGandr as a gamification approach to multi-dose PNF for reducing first-year college students' alcohol use. Outcomes were conceptualized in three domains: (1) descriptive norms, (2) alcohol consumption (drinks during a typical week and during one's heaviest drinking occasion), and (3) alcohol-related consequences. All assessments and interventions were implemented remotely, and participants did not interact directly with any research staff. To examine long-term effects, outcomes were measured at 4, 9, and 12 months after baseline.

Participant Recruitment

The present study's primary recruitment sites were a large, public university in Texas (TX) and a small, private college in California (CA). At the beginning of the 2022 and 2023 fall semesters, incoming students from these two universities were invited to create a CampusGandr account via emails and in-person information booths on campus. From Weeks 5 to Week 8, app users were invited to join the study as "Official Testers" and receive \$25 in gift cards for completing the baseline survey. Concurrently, students who didn't yet have accounts were invited via school email to become Official Testers by completing the baseline survey, downloading and creating a CampusGandr account, and begin playing the rounds. All recruitment materials and procedures were reviewed and approved by the universities' IRBs.

To improve participant enrollment for Fall 2023, recruitment efforts were supplemented through BuildClinical (BC), a digital platform specializing in targeted research recruitment. BuildClinical designs and deploys advertisements across a range of online channels, including search engines (e.g., Google) and social media platforms (e.g., Instagram, Snapchat, and Facebook). For this study, BC developed tailored advertisements targeting incoming first-year students at four-year public and private universities in Texas and California (to align with the study's in-person recruitment sites). Individuals who clicked on the ads were directed to a landing page and then a screening survey hosted by BC to assess eligibility. Eligible leads were then directed to our survey hosted on Qualtrics, where we obtained informed consent and administered the survey and invited them to download and play the game.

Procedure

Students were considered enrolled as participants in the study if they were (a) 18 to 20 years of age, (b) consented, (c) completed the baseline survey, (d) provided a valid U.S. phone number and an email address associated with a university in Texas or California, and (e) completed at least one round of CampusGandr prior to the delivery of the first alcohol feedback in week 9 (recruitment was completed during week 8). Enrollment lasted from the beginning of August to the end of September. All surveys for this study were completed online via Qualtrics. The game included 16 weekly rounds of synchronous play, starting the first week of August and ending the last week of November). All participants consented to participate prior to receiving access to the baseline survey. Participants were invited to complete follow-up surveys 4, 9, and 12 months later and received a \$35 e-gift card for completing the baseline survey and then a \$25 e-gift card for completing each follow-up. As a bonus, participants received \$20 in October and \$20 in November if they completed at least 3 out of 4 rounds in each of those months. All study

procedures were approved by the Loyola Marymount University Institutional Review Board (IRB), which served as the single IRB of record for this project.

In total 2,898 students consented and then took the baseline survey and/or played CampusGandr. Of those, 1,143 students were considered fully enrolled in the study, as they provided consent, completed the baseline survey, and played at least one round of CampusGandr. Participants were randomized using an automated urn strategy so that each of the three conditions were filled evenly by a gender and baseline drinking status (any, none). All PNFs were delivered remotely and automatically; therefore, participants, but not researchers, were blind to allocation. Based on condition assignment, participants could see up to 6 alcohol feedbacks (More Alcohol Feedback; MAF), up to 3 alcohol feedbacks (Less Alcohol Feedbacks; LAF) or 0 alcohol feedbacks (No Alcohol Feedback; NAF) during the weekly game. Participants were unaware of study condition, and randomization was not based on any variables. Condition assignment to the LAF and MAF conditions did not guarantee that the participants played the round (i.e., estimating their peers' answer and providing their own answer) and viewed the results (i.e., PNF). Approximately 31% ($n=130$) of participants in the MAF condition saw all 6 alcohol feedbacks and 37% ($n=137$) of participants in the LAF condition saw all 3 alcohol feedbacks. On average, participants in the MAF condition saw 3.0 alcohol feedbacks ($SD=2.6$), and participants in the LAF condition saw 1.5 alcohol feedbacks ($SD=1.3$).

Survey Measures

Descriptive Drinking Norms

Estimates of peers' drinking quantity was measured using the Drinking Norms Rating Form (Baer, 1994). Participants reported the number of standard drinks they believed that a same-gender peer consumed on each day of the week (e.g., a typical Friday, a typical Saturday) in the past 30 days. Participants were asked to think about, "a typical [*male/female/student*] at [*specific college name*]" when answering. Responses were summed across the 7 days, and the sums were truncated at 80.

Injunctive Drinking Norms

The Injunctive Norms Questionnaire (Baer, 1994) assessed participants' personal approval and perceptions of the approval of a typical same-sex first-year student at their specific university for five risky drinking behaviors including "playing drinking games," "drinking shots," "drinking to get drunk," "drinking alcohol every weekend," and "drinking under age 21." Response options ranged from 1 (*strongly disapprove*) to 7 (*strongly approve*). Internal consistency was high in $\alpha = .89$ for and responses were averaged to create a composite score.

Heaviest Drinking Occasion (Peak Drinks)

Participants were instructed to think about their drinking in the past 30 days and respond to the question, "What is the maximum number of drinks you drank during any one drinking occasion?" Values were truncated at 30.

Typical Weekly Drinking

Typical drinking was measured using the Daily Drinking Questionnaire (Collins et al., 1985). Participants were asked to report the number of standard drinks they consumed on each day (e.g., a typical Monday, Tuesday) of the week during the past 30 days. Responses were summed across the 7 days, and the sums were truncated at 80.

Alcohol-Related Problems

Problems arising from alcohol use were measured using the Brief Young Adult Alcohol Consequences Questionnaire (Kahler et al., 2005). Participants indicated (no=0, yes=1). if they

had experienced 24 negative experiences after drinking alcohol (e.g., “I have felt very sick to my stomach or thrown up after drinking”). Responses were summed, with total scores ranging from 0 to 24. Cronbach’s alphas were acceptable across the four timepoints ($\alpha=0.89-0.92$).

App Measures

Number of Game Feedbacks Viewed

Whether or not participants viewed each round of game feedback was recorded in the app’s backend. This allowed us to create variables indicative of (1) the total number of feedback viewed; and (2) the number of alcohol-specific feedback viewed.

Statistical Analysis Plan

A preliminary examination of the outcome distributions revealed that a large proportion of the sample did not drink, and the distributions of outcomes were all positively skewed. A generalized linear mixed modeling approach was used for all analyses. Given the large proportion of non-drinkers, we conducted hurdle-negative binomial mixed models to evaluate peak drinks and alcohol-related problems. Hurdle models are two-part models that independently predict zero versus non-zero counts in one part and values of non-zero counts in the other (Cameron & Trivedi, 2013; Hilbe, 2011). For peak drinks, the zero versus non-zero part of the model predicts whether individuals drank any alcohol using a logistic mixed model. The non-zero counts part of the model uses a truncated (i.e., zeros are removed, and values are subtracted by one) negative binomial mixed model to predict the number of alcoholic beverages consumed during drinkers’ heaviest occasion. Similarly, for alcohol-related problems, whether individuals experienced any alcohol-related problems or not was evaluated with a logistic mixed model, and the number of problems among those who experienced any was examined with a truncated negative binomial mixed model. Analyses examining the typical number of drinks consumed per week focused exclusively on counts, using a truncated negative binomial model; this approach avoided duplicating the logistic part of the peak drinks analysis, which would have occurred if zero versus non-zero values were compared, as this would have resulted in less precision.

Modeling Treatment. The intervention was evaluated using two strategies. The first evaluated conditions using an intent-to-treat (ITT) approach, in which outcomes were analyzed based on condition assignment, regardless of treatment participation and adherence (McCoy, 2017). Extending the short-term analyses presented in LaBrie et al. (2025), the second strategy evaluated outcomes at follow-up as a function of the number of alcohol feedbacks viewed (i.e., 0-6), which helped to eliminate the noise associated with variability in number of alcohol feedbacks viewed within LAF and MAF conditions.

Modeling Time. To test the intervention’s effects on outcomes at each follow-up, Step 1 of each model evaluated outcomes while controlling for baseline values, sex, site, and follow-up time point. Data from all enrolled participants were utilized in the analyses as modern approaches to handling missing data mostly recover power that would otherwise be lost to attrition (Enders, 2010).

Power. Assuming that the average abstinence rate would be 30% in each condition and baseline outcomes account for 25% of the variance in any drinking at follow-up, the *a priori* power analysis indicated that a sample of 1,200 would yield .89 power to detect abstinence rates as small as 5% lower than control in addition .87 to detect predicted differences among

conditions with rate ratios of 1.2 (i.e., 20% differences or higher between contrast groups). No interim analyses were conducted, nor stopping guidelines were in place.

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