Peer Groups and Broad Social Motives' Influence on College Student Drinking: A Multimethod Approach Using Alcohol Administration and Daily Diary

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Abstract

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Most commonly, college students report drinking for social facilitation, but do not report drinking equally across all social groups. Research is mixed on how composition of social groups impacts drinking behavior. Further, while much research has evaluated those who drink for social rewards, less research has focused on whether some individuals may have greater sensitivity to social rewards. Preliminary studies have found these broad social motives (BSM) to predict changes in drinking behavior over and above social drinking motives. Thus, further exploration into the circumstances in which those with BSM are more susceptible to heavy drinking is warranted. The current study aimed to fill these gaps by 1) investigating the measurement of BSM, 2) evaluating relations between BSM, peer group, and alcohol-related outcomes and 3) utilizing an innovative multimethod approach to predict natural drinking behavior from changes in risk-taking and self-administered alcohol

use in a controlled lab setting. We hypothesized those with greater BSM and those drinking with their close friends, as opposed to new peers, would drink more and experience greater risky behaviors both in the lab and during naturalistic assessments. Further, higher number of drinks consumed and larger increases in risk-taking in the lab were expected to predict greater increase in drinking behavior on days where most drinking companions are close friends, compared to new peers. Results showed when socializing with groups on days where individuals experienced higher BSM than typical, the higher number of friends present in groups the more alcohol they consumed, and they reached a higher estimated blood alcohol concentration (BAC). Yet, neither BSM nor number of friends were related to alcohol consequences. While consistent with existing literature and hypotheses, the robustness of effects is questionable. Not all aims were able to be thoroughly evaluated due to the unexpected onset of the COVID-19 pandemic during study recruitment.

Contents

Chapter 1: Introduction

Background and Importance of the Problem

College is a high-risk period for heavy alcohol use and developing alcohol use disorders (AUD, Adams, Milich, Lynam, & Charnigo, 2013; Corbin, Iwamoto, & Fromme, 2011). Among college students, 65% report being drunk in their life and 24% report heavy episodic drinking (5+ drinks in a row) in the past two weeks (Schulenburg et al., 2021). Students who use alcohol in an unhealthy way experience detrimental consequences (Hultgren, Canning, & Larimer, 2018); 30% of college freshmen report academic problems due to drinking (Baer, Stacy, & Larimer, 1991), 10-16% of students drive after drinking (Association, 2017; Baer et al., 1991; Hingson et al., 2017) and 28%-54% experience blackouts (Association, 2017; Barnett et al., 2014) each year. Prevalence rates of alcohol use among college students declined significantly from 2019 to 2020, likely due to changes in social environments during the COVID-19 pandemic (White et al., 2020). Reports of being drunk in the past month decreased from 35% in 2019 to 28% in 2020 after remaining relatively stable for the prior 5 years, and binge drinking decreased from 32% to an all-time low of 24% (Schulenburg et al., 2021). However, similar drops during the pandemic were not seen amongst young adults not in college (Schulenburg et al., 2021), highlighting the unique impact of the college social environment on alcohol use, which was disrupted due to school and dorm closures (White et al., 2020; Jaffe et al., 2021; Hultgren et al., 2022). Among college students, alcohol is most commonly consumed in social settings and is used for social facilitation (Cooper et al., 2016; O'Hara et al., 2015). However, students do not report drinking the same amount in all social contexts; many students reported reducing their drinking because they were consuming fewer drinks with their family during the pandemic compared to drinking with friends before lockdowns (Jackson et al., 2021). The composition of peer groups (close friends vs. other peers) may differentially activate individual

differences in broad social motives (BSM), or sensitivity to social rewards, which interact to create a specific context that facilitates heavier drinking among students.

Risk-Taking and Alcohol Use

Alcohol use is a common risk-taking behavior where individuals seek the pleasurable effects of alcohol despite the potential for negative consequences. Behavioral economic models of alcohol use posit individuals balance the costs with the potential benefits of drinking when making alcohol-related decisions (Hursh & Roma, 2016; Moore & Gullone, 1996). Adolescents who perceive greater benefits independent of perceived costs from using substances are more likely to engage in substance use (Fromme, Katz, & Rivet, 1997). Willingness to pay more for alcohol, as measured by alcohol demand tasks, is associated with more weekly alcohol use and alcohol-related problems (Murphy, MacKillop, Skidmore, & Pederson, 2009), heavy drinking (Murphy & MacKillop, 2006), and greater risk for alcohol use disorder (Gray & MacKillop, 2014). Further, alcohol myopia theory (Steele & Josephs, 1990) describes how individuals attend to more salient activating cues rather than inhibitory cues under the influence of alcohol. This accounts for increases in risky behavior after drinking such as risky sex, driving under the influence, aggressive behavior, and suicide (see Giancola et al., 2010 for review). Thus, one's propensity for risk-taking both sober and under the influence of alcohol is crucial to understanding alcohol use and negative alcohol consequences.

One measure of risk-taking propensity, the Balloon Analogue Risk Task (BART; Lejuez et al., 2002), has grown in popularity within alcohol research over the past two decades. The task is designed to capture positively reinforced risk-taking where the likelihood of experiencing costs increases as risky behavior increases (Lejuez et al., 2002). The BART has been validated by associating it with several real-world risk-taking behaviors such as alcohol use (Weafer, Milich, &

Fillmore, 2011), substance use (Biernacki, McLennan, Terrett, Labuschagne, & Rendell, 2016; Lejuez et al., 2002), gambling (Mishra, Lalumière, & Williams, 2017), and risky sexual behavior (Bornovalova, Gwadz, Kahler, Aklin, & Lejuez, 2008). However, research on how the BART is associated with alcohol use and negative consequences has been mixed. A recent systematic review of the literature suggests the relation between risk-taking propensity on the BART clearly depends on several moderators (Canning et al., 2022). Whether the BART predicts drinking has been found to depend on individual demographics (Corbin, Scott, Boyd, Menary, & Enders, 2015), context (Erskine-Shaw, Monk, Qureshi, & Heim, 2017), personality (Hamilton, Felton, Risco, Lejuez, & MacPherson, 2014), and mental health (Weafer et al., 2011). Research is needed to explore the moderators that explain when and for whom risk-taking propensity is associated with greater alcohol use and consequences.

Risk Shift and Alcohol Use in Peer Groups

Risk shift (Stoner, 1961) is the phenomenon in which individuals engage in risky behavior more frequently in peer groups than when alone. The concept of risk shift is supported by Social Action Theory (Ewart, 1991) which posits risk and protective behaviors are impacted by social context affecting mood states and activating different motives and skills of the individual. Effects of risk shift have been shown in risky driving (Centifanti, Modecki, MacLellan, & Gowling, 2016), perceptions of risky situations (Knoll, Magis-Weinberg, Speekenbrink, & Blakemore, 2015), and drinking (Varela & Pritchard, 2011). Many studies suggest adolescents, young adults, and adults engage in riskier decisions within groups (Erskine-Shaw et al., 2017; Gardner & Steinberg, 2005; Haddad, Harrison, Norman, & Lau, 2014; Reniers et al., 2017). Further, the BART has been used to demonstrate risk-shift between individual and peer groups in several studies (Cavalca et al., 2013; Erskine-Shaw et al., 2017; MacLean, Geier, Henry, & Wilson, 2014; Ronay & Kim, 2006). Risk shift

may explain why individuals are more likely to drink and drink more heavily when they are with peers than when they are alone. However, examinations of risk-shift specific to drinking have been mixed. College students report heavier drinking when with a friend than when alone (Varela & Pritchard, 2011). Using daily diaries, students reported drinking more when they were with a larger number of peers (Cullum, O'Grady, Armeli, & Tennen, 2012). However, looking at experimental alcohol administration, where participants are asked to drink in a simulated bar or lab setting, has been inconsistent with self-reported drinking. Specifically, ad-lib administration allows participants to self-administer as many drinks as they want, consistent with ordering drinks at a bar or restaurant, allows us to evaluate how much individuals choose to drink in different contexts. When participants were asked to drink with their friends in an ad lib study, the presence of a best friend did not increase drinking, however, in this study all peers were considered friends (Overbeek et al., 2011). Another study found social context did not predict number of drinks consumed when controlling alcohol expectancies (Fromme & Dunn, 1992).

Discrepancies in risk shift findings may be due to differences in peer groups. Social Action Theory suggests the types of social interactions and their effects on risk behavior may differ depending on the social relationship. This is supported by studies that show students drink more with friends compared to family or their partner (Varela & Pritchard, 2011). Consistent with this, students who moved out of their dorms and returned home to family during the pandemic were more likely to reduce their drinking during COVID lockdowns (Jaffe et al., 2021). Research has shown proximal peer groups (e.g. close friends) are better predictors of drinking than general same-aged peers (Morgan & Grube, 1991; Stappenbeck, Quinn, Wetherill, & Fromme, 2010; Urberg, Degirmencioglu, & Pilgrim, 1997), and close friend binge drinking prospectively predicted drinking over and above a random peer's drinking (Jaccard, Blanton, & Dodge, 2005). This may also be the case in experimental

designs that use unfamiliar peer groups created in labs. The complex nature and mixed findings of risk shift support utilizing multiple research methods to compare controlled and natural drinking events, allowing for a more nuanced understanding of risk-shift in college students. Thus, experimental research assessing risk-shift with types of peer groups (close friends vs new peers) is needed. One mechanism of risk-shift is an increased preference for immediate rewards (Chein, Albert, O'Brien, Uckert, & Steinberg, 2011; O'Brien, Albert, Chein, & Steinberg, 2011; Reniers et al., 2017).

Broad Social Motives and Alcohol Use in College

According to Social Action Theory (Ewart, 1991), in the context of different peers, individuals will experience activation of positive mood to varying degrees, which may influence individual differences in the amount of Risk Shift produced. Reward sensitivity is the degree to which individuals' behavior is motivated by their reaction and pursuit of positive stimuli. General reward sensitivity is presumed to be associated with sensitivity to the stimulating effects of alcohol (Hurlbut & Sher, 1992), however, meta-analyses have found weaker effects of reward sensitivity compared to other personality traits (Stautz & Cooper, 2013). This may be due to lack of specificity in measures of reward sensitivity, as not all types of rewarding stimuli, such as food, put individuals at risk for heavy alcohol use (Stautz & Cooper, 2013). Broad Social Motives (BSM) is the sensitivity to social rewards specifically, where individuals are highly motivated by prosocial interaction across various relationships. BSM may be distinct from sensitivity to other types of rewards; for example, one fMRI study found a social reward task elicited additional activation in the medial pre-frontal cortex, which was not found during a monetary reward task (Izuma, Saito, & Sadato, 2008). Despite differences in reward responses to social stimuli compared to other rewards, evaluations of BSM and how this influences alcohol use are lacking. Several social constructs conceptually related to BSM have been

linked to alcohol use. Students who spend more time socializing engaged in more heavy episodic drinking (Wechsler, Dowdall, Davenport, & Castillo, 1995). Adolescents who endorse interpersonal relationships as an important goal are more likely to express intentions to drink, regardless of status in heavy drinking peer groups (i.e., fraternities and sororities; Rhoades & Maggs, 2006). BSM appears to be distinct from other social and reward sensitivity constructs. BSM is distinguished from extraversion because extraversion measures sociability (McCrae & Costa, 1987) as opposed to the motivation to be involved socially (Roberts, O'Donnell, & Robins, 2004). Considering differences in social contexts that occur daily, assessing how BSM may vary across time and context and how this variation relates to alcohol use is essential. The limited research on BSM shows it predicts alcohol consequences (e.g., withdrawal symptoms, missing work/school) in both high school and college students (Vaughan, Corbin, & Fromme, 2009), and predicts changes in use over time (Canning et al., 2016; Corbin et al., 2011). Consistent with Social Action Theory and empirical support of effects of proximal peer groups, familiar friends may produce more positive emotional rewarding effects of alcohol use, and thus promote the use of more alcohol. Thus, BSM may also vary across several relationship types.

Despite the presumed higher positive emotional rewards of close friends and likely greater activation of BSM, it is possible individuals with social anxiety may drink more when fearing negative evaluation (e.g. from new peers) for stress reducing effects of alcohol (Stewart, Morris, Mellings, & Komar, 2006). Alcohol use disorder is highly comorbid with anxiety (Morris, Stewart, & Ham, 2005) and in a study of undergraduates, those classified as problem drinkers scored higher on social anxiety (Lewis & O'Neill, 2000). However, research has suggested social anxiety is associated with frequency of use, not quantity or alcohol-related consequences (Stewart et al., 2006). This is consistent with research related to risk-taking propensity suggesting individuals with greater alcohol

use and consequences may be less sensitive to potential negative consequences on the BART (Ashenhurst, Jentsch, & Ray, 2011; Claus & Hutchison, 2012; Holmes et al., 2009; Sehrig, Weiss, Miller, & Rockstroh, 2019). Therefore, while social anxiety may affect drinking, it is unlikely to strongly affect the amount of alcohol consumed, our primary outcome. Nonetheless, it is important to control for anxiety when considering the impact of BSM on drinking.

The Present Study

The present study aimed to address several gaps in current literature by using a novel multimethod approach. Specifically, this study was designed to investigate 1) whether different types of peer groups impact risk-taking propensity and behavior differently, 2) who is most sensitive to increases in risk-taking behavior in groups, and 3) whether increases in risk-taking behavior induced experimentally can predict changes in risk-taking behavior in naturalistic settings. Expanding on previous risk-taking research, this study investigated the interaction between college students' social motivations and different peer groups to impact alcohol use. Further, the study was designed to evaluate whether changes in risk-taking propensity on the BART after entering peer groups and alcohol use in the lab would predict daily alcohol use and consequences in natural peer groups. Risk-taking during natural drinking events was assessed by evaluating real-world alcohol consequences using daily diaries. By evaluating behavior both in a controlled lab setting (through ad lib alcohol administration) and in naturally occurring settings (utilizing daily diaries) with the same sample, this study aimed to support the validity and robustness of findings by converging on results with both methods. Figure 1 shows the theoretical conceptual model investigated across a series of 3 studies.

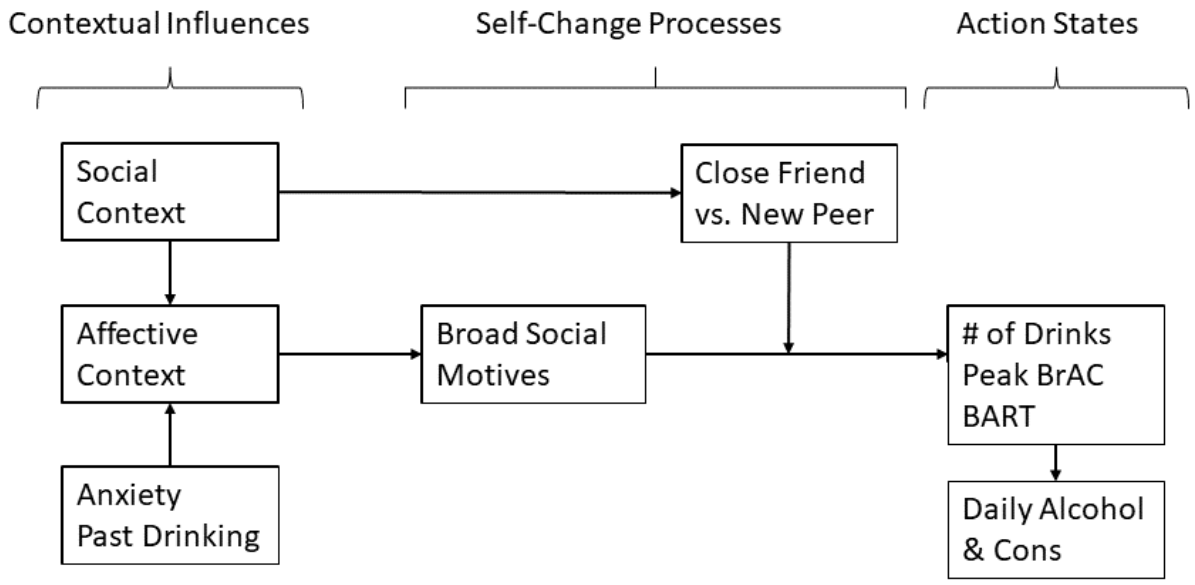

Figure 1: Conceptual model based on Social Action

Study Aims

To address identified gaps in the literature regarding the role of BSM and peer group composition in alcohol-related risk shift, the current study had 3 primary aims:

Aim 1. Investigate the measurement of BSM. Given the limited assessment of reward sensitivity specific to social rewards, existing measures of BSM are limited and those that do exist do not evaluate BSM for different peer groups. Thus, a new measure of BSM was created for the purposes of this study (See Appendix B) and reliability and validity of the measure was evaluated. Hypotheses: The factor structure of BSM will be consistent with separate factors for each type of relationship. BSM will be related but distinguished from other similar constructs (e.g., extraversion, self-monitoring, and general reward sensitivity). BSM for friends will be most strongly related to alcohol use and consequences compared to other relationship types.

Aim 2. Examine relations between BSM factors, peer group and alcohol-related outcomes. I assessed how individuals with varying levels of BSM differed in response to peer group type (e.g., close friends, new peers, family) influences on drinking and risk-taking using an experimental ad-lib drinking design and daily diary assessments on four consecutive weekends. Hypotheses: those with greater baseline BSM were expected to drink more during ad-lib and have larger increases in BART scores than those lower in BSM. Further, those drinking with their close friends, as opposed to new peers, were expected to drink more and have greater increases in BART scores. Finally, consistent with an interaction effect, those higher in BSM were expected to experience greater risk shift in close friend groups (compared to new peer groups) than those lower in BSM.

Aim 3. Predict drinking during natural observation from behavior observed in lab context. Observations of drinking and risk-taking in the lab were proposed to be used as time-invariant, person-level predictors of drinking assessed by daily diary. Hypotheses: Those who drank more drinking during ad-lib and had larger increases in BART scores in lab were expected to show greater increases in drinking on days where most drinking companions were close friends, compared to new peers. Larger increases in BART scores were expected to predict greater increases in drinking on days with higher BSM.

Chapter 2: Study 1

Measurement of Broad Social Motives

Methods

Participants and Procedures

Participants (N = 473) were recruited through the University of Washington Psychology Research Pool of students enrolled in Psych 101 and Psych 202. Participants were between the ages of 18 – 34 years old, and identified as 62.9% female, 0.06% Hispanic/Latinx ethnicity, 59.8% Asian, 34.5% White, 0.02% Black/African American, and 0.04% race not listed. Students were asked to complete two surveys approximately 4 weeks apart and surveys were active for 1 week each. Retention across the 4 weeks was poor with 54% of participants completing the second survey. Thus, only time 1 is used for analyses. Participants were emailed an anonymous link to the survey in Qualtrics and completed them on their computer or phone. Surveys were linked via a unique identifier created by students of their initials and the last 3 digits of their phone number. Additionally, a backup security question, "what is your favorite movie", was used to help identify surveys without matching unique IDs. Each survey took approximately 30 minutes to complete, and students were compensated with one extra credit hour per survey completed.

Measures

Demographics. Participants reported on several demographics including age, height, weight, sex assigned at birth, gender, race, ethnicity, household income, parental education, academic standing, and GPA.

Broad Social Motives. A new measure of broad social motives was developed for use in this project, which proposes sensitivity to social rewards should be assessed by relationship type. See Appendix B for all items. The measure was designed by adapting reward sensitivity and Social Goals

(Maggs, 1997) measures to specific social situations and assesses five relationships: Co-workers (8 items), school peers (9 items), close friends (10 items), strangers (8 items), and family (9 items). Response options ranged from 0 = "strongly disagree" to 4 = "strongly agree". Example items include: "If _____ was feeling down, it would be important for me to make them feel better" and "I cherish the moments I say or do something to make _____ smile", as well as some relationship specific questions (e.g., "I prefer to work with a team rather than alone").

Social Reward Questionnaire. The SRQ (Foulkes et al., 2014) is a 23-item measure and similar to BSM, captures the degree of value placed on social rewards. It captures 6 different domains of social rewards: admiration (4 items), negative social potency (5 items), passivity (3 items), prosocial interactions (5 items), sexual relationships (3 items), and sociability (3 items). Participants are asked to rate how strongly they agree with each statement as it applies to all of their social relationships (e.g., friends, co-workers, family etc.) and response options range from 0 = "strongly disagree" to 6 = "strongly agree". Mean scores of each factor were created and the admiration, prosocial interactions, and sociability factors are used to compare to BSM.

Reward Responsiveness. The Behavioral Inhibition System/Behavioral Activation measure (BIS/BAS; Carver & White, 1994) captures sensitivity to behavioral inhibition, fun seeking, drive, and reward responsiveness. The 5-item reward responsiveness subscale was used as a measure of general reward sensitivity. Example items include "when I get something I want, I feel excited and energized" and "when good things happen to me, it affects me strongly". Items are rated on a 4-point Likert scale ranging from 1 = strongly disagree to 4 = strongly agree, with no neutral response. A mean score of all 5 items was used.

Extraversion. The Big Five Inventory (BFI; John et al., 1991) was used to assess sociability with the extraversion subscale. The BFI asks participants to rate whether they see describe themselves

based on a list of trait adjectives. Extraversion is captured with 8 items on a 5-point Likert scale ranging from 1 = disagree strongly to 5 = agree strongly. Example items include “talkative” and reverse coded “reserved”. A mean score of all 8 items was used for analyses.

Self-Monitoring. The Self-Monitoring Scale (Lennox & Wolfe, 1984) was used to determine if BSM simply captured socially desirable responses. Self-monitoring is situational awareness of one’s behaviors and other’s reactions, which is motivated by a desire to be perceived as socially appropriate. The Self-Monitoring Scale captures two subscales: Ability to modify self-presentation is captured by 7 items (e.g., When I feel that the image I am portraying isn’t working, I can readily change it to something that does.) and Sensitivity to the expressive behavior of others is captured by 6 items (e.g., I can usually tell when I’ve said something inappropriate by reading it in the listener’s eyes). Items are rated on a 6-point Likert scale ranging from 0 = almost certainly false to 5 = certainly always true. Mean scores for each subscale were created.

Alcohol Consequences. The Young Adult Alcohol Problem Screening Test (YAAPST; Hurlbut & Sher, 1992) is 27 items measuring frequency of experiencing negative alcohol consequences typically reported by young adults over the past year. Participants will report on consequences at baseline assessments. All items have the response options 0 = “No, never” and 1 = “Yes, but not in the past year” and past year response options vary by item. The first eight items are consequences that may occur regularly such as “Have you ever driven a car when you knew you had too much to drink to drive safely?”. Past year response options ranged from 2 = “1 time” to 9 = “40 or more times”. The next twelve questions represent consequences that may not happen every time the participant drinks such as “Have you ever received a lower grade on an exam or paper than you should have because of your drinking?”. Past year response options range from 2 = “1 time” to 4 = “3 or more times”. Finally, the last seven items are rarely occurring consequences related to stopping or

cutting down such as “Have you ever gone to anyone for help to control your drinking?”. Past year response options were only 2 = “ Yes, in the past year”. A sum score of the past year response options (excluding 0s and 1s) create a consequence severity score.

Alcohol Use Disorders Identification Test. AUDIT (Reinert & Allen, 2002) is a 10 item questionnaire assessing drinking and negative consequences experienced from drinking. The first three items represent consumption of alcohol assessing 1) the typical frequency of alcohol use ranging from “never” or “daily or almost daily” 2) the typical quantity of alcohol use ranging from “1 or 2” to “10 or more” and 3) the frequency of heavy drinking defined as 6 or more drinks on one occasion ranging from “never” to “daily or almost daily”. The remaining seven items assess negative consequences such as inability to control drinking and blackouts. Response options range depending on the question and are either from “never” to “daily or almost daily” or from “no, never”, “yes, but not in the past year” to “yes, during the past year”. Scores for each question range from 0 to 4 with higher scores representing more risk for alcohol use disorders. A quantity*frequency measure was created to indicate alcohol use and the sum score of all 10 items was used to measure overall risk for AUD.

Analytic Plan

Parallel analysis was conducted to determine the proposed number of factors given the data. Exploratory factor analyses (EFA) were used to investigate the factor structure of BSM based on parallel analyses and the five relationship types. Oblimin rotation was used to allow correlations between latent factors. Global fit was assessed by χ^2 test of model fit, RMSR, RMSEA, and TLI. Additionally, EFA fit was evaluated for standardized loadings > .30 and by observing overall patterns. To evaluate convergent and discriminant validity, the final scale was correlated with the

SRQ, extraversion from the BFI, general reward sensitivity, and self-monitoring. Additionally, correlations among alcohol outcomes and BSM factors were examined.

Results

Aim 1: BSM Measurement

EFAs were run for 6-, 5-, 4-factor models of BSM. Parallel analysis suggested a 6-factor model of BSM. Scree plot is displayed in Figure 2.

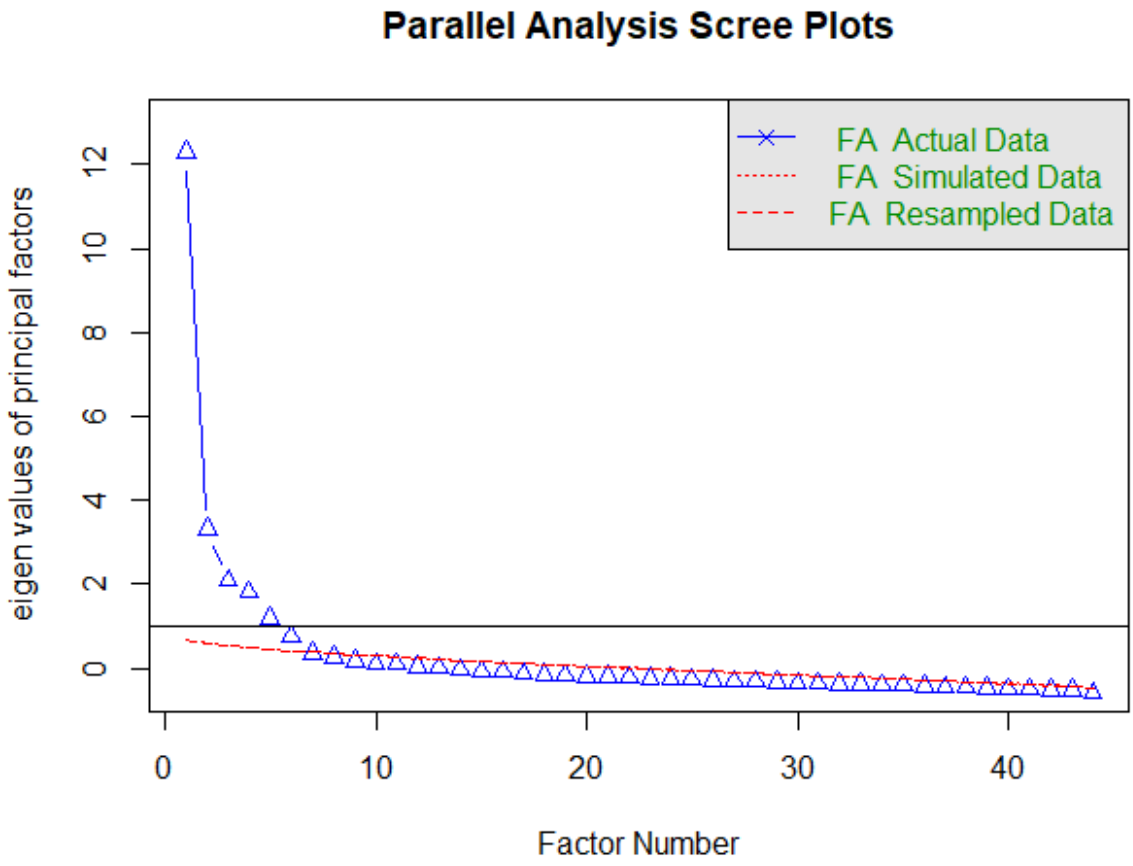

Figure 2. Parallel analysis for full 44 item BSM scale.

Based on parallel analysis, a 6-factor model would be best, however, based on eigenvalues greater than 1 only 5-factors were indicated. A 6-factor model was run first and was largely consistent with factors by relationship type. Factor loadings are reported in Table 1. However, upon inspecting the item loadings, several close friend items, were cross-loading onto multiple factors and the 6th factor did not have any strongly loading items. Only 1 item loaded onto factor 6 more strongly than other factors. With a standardized loading of 0.43, "If I were to settle down, I would miss the excitement of my social life" appeared to be driving this 6th factor. Thus, a 6-factor model appeared to be overfitting the data and analyses proceeded with a 5-factor model. Next a 5-factor model was considered. Item loadings are reported in Table 2 Evaluation of factor loadings revealed the coworkers, strangers, and friends loaded onto their own factors. However, friends and school peers appeared to be largely loading onto factor 1 with some items from both sub scales loading onto factor 3, many of which were cross-loaded items. Interestingly, one item from the coworkers subscale, "I cherish the moments when I say or do something to make my coworkers smile", and one item from the stranger subscale, "If I moved it would be important for me to create new social bonds", also cross-loaded onto factor 3. Based on the number of cross-loading items from factor 1 and 3, it was concluded that school peers and close friends may be too similar as social groups among college students.

Finally, a 4-factor model was run, after dropping the school peers items. None of the other cross-loading items were removed to limit changes to the scale based on exploratory analyses. Item loadings are displayed in Table 2. Standardized factor loadings were consistent with a 4-factor structure based on different relationship types. One exception, "If I moved it would be important for me to create new social bonds", cross-loaded onto both the stranger and close friends subscales. Conceptually, this makes sense given at face value the question asks about motivation to turn

strangers into close friends. Thus, this item is likely to perform poorly because it captures both a motivation to engage with strangers but also motivation to have close personal bonds locally. Thus, a 4-factor model was determined to fit best both conceptually and based on item loadings, however, model fit and cross-loading or modestly loading items suggest the need for further evaluation and refinement of the measure in future studies.

Table 1.

BSM Scale loadings > .30 from exploratory factor analyses

	Six-Factors					
Item	F1(1)	F2(4)	F3(5)	F4(3)	F5(2)	F6(6)
School Peers						
BSM 1	0.59	-	-	-	-	-
BSM 2	0.69	-	-	-	-	-
BSM 3	0.67	-	-	-	-	-
BSM 4	0.55	-	-	-	-	-
BSM 5	0.59	-	-	-	-	-
BSM 6	0.69	-	-	-	-	-
BSM 7	0.40	-	-	-	-	-0.33
BSM 8	-	-	0.41	-	-	-
BSM 9	0.50	-	-	-	-	-
Coworkers						
BSM 10	-	0.69	-	-	-	-
BSM 11	-	0.31	-	-	-	-
BSM 12	-	0.74	-	-	-	-
BSM 13	-	0.54	-	-	-	-
BSM 14	-	0.63	-	-	-	-
BSM 15	-	0.72	-	-	-	-0.30
BSM 16	-	0.68	-	-	-	-
BSM 17	-	0.65	-	-	-	-
Close Friends						
BSM 18	0.30	-	0.43	-	-	-
BSM 19	-	-	0.55	-	-	-
BSM 20	-	-	0.64	-	-	-
BSM 21	-	-	-	-	-	0.43
BSM 22	-	-	0.67	-	-	-

BSM 23	-	-	0.75	-	-	-
BSM 24	-	-	0.54	-	-	0.35
BSM 25	-	-	0.39	-	-	0.30
BSM 26	-	-	0.41	-	-	-
BSM 27	0.33	-	-	-	-	0.32
Strangers						
BSM 28	-	-	-	0.76	-	-
BSM 29	-	-	-	0.64	-	-
BSM 30	-	-	-	0.75	-	-
BSM 31	-	-	-	0.72	-	-
BSM 32	-	-	-	0.71	-	-
BSM 33	-	-	-	0.78	-	-
BSM 34	-	-	0.38	0.40	-	-
BSM 35	-	-	-	0.59	-	-
Family						
BSM 36	-	-	-	-	0.77	-
BSM 37	-	-	-	-	0.78	-
BSM 38	-	-	-	-	0.63	-
BSM 39	-	-	-	-	0.78	-
BSM 40	-	-	-	-	0.79	-
BSM 41	-	-	-	-	0.65	-
BSM 42	-	-	-	-	0.72	-
BSM 43	-	-	-	-	0.88	-
BSM 44	-	-	-	-	0.75	-

Factor Correlations

	F1(1)	F2(4)	F3(5)	F4(3)	F5(2)	F6(6)
F1	1.00					
F2	0.36	1.00				
F3	0.46	0.28	1.00			
F4	0.53	0.39	0.26	1.00		
F5	0.33	0.26	0.31	0.27	1.00	
F6	0.20	-0.03	-0.06	0.07	0.01	1.00

Table 2.

BSM Scale loadings > .30 from exploratory factor analyses

	Five-Factors					**Four-Factors**			
Item	F1	F2	F3	F4	F5	F1	F2	F3	F4

School Peers									
BSM 1	0.43	-	-	-	-	-	-	-	-
BSM 2	0.57	-	-	-	-	-	-	-	-
BSM 3	0.43	-	-	-	-	-	-	-	-
BSM 4	0.37	-	-	-	-	-	-	-	-
BSM 5	0.51	-	-	-	-	-	-	-	-
BSM 6	0.53	-	-	-	-	-	-	-	-
BSM 7	-	-	-	-	-	-	-	-	-
BSM 8	0.34	-	0.37	-	-	-	-	-	-
BSM 9	0.48	-	-	-	-	-	-	-	-
Coworkers									
BSM 10	-	0.69	-	-	-	0.70	-	-	-
BSM 11	-	0.32	-	-	-	0.32	-	-	-
BSM 12	-	0.73	-	-	-	0.72	-	-	-
BSM 13	-	0.55	-	-	-	0.56	-	-	-
BSM 14	-	0.62	-	-	-	0.62	-	-	-
BSM 15	-	0.75	-	-	-	0.76	-	-	-
BSM 16	-	0.68	-	-	-	0.70	-	-	-
BSM 17	-	0.67	0.31	-	-	0.70	-	-	-
Close Friends									
BSM 18	0.62	-	-	-	-	-	0.65	-	-
BSM 19	0.54	-	0.30	-	-	-	0.69	-	-
BSM 20	-	-	0.64	-	-	-	0.60	-	-
BSM 21	0.59	-	-	-	-	-	0.43	-	-
BSM 22	0.44	-	0.50	-	-	-	0.78	-	-
BSM 23	-	-	0.69	-	-	-	0.71	-	-
BSM 24	0.54	-	-	-	-	-	0.66	-	-
BSM 25	0.38	-	-	-	-	-	0.48	-	-
BSM 26	-	-	-	-	-	-	0.40	-	-
BSM 27	0.59	-	-	-	-	-	0.42	-	-
Strangers									
BSM 28	-	-	-	0.75	-	-	-	0.76	-
BSM 29	-	-	-	0.62	-	-	-	0.71	-
BSM 30	-	-	-	0.74	-	-	-	0.71	-
BSM 31	-	-	-	0.72	-	-	-	0.75	-
BSM 32	-	-	-	0.72	-	-	-	0.66	-
BSM 33	-	-	-	0.78	-	-	-	0.75	-
BSM 34	-	-	0.34	0.43	-	-	0.47	0.37	-
BSM 35	-	-	-	0.61	-	-	-	0.48	-
Family									

BSM 36	-	-	-	-	0.78	-	-	-	0.78
BSM 37	-	-	-	-	0.78	-	-	-	0.79
BSM 38	-	-	-	-	0.63	-	-	-	0.63
BSM 39	-	-	-	-	0.78	-	-	-	0.78
BSM 40	-	-	-	-	0.79	-	-	-	0.78
BSM 41	-	-	-	-	0.66	-	-	-	0.66
BSM 42	-	-	-	-	0.74	-	-	-	0.73
BSM 43	-	-	-	-	0.88	-	-	-	0.88
BSM 44	-	-	-	-	0.75	-	-	-	0.75
Factor Correlations									
	F1	F2	F3	F4	F5	F1	F2	F3	F4
F1	1.00					1.00			
F2	0.29	1.00				0.40	1.00		
F3	0.22	0.22	1.00			0.40	0.37	1.00	
F4	0.43	0.40	0.15	1.00		0.30	0.39	0.26	1.00
F5	0.31	0.27	0.23	0.28	1.00	-	-	-	-

All subscales of BSM were related but distinct from general reward sensitivity (r = 0.29 – 0.44), extraversion (r = 0.22 – 0.53) and self-monitoring (r = 0.09 – 0.29). BSM factors were also related but distinct from SRQ (r = 0.14 – 0.39), with BSM for friends having the strongest association. However, it is unclear whether these modest correlations are due to BSM measuring a distinct construct or the SRQ averaging across all relationship types. BSM for friends are most strongly related to alcohol use (r = 0.29) and consequences (r = 0.18) compared to other BSM subscales.

Chapter 3: Study 2

Multimethod Study of Alcohol Administration and Daily Diaries

Methods

Participants

Students (N=13) enrolled in university between 21-24 years old were recruited. See figure 3 for recruitment details throughout stages of screening. Primary participants were randomized to either drink with close friends (N = 8; Friends N = 16), or new peers (N = 5). Proposed analyses focused on primary participants due to the imbalanced nature of the groups, with only one condition having truly nested data. Participants were on average 21.46 (SD = 0.78) y.o. and identified as 69% female, 100% cis-gender, 7.7% Hispanic/Latinx, 77% White, 15.4% Asian, and 7.7% mixed race. Notably, due to the small sample size, 1 participant represents 7.7% of the sample. Frequencies of reported demographics by condition and for the total sample are reported in Table 3 in the results section. Eligible participants reported consuming at least 3 drinks in one sitting within the last month and a drinking frequency of at least once per week. Participants were excluded and received a clinical call to recommend local mental health resources if they met criteria for past-month alcohol or other substance dependence, past-month mood or anxiety disorders, suicidal ideation, or alcohol consumption at lethal doses (BAC >.30%). All clinical calls informed the participants of their risk and then provided a list of local resources for mental health. Three clinical call attempts were made before emailing participants the resource list without a verbal discussion provided. Participants reporting suicidal ideation also completed a telephone assessment for imminent risk and were provided with the National Suicide Hotline number and other clinical steps as necessary to protect their safety. Participants were also excluded, but did not receive follow-up clinical calls, for serious medical

conditions including diabetes, liver disease, history of high blood pressure, history of heart attack or stroke, or any other serious medical condition which may be worsened by drinking alcohol. Additionally, participants were excluded without follow-up for regular use of prescription psychotropic or pain medication, history of negative reactions to alcohol, history of abstinence-oriented treatment for alcohol use, or pregnancy or nursing. These inclusion and exclusion criteria are consistent with other alcohol administration protocols (Leeman et al., 2013; Morean, Corbin, & Treat, 2013; Sayette et al., 2012) to ensure safety of participants. Participants recruited after March 2020 were excluded if they were not fully vaccinated against COVID. See Figure 3 below for a participant flow diagram.

Recruitment and Screening

Participants were recruited through direct outreach to students 21-24 years old obtained via the UW Registrar's directory list, as well as community flyers distributed at colleges in the local area, online advertisements, and word of mouth. Similar recruitment procedures conducted by faculty at UW have been successful in the past (Gullo & Dawe, 2008; Kaysen et al., 2010; Zimmerman, Darnell, Rhew, Lee, & Kaysen, 2015). Figure 3 shows participant flow. Participants completed a brief screener online which took approximately 15-20 minutes and were entered into a monthly drawing for a $100 Amazon gift card for completion. If not excluded by the brief screener, participants were redirected to complete a modified version of the AUDADIS (Grant et al., 2003) online and were paid $10 for this survey regardless of eligibility. Ineligible participants at risk for mental health disorders received a clinical call within 48 hours of completing the screener. Clinical calls were conducted by Jessica Canning, a clinical psychology trainee, under the supervision of Dr. Mary Larimer.

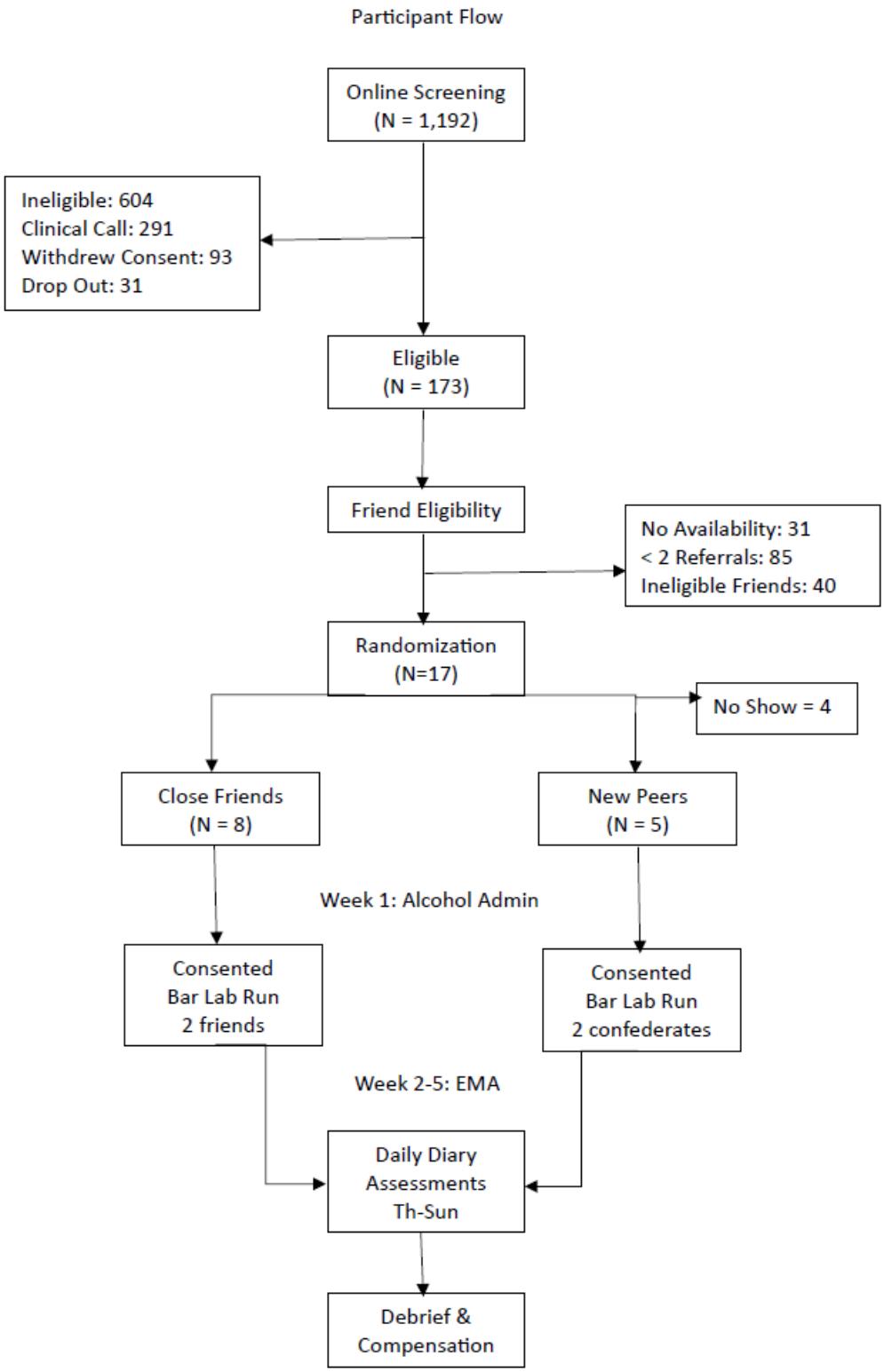

Figure 3: Participant flow and screening data

Stratified random sampling was used to assign individuals to one of two conditions. Stratification criteria were sex assigned at birth (M or F), age (21-22 or 23-24), and past 30-day typical number of drinks consumed (< 5, 5-9, or 10+). For each pair of matching strata, a random number generator determined the assigned condition. The experimental conditions were 1) close friends, where participants drank with two of their close friends, or 2) new peers, where participants drank with two undergraduate confederates (i.e., research assistants). For each pair of participants matched on the three strata (age, sex, alcohol use), confederate drinkers in the new peer group were matched to the sex of the close friends for the other group. For example, of two participants who are female, 21, and drink less than 5 drinks typically, one would be asked to nominate friends. After the friends had been determined to be eligible, if her friends include one male and one female, the confederate peers for the second participant would be one male and one female. Confederates were not matched for other group demographics. See Figure 4 for stratification structure.

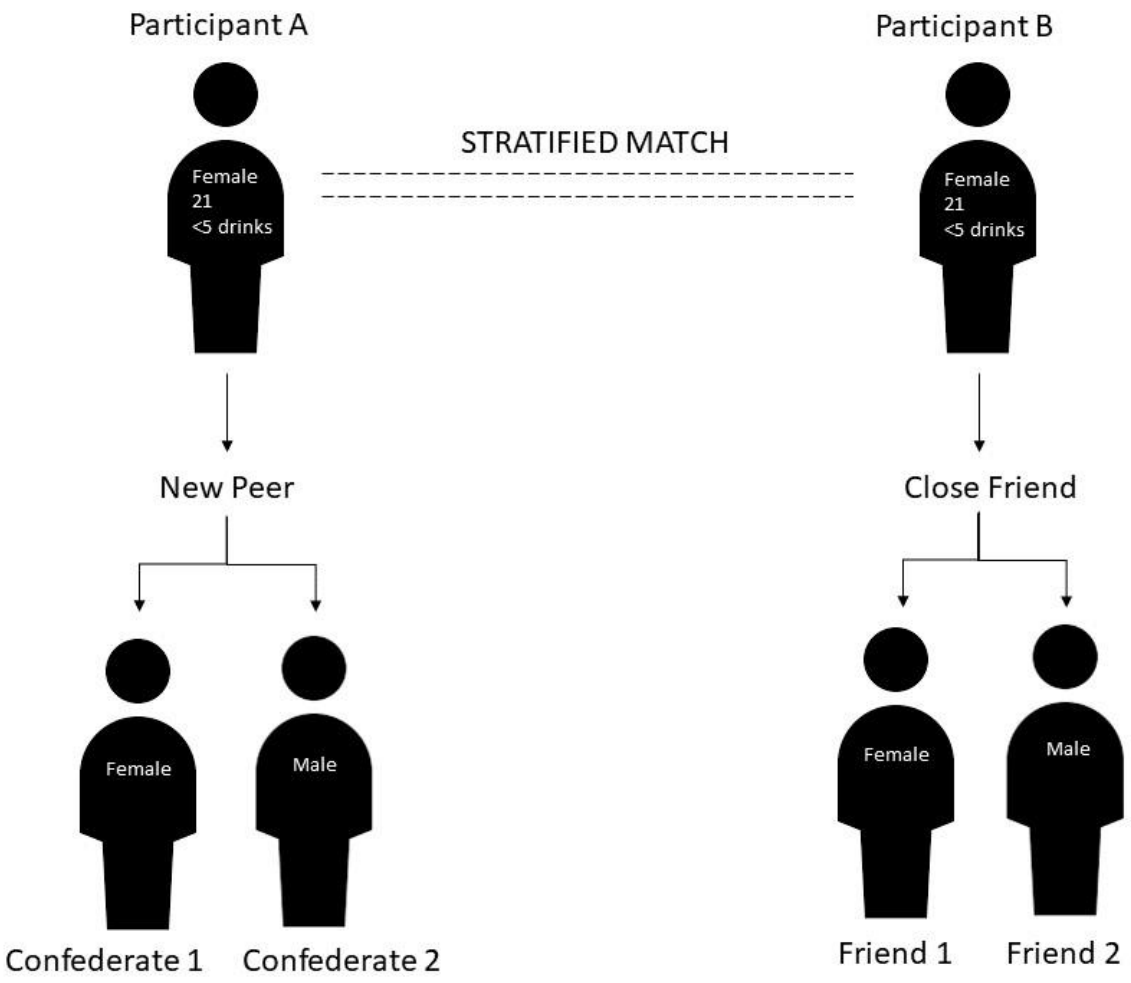

Figure 4: Stratification of groups by peer condition

Any RA who knew a particular participant was not scheduled for that participant's run and backup RAs were scheduled in case the situation was not caught before the run. Friend recruitment utilized two different procedures. Initially, those assigned to the close friend group were asked to provide email, phone numbers and rate the degree of closeness on a scale of 1-10 for five to seven close friends to ensure at least two eligible friends. Friends were contacted via phone starting with the closest relationship and had 1 week to complete online screening materials until two eligible friends agreed to participate. This was the procedure for the first 4 groups run; however, recruitment was revisited due to poor friend recruitment. Following the updated protocols, all eligible participants

were assigned a referral number and custom survey link to share with their friends with the referral number embedded. Participants were then instructed to refer 5-7 close friends. Once a participant recruited 2 eligible friends, they were stratified into either the new peer or close friends group and scheduled. Romantic partners were not excluded as they are typically included in social drinking groups. Close friends met the same inclusion and exclusion criteria as target participants and went through the same procedures during alcohol administration.

Procedures

Alcohol Administration. Alcohol administration runs took place on Wednesdays – Sundays and all runs started at 1:00 pm PST. Participants and their friends were asked not to travel together to the lab to ensure they were not exposed to their peer group before entry to the bar. All participants and peers reviewed and signed the consent form and provide a baseline breath alcohol content (BrAC) reading of 0.00%. Female participants and peers were asked to take a urine pregnancy test and no females had positive test results. If any participant was ineligible to participate, the whole group run was canceled. In some cases, the group was allowed to reschedule their run.

Participants and peers completed 15-20 minutes of baseline measures individually prior to entry to the bar. Participants joined their close friends or new peers in the bar and were given 20 minutes to acclimate to the group while the researcher prepared the materials. After entering their groups but prior to receiving alcohol, participants and peers completed pre-alcohol measures. Importantly, a subset of the participant groups (N = 9) including friends and confederate peers were required to adhere to additional COVID-related precautions upon entering the bar. COVID precautions included maintaining at least 6-feet of distance between seats in the bar, wearing masks whenever not eating or drinking, no-contact delivery of food and drink, and relocating to administer breathalyzer readings in a designated safety area.

During the drinking hour, participants were allowed to order anything from a small bar menu for one hour and allowed to drink freely within safety limits (BAC = .12%). The menu included vodka and blanco tequila based mixed drinks. All beverages were mixed at a 3:1 ratio of mixer to liquor and were equivalent to one standard drink (50 mL of 80 proof alcohol). Glasses were prepared by misting vodka into the glasses using a fine spray bottle and storing them upside down on a towel to avoid evaporation. Glasses were prepared prior to the drinking hour, so all glasses were sprayed with vodka regardless of the participant's order. Each drink was also topped with a float of vodka or blanco tequila from a lime or grenadine bottle depending on the drink ordered. Participants observed the bartender pouring from alcohol bottles. Thus, olfactory and visual alcohol cues aided with expectations of a strong alcohol flavor. These procedures were used to allow bartenders to switch to serving placebo beverages if participants ordered more alcohol beverages than allowed. Estimated BAC levels based on age, sex, height, and weight were calculated prior to each drink served to ensure the safety of consuming each drink (See Appendix A for estimation formula) without interrupting social interaction and making the participant's BAC more salient. During ad-lib, all participants and close friends were served real alcohol drinks until their estimated BAC would exceed 0.12%, at which point the bartender continued to accept orders but served the at-risk participant placebo beverages. Research assistants observing through a two-way mirror completed the estimated BAC calculations and texted the bartenders whether to serve alcohol or placebo for each drink. Placebo beverages used 50 mL of flat tonic water poured from an identical liquor bottle in place of alcohol and all other mixing procedures remained the same. Since confederate peers are research assistants, they were only served placebo beverages for safety and ethical reasons. Further, they were instructed to match the participant's drinking behavior, sip for sip, to minimize likelihood of influencing how much the participant drinks. Presumably, participants would be less likely to feel pressure to drink more

because they are already keeping pace with everyone else in the room and would never observe someone else drinking when they were not. However, a small subset of individuals may be motivated to out-pace others rather than simply keep up, yet, given prior research on drink matching (Petersen, 2005) this was still considered the safest approach by institutional review boards.

After ad-lib, participants completed post-alcohol measures and received entertainment and food until BrAC was below .03%. Primary participants but not peers completed a brief (5 minute) training on the procedures for the daily diary procedures once their BAC was below .03% (see below). The active protocol took approximately 2.5 hours. Once sober, participants were debriefed if confederate peers were involved and then paid for their time at a rate of $15 per hour, and were taken home using ride share services (e.g. Lyft). Friends were also paid at the same rate and provided a Lyft home. Close friends and new peers did not complete the daily diary protocols.

Daily Diary. Only primary participants (N=13) completed daily diary follow-up assessments. Daily diary measures started on Thursday following each participant's alcohol administration appointment and were collected for potential drinking events on Thursday, Friday, and Saturday over the following four consecutive weeks. The first Tuesday prior to starting daily diary assessments, participants received an email reminder of the follow-up period. Each week on Wednesday, participants received a text message reminder that the weekend surveys will begin the next day.

Each day, participants were notified of surveys by text message at 4 pm (Thursday, Friday and Saturday) and the following morning at 11am (Friday, Saturday, and Sunday) for a total of 24 assessments. Surveys were available for 2 hours and reminders were sent via text 30 minutes before closing if assessments had not been completed. Afternoon assessments took approximately 5 minutes and measured prospective drinking and social plans for the evening (See Measures for details of all

assessments). Morning assessments took approximately 5-7 minutes to complete and assessed retrospective recall of the previous night's drinking and social activities. Participants were compensated $2 per survey, with a bonus of $10 for completing at least 19 (80%) surveys. Many daily diary studies have used similar methods including pay schedule (Fairlie, Ramirez, Patrick, & Lee, 2016), number of surveys (Patrick & Lee, 2010), and duration and days of assessment (Weiss, Bold, Sullivan, Armeli, & Tennen, 2017). These studies have completion rates ranging from 84% to 92%. Upon completion, participants were sent an email reviewing payment detail and instructed to contact the study team for any discrepancies. Participants earned up to $200 depending on time spent in lab and number of assessments completed and were compensated with electronic gift cards the Monday after procedures were completed. Participants took approximately 5 weeks to complete all procedures.

Measures

Screening. All screening measures were completed online via Qualtrics and could be completed on a cell phone or computer at the participant's convenience.

Demographics. Participants reported on several demographics on the brief screener. These items include sex assigned at birth, gender, race/ethnicity, student status, age, height, weight, and dietary restrictions. Females (assigned at birth) only were asked about whether they were currently nursing or had any possibility of being pregnant.

AUDIT. The brief screener assessed risk for alcohol use disorder with the Alcohol Use Disorders Identification Test (AUDIT; Saunders et al., 1993). AUDIT is a 10-item questionnaire assessing drinking and negative consequences experienced from drinking. The first three items represent consumption of alcohol assessing 1) the typical frequency of alcohol use ranging from

"never" or "daily or almost daily" 2) the typical quantity of alcohol use ranging from "1 or 2" to "10 or more" and 3) the frequency of heavy drinking defined as 6 or more drinks on one occasion ranging from "never" to "daily or almost daily". The remaining seven items assess negative consequences such as inability to control drinking and blackouts. Response options vary depending on the question and are either ranging from "never" to "daily or almost daily" or from "no, never", "yes, but not in the past year" to "yes, during the past year". Scores for each question range from 0 to 4 with higher scores representing more risk for alcohol use disorders. A sum score of all 10 items was used to assess overall risk and participants received a clinical call if they received a score of 16 or higher. Participants were excluded if they reported drinking less than weekly or less than 3 drinks typically.

DASS. The depression and anxiety subscales from the Depression Anxiety Stress Scales (DASS; Lovibond & Lovibond, 1995) provided an initial mental health screening on the brief screener. The depression scale consists of seven items and rates symptoms over the past week. Response options range from 0 = "never" to 3 = "most of the time". A sum score from all the items multiplied by 2 is used to indicate risk for depression. Participants will receive a clinical call if they score 21 or higher. The anxiety scale consists of seven items and rates symptoms over the past week. Response options range from 0 = "never" to 3 = "most of the time". A sum score from all items multiplied by 2 is used to indicate risk for anxiety. Participants received a clinical call if they scored 15 or higher.

Health Risks. Participants were screened for several health risk factors. They reported on any serious medical conditions for which they were under the care of a physician. Additionally, they were specifically asked about history of heart attack or stroke, heart trouble, high blood pressure, diabetes, and liver disease. Additionally, six items specifically assessed adverse reactions to alcohol including:

fainting or seizures, flushing, liver problems, psychological reactions, abstinence-oriented treatment, and religious reasons for not drinking. Each item consisted of a single "yes" or "no" response and if selected "yes" they were prompted to complete a free response explaining their experience. Finally, participants reported on how many medications they were currently taking. For each medication they were asked to report the name, type of medication (i.e. use), dosage, and frequency of use. Participants were excluded for any health risks that may be made worse by drinking alcohol and any medication contraindicated for alcohol use.

COVID-19 Vaccination. Following the return to in-person alcohol administration research in 2021, participants were also asked about their COVID Vaccination status. Participants were excluded if not fully vaccinated, defined as having the 2-shot sequence of Moderna/Pfizer vaccines or the single Johnson & Johnson shot.

AUDADIS. The Alcohol Use Disorder and Associated Disabilities Interview Schedule (AUDADIS; Grant et al., 2003) is a structured interview to assess criteria for mental health disorders from the Diagnostic and Statistical Manual – 5 (DSM-5; *Diagnostic and statistical manual of mental disorders*, 2013). The structured interview was adapted into an online assessment to increase feasibility of the study and reduce the likelihood of ineligible participants being scheduled for in-person runs. While not necessary for this study, this online assessment should not be used diagnostically. Participants were assessed for past month alcohol experiences, depression, dysthymia, mania, panic, social anxiety, specific phobia, and generalized anxiety. Scores indicate risk for mental health disorder and participants received a clinical call if they met risk criteria for any disorder except specific phobia. Participants were excluded for specific phobia if they might encounter their feared object or situation in the bar (e.g., crowds, small spaces etc.).

Alcohol Administration. Alcohol administration assessments were completed on a laptop computer. There were three primary assessment points during the alcohol administration runs: baseline individual, group pre-alcohol, and group post-alcohol.

TLFB. The Time-Line Follow Back (TLFB; Sobell & Sobell, 1992) is a semi-structured interview to collect details of drinking events over the past month. Participants completed the TLFB interview during the individual baseline assessment. For each drinking day, participants were asked about the number of standard drinks they consumed and the time spent drinking. A standard drink was defined for the participants as 1.5 oz of 40% alcohol-by-volume(ABV) liquor, 5 oz of 12% ABV wine, or 12 oz of 5% ABV beer. Frequency (i.e., number of drinking days), average quantity of alcohol use, and frequency of binge drinking days (i.e., 4+/5+ drinks over a 2 hour period for women/men) were calculated for use in analyses.

Negative Alcohol Consequences. The Young Adult Alcohol Problem Screening Test (YAAPST; Hurlbut & Sher, 1992) includes 27 items measuring frequency of experiencing negative alcohol consequences typically reported by young adults over the past year. Participants reported on consequences on the individual baseline assessment. All items have the response options 0 = "No, never" and 1 = "Yes, but not in the past year" and past year response options vary by item. The first eight items are consequences that may occur regularly such as "Have you ever driven a car when you knew you had too much to drink to drive safely?" Past year response options ranged from 2 = "1 time" to 9 = "40 or more times". The next twelve questions represent consequences that may not happen every time the participant drinks such as "Have you ever received a lower grade on an exam or paper than you should have because of your drinking?" Past year response options range from 2 = "1 time" to 4 = "3 or more times". Finally, the last seven items of rarely occurring consequences

related to stopping or cutting down such as “Have you ever gone to anyone for help to control your drinking?” Past year response options were only 2 = “ Yes, in the past year”. A sum score of the past year response options (excluding 0s and 1s) was created as a consequence severity score.

Drinking Motives. The Drinking Motives Questionnaire (DMQ; Cooper, 1994) was measured at individual baseline and uses 20 items to capture how much participants drink for different reasons within four motivation domains (5 items each). Social motives reflect external positive reinforcement motives, which describe how much individuals drink to facilitate social engagement. An example item is “To celebrate a special occasion with friends”. Enhancement motives reflect internal positive reinforcement motives, which describe individuals drinking to enhance positive moods. An example item is “Because it gives you a pleasant feeling”. Conformity motives reflect external negative reinforcement motives, which describe drinking to remove social awkwardness and fit in. An example item is “So you won’t feel left out”. Finally, coping motives reflect internal negative reinforcement motives, which describe drinking to alleviate negative moods. An example item is “To forget your worries”. All items are assessed on a 5 point Likert scale ranging from 0 = “Almost never/Never” to 4 = “Almost always/Always”. Sum scores for each of the four factors were used to indicate drinking motives.

Alcohol Norms. Drinking norms (Baer et al., 1991) refer to perceptions of normative drinking behavior for a target group. Drinking norms for college students were assessed at individual baseline and drinking norms for the lab peer group were assessed in the pre-alcohol surveys. Broadly, drinking norms are captured by two types of perceptions: descriptive norms capture the perception of how much the target group drinks, while injunctive norms capture the perception of how much a target group approves of drinking behavior. A descriptive norms item is “How many standard alcoholic

drinks do you think a typical college student consumes on a given drinking occasion?" An injunctive norms item is "How many standard alcoholic drinks do you think a typical college student finds acceptable to drink on a given occasion?" Items reflect quantity and frequency of drinking to obtain scores of 1) the perceived frequency (or perceived acceptable frequency) of typical college drinking per month, 2) the perceived average number of drinks (or perceived acceptable average number of drinks) on drinking days and 3) the perceived frequency (or perceived acceptable frequency) of "binge" drinking (consuming 4+ drinks for women or 5+ for men on a single occasion) per month. A quantity X frequency indicator of perceived total drinks per month was obtained by multiplying the perceived average number of drinks by the perceived frequency of monthly drinking.

Perceptions of Peers. Perception of lab peers was measured in the pre-alcohol surveys and was assessed similarly to measures of perceptions of drinker prototypes (Teunissen, Spijkerman, Kuntsche, Engels, & Scholte, 2017). Participants rated how much they perceived their peers in the lab to be "smart", "attractive", "popular", "impulsive", "immature", and "careless" on a 5-point Likert scale from 0 = "Not at all" to 4 = "Extremely". The last three items were reverse scored and a sum score was created with higher scores reflecting more positive peer perceptions. Additionally, participants were asked "How similar do you feel you are to your peers?" rated from 0 = "Not at all similar" to 4 = "Very similar" to indicate perceived peer similarity.

State Affect. The state version of the Positive and Negative Affect Scale (PANAS; Watson, Clark, & Tellegen, 1988) assessed affect at baseline, pre-alcohol and post-alcohol time points. The PANAS is a 20-item measure which asks participants to indicate the extent to which they currently are feeling each of the listed adjectives. All adjectives reflect positive (e.g., excited) or negative (e.g.,

hostile) feeling words. Response options are rated on a 5-point Likert scale from 0 = “Very slightly or not at all” to 4 = “Extremely”. Sum scores for positive and negative affect were calculated separately.

Broad Social Motives. Broad social motives (BSM) were assessed at baseline, pre-alcohol and post-alcohol using an expanded version of the measure from study 1. See Appendix B for all items. BSM captures sensitivity to social rewards and proposes motives may vary by types of relationships. Based on study 1 analyses, BSM was assessed for four different relationship types: close friends, co-workers, strangers, and family. Additionally, items from the Social Reward Questionnaire (Foulkes et al., 2014) were adapted to be assessed for each relationship type. The SRQ items used capture 3 of the 6 subscales: admiration, prosocial interactions, and sociability. These items were added to ensure all aspects of social reward sensitivity were being captured and evaluate whether the SRQ was still distinct from BSM when no longer collapsing across all relationship types. The full measure assessed BSM for close friends (21 items), co-workers (20 items), strangers (20 items), and family (21 items). Response options ranged from 0 = “Strongly disagree” to 4 = “strongly agree”.

Risk Taking. The Balloon Analogue Risk Task (BART; Lejuez et al., 2002) measured risk-taking propensity at baseline, pre-alcohol and post-alcohol assessment points. The BART is a computer-based task where participants are presented with 30 trials of balloons. Participants were informed that for each pump of air, they would earn fake money in the game ($0.01 cent/pump) but at a random point the balloon will explode. The explosion point is a random number between 1 and 128 such that the probability of explosion on the first pump is 1/128, the probability of explosion on the second pump is 1/127, and so forth. Cashing out before the balloon explodes allows participants to keep the money in the game, however, if the balloon explodes, they lose all the money for that balloon. Exploded balloons do not affect the fake money earned on previous balloons. Participants

knew all money earned was in the game and they did not receive any additional compensation based on their performance on the BART. Scores were calculated by averaging the number of pumps for unexploded balloons, with higher scores reflecting greater risk-taking (Figure 5 from Schonberg et al., 2012). Change scores from baseline (alone) to pre-alcohol (group) were calculated to indicate risk-shift upon entering groups.

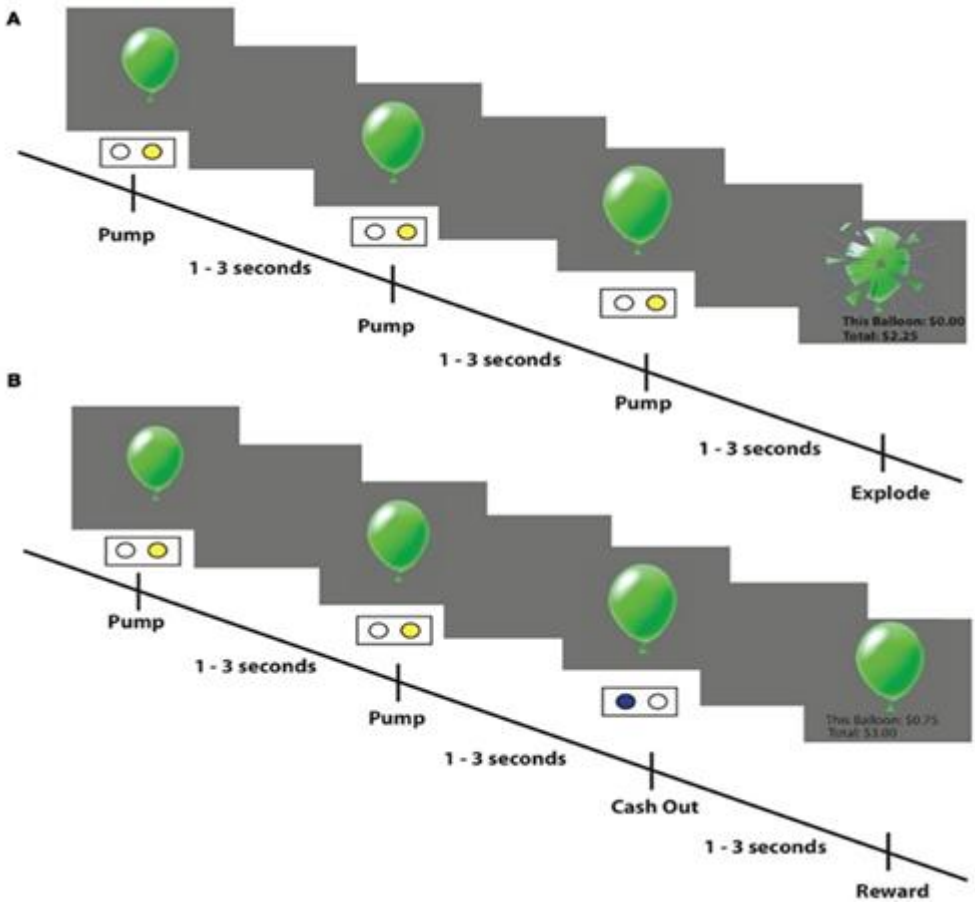

Figure 5: Balloon Analogue Risk Task

Ad-lib Drinking. Alcohol consumption was tracked during the ad-lib drinking hour by observation. The number of standard alcoholic drinks consumed and the number of placebo beverages together represent the total number of drinks the participant would have consumed (as participants were unaware that placebo drinks were being served if they exceeded safe intoxication levels).

Additionally, the time each drink was ordered was tracked to represent the rate of drinking with less average time between drinks representing a faster drinking rate.

Daily Diary. Daily diary measures were programmed in Qualtrics and DatStat and surveys could be completed on the participant's phone, tablet, laptop, or desktop, at their preference. Because daily diary measures by necessity were required to be brief, several modifications to existing measures were made, in consultation with senior researchers in the field of daily diary methods, to maintain feasibility while addressing study aims. Measures and modifications for daily diary administration are described below.

Broad Social Motives. Broad social motives were assessed during the Daily Afternoon surveys. To determine which items to include in daily surveys, items from the full BSM measure used during alcohol administration, were reviewed for items that could vary daily. First, duplicate or near duplicate items across scales were eliminated favoring the briefest phrasing. Second, items that were unlikely to change daily were eliminated (e.g., "I enjoy it if someone accepts me as I am, no matter what"). Finally, items were chosen that could apply to all four relationship types (co-workers, friends, strangers, and family). See Appendix B for all items. Five items per relationship type were assessed for a total of 20 items. Response options were rated on the same 5-point Likert scale from 0 = "Strongly Disagree" to 4 = "Strongly Agree".

Drinking Motives. The Drinking Motives Questionnaire (Cooper, 1994) was modified to assess drinking motives during Daily Afternoon assessments. Specifically, drinking motives items were modified into a brief prospective measure consistent with modifications used in other studies (Dvorak, Pearson, & Day, 2014). Participants were asked to rate how much they would drink that evening for the following reasons. An example of a modified item is "If someone encourages me to

drink, I will" rather than "because my friends pressured me to drink". Thus, prospective and retrospective reports of motives may function slightly differently, as retrospective reports tend to capture whether motives were activated. For example, "because my friends pressured me to drink" may not be endorsed retrospectively either because the participants did not want to conform to the group or simply because no one pressured them to drink. Prospective assessment may capture openness to planned and unplanned reasons for drinking irrespective of whether that motivation is activated. Most items required no modification such as "to forget my worries" and "because it's fun". Each factor (social, enhancement, coping and conformity) was assessed by three items each for a total of 12 items. Items were selected because they did not need to be modified or were easily modified to assess prospective motives. All items were assessed using a 5-point Likert scale ranging from 0 = "Strongly Disagree" to 4 = "Strongly Agree". A mean score for each factor is used.

Reasons Not to Drink. Reasons not to drink were assessed prospectively on the Daily Afternoon assessments with a measure developed from the Reasons for Abstaining or Limiting Drinking scale (Epler, Sher, & Piasecki, 2009). Participants were asked to rate how much they agreed 12 items reflect reasons they would avoid drinking that evening. Six items reflect Losing Control, and six items reflect Adverse Consequences. Sample items include "I don't want to lose control of myself" and "I don't want to spend money" for each factor respectively. Items were rated on a 5-point Likert scale from 0 = "Strongly Disagree" to 4 = "Strongly Agree". A sum score for each factor was calculated to indicate motives for not drinking.

State Affect. The state version of the Positive and Negative Affect Scale (PANAS; Watson et al., 1988) assessed affect during the Daily Afternoon assessments. The measure was not modified for

daily diary measures, thus all 20 items as described above were used to assess current affect. Sum scores for both positive and negative affect were used.

Social Plans. During Daily Afternoon assessments, participants were asked if they had any social plans for the evening. If they indicated yes, they were asked "Where do you plan on spending the evening tonight?" and responses included multiple-selection categorical responses. Response options were "my house", "someone else's house", "the movies", "a bar or club", "a restaurant or café", "a mall or retail store", "school", "at extracurricular activities", "work or volunteering", "outdoors", "at religious services or groups", and "other". Participants were also asked "What is the relationship you have to the majority of your social group for tonight's plans?" and participants were required to select only one option. Response options included "close friends", "acquaintances or new friends", "school/extracurricular peers", "work colleagues", "family", "religious peer group", "strangers or meet-up group", and "other".

Alcohol Use. Alcohol use was reported retrospectively at Daily Morning assessments and asked about the previous nights' drinking. First, participants were asked a yes or no question about whether they drank or not. If they indicated yes, they were asked the number of standard drinks they consumed and the time they spent drinking. An estimated BAC was calculated using their sex assigned at birth, and weight.

Negative Alcohol Consequences. Participants reported on negative consequences they experienced if they drank at Daily Morning assessments. This was assessed using 15 items reflecting consequences from the YAAPST (Hurlbut & Sher, 1992) that could occur after only one drinking occasion, which were rated as "yes" they occurred or "no" they did not. A count of all negative consequences that occurred was used.

Social Group. Participants reported whether they actually engaged in social activities at Daily Morning assessments. If they indicated yes, participants were asked how many different TYPES of social groups they were with last night. TYPES of social groups were defined for participants: A different social group is classified as being in a group where the majority of the people have a different relationship to you than the last group you were with. For example, if you were at a bar with work colleagues and then went to a party where most people were acquaintances that would count as 2 social groups. However, if you were at a restaurant with mostly close friends and more friends joined you later in the evening that would still count as 1 social group because the majority of people were close friends even though the size of the group changed.

For each peer group reported (up to five groups), participants reported the following characteristics of the group: a) size of the group was indicated by the total number of people the participants were with; (b) peer relationships was indicated by the number of people with the participant who were considered “close friends”, “acquaintances or new friends”, “school/extracurricular peers”, “work colleagues”, “family”, “religious peer group”, “strangers or meet-up group”, and “other”; (c) sex composition of the group was based on sex assigned at birth rather than gender composition and was a categorical response of “same-sex”, “same-sex, but of the opposite sex to you” or “mixed sex”; (d) time spent with each group was reported in hours; and finally (e) if participants indicated they drank alcohol that evening, they were asked if they consumed alcohol with each group and the number of standard drinks consumed while with each group.

Analytic Plan

Preliminary Analyses.

Power Analyses. No known estimate of effect size for direct comparison of different types of peer's influence on alcohol use for alcohol administration is available. Average effect size of BSM association with alcohol is d = .52 (Canning, 2016; Corbin et al., 2011; Vaughan et al., 2009) and effect size of risk-taking in peer group versus individual for young adults is d = .47 (Gardner & Steinberg, 2005); the latter was used for power to remain conservative. Using NIH power calculator for clustered data with alpha = .05, power = .80, ICC = .41 (based on a conservative estimate of between peer cluster variance in alcohol use (Kiuru, Burk, Laursen, Salmela-Aro, & Nurmi, 2010)), 3 individuals per cluster, and a moderate amount of variance explained by covariates (.13) resulted in a proposed sample size of 43 clusters per condition. Power for daily diaries was estimated in G*Power 3.1 (Faul, Erdfelder, Lang, & Buchner, 2007) for repeated measures multivariate analyses, to address count data. With 12 days of assessments assuming .6 correlations among repeated measures a sample of 22 participants was required. A sample size of 100, with 50 clusters per condition, was initially proposed to account for potential attrition.

Data Description. Descriptive statistics were summarized by frequency distributions, means and standard deviations of all variables. Bivariate correlations were computed to identify zero-order relations among all variables. Intraclass Correlations (ICCs) are also reported for all daily diary measures. Evidence of associations, distributional abnormalities, or outliers are described in reports of findings.

Primary Analyses.

Aim 2. To address Aim 2, regression analyses were proposed to examine the interaction between BSM, group condition (close friends vs new peers), and their interaction to predict number of drinks consumed during ad-lib and changes in BART scores from baseline to pre-alcohol assessments. Due to the fact that study procedures were conducted in groups, masking of participants at all times was not possible due to the need to eat and drink during the protocol, and use of breathalyzers was considered an aerosolizing procedure which was presumed to increase risk for Covid-19 transmission, our alcohol administration study was shut down for 1.5 years during the COVID-19 pandemic of the proposed 2 years of data collection. Thus, the obtained sample size (N=13) was severely limited compared to the proposed sample (N = 100) and based on power analyses, our current sample is not sufficient to address significance of findings for Aim 2. Nonetheless, key descriptive information was summarized. Correlations are reported for anxiety, BSM, number of drinks consumed, peak BrAC readings, changes in BART scores. Number of drinks consumed and changes in BART scores are both reported by group condition (close friends vs. new peers). These same correlations were reported at both the individual and daily level using daily diary assessments.

Aim 3. Aim 3 was designed to investigate whether behavior in a controlled lab setting could predict behavior reported during natural drinking sessions. While closer to the required sample size based on power analyses (N=22), recruitment for study 2 was still inadequate to analyze the daily diary assessments. Correlations at the individual level among number of drinks consumed during ad-lib, changes in BART scores, alcohol use during diary assessments, and negative alcohol consequences were reported to evaluate potential associations.

Results

Aim 2: Associations among BSM, Friends, and Alcohol Outcomes

Alcohol Administration. A total of 13 participants completed procedures with 8 in the Close Friends condition and 5 in the New Peers condition. Four participants, two in each condition, completed procedures prior to the COVID-19 pandemic and the remaining completed in late 2021 – early 2022. On average primary participants drank 3.46 standard drinks during the ad-lib hour and reached peak BrACs from 0.04% - 0.12%. Participant demographics and outcomes are reported by condition in Table 3. Means, standard deviations and correlations for BSM, anxiety, number of drinks consumed, and changes in BART scores are reported in Table 4.

Descriptively, those drinking with friends consumed 0.43 standard drinks more than those drinking with new peers. However, peak BACs for both conditions were ~0.08%. It is unclear whether any differences would be maintained in the full sample size. Additionally, BSM factors were inconsistently related to alcohol outcomes when considering effect sizes (r^2), with BSM for coworkers associated with peak BrAC being the largest effect at 0.21 (moderate effect size). Those assigned to the close friend condition experienced an increase in BART score much larger than those in the new peers condition (16.21 vs 6.99 pumps respectively). This heightened risk taking continued with scores increasing even further after consuming alcohol, however, it was more comparable between conditions where those in the close friends condition increased an additional 9.36 pumps and those in the new peers condition increased another 6.87 pumps. Without significance testing, it is plausible neither of these differences are sufficiently different from 0. However, increases in BART scores upon entering social groups were associated both with consuming more alcohol and reaching a high breath alcohol concentration in the lab ($r^2 = 0.12 – 0.44$).

Table 3

Study 2 Demographics and Outcomes by Condition

	Condition		Total
	Close Friends	New Peers	
	N	N	N
Assigned Sex			
Female	5	4	9
Male	3	1	4
Gender			
Cis-gender woman	5	4	9
Cis-gender man	3	1	4
Race			
AIAN	0	0	0
Asian	1	1	2
Black/African American	0	0	0
Pacific Islander	0	0	0
White	7	3	10
Mixed Race	0	1	1
Ethnicity			
Hispanic/Latinx	1	0	1
Non-Hispanic/Latinx	7	5	12
	M(SD)	M(SD)	M(SD)
Age	21.5	21.4	21.46(0.78)
BSM at baseline			
Co-Workers	4.45(0.39)	3.83(0.59)	4.21(0.55)
Friends	4.58(0.32)	4.06(0.44)	4.38(0.44)
Family	4.62(0.27)	3.53(0.84)	4.20(0.76)
New Peers	3.94(0.51)	2.87(0.23)	3.53(0.68)
Anxiety at screening	2(2.62)	6(4.90)	3.54(4.01)
Affect at baseline			
Positive	3.16(0.50)	2.7(0.68)	2.98(0.60)
Negative	1.11(0.14)	1.4(0.27)	1.22(0.24)
Prior Alcohol at baseline			
Past 30-day Consequences	20(15.76)	16.2(6.72)	18.54(12.79)
Past 30-day Average # of drinks	3.04(1.15)	2.91(0.93)	2.99(1.03)
Outcomes			
# of drinks during ad-lib	3.63(0.74)	3.20(0.45)	3.46(0.66)
Peak BrAC post ad-lib	0.084(0.019)	0.086(0.033)	0.085(0.02)
BART Baseline	35.61(19.75)	37.73(16.95)	36.31(18.10)
BART Pre-Alcohol	51.82(13.75)	44.72(15.05)	48.86(14.10)
BART Post Alcohol	61.18(29.06)	51.59(23.75)	57.69(26.45)

Table 4

Correlations for Alcohol Administration Data

	1	2	3	4	5	6	7	8
1. BSM Coworkers								
2. BSM Friends	0.39							
3. BSM Family	0.42	0.84						
4. BSM New Peers	0.51	0.44	0.58					
5. Anxiety	-0.27	-0.31	-0.21	-0.29				
6. Number of Drinks	0.18	0.19	0.32	0.31	0.02			
7. Peak BrAC	0.46	-0.15	0.14	0.21	0.51	0.44		
8. Change in BART (Baseline to Pre-Alcohol)	0.44	-0.04	0.05	0.13	-0.59	0.34	0.56	
9. Change in BART (Baseline to Post-Alcohol)	0.58	0.36	0.33	0.27	-0.26	0.66	0.61	0.52

Daily Diaries. Primary participants completed an average of 72% of daily diary surveys and reported 4 drinking days on average. On drinking days, participants reported consuming an average of 2.77 standard drinks over 2.49 hours with estimated BACs ranging from 0.00% - 0.203%. Means, standard deviations, correlations for BSM, affect, number of close friends, number of drinks consumed, negative consequences, and estimated BAC are reported in Table 5 for between person estimates and Table 6 for within person correlations.

Table 5

Between Person Means, Standard Deviations, and Correlations

	M	SD	1	2	3	4	5	6	7	8	9	10
1. BSM Coworkers	3.45	1.04	1.00									
2. BSM Family	4.63	0.42	-0.10	1.00								
3. BSM New Peers	3.35	0.33	0.57	-0.19	1.00							
4. BSM Friends	4.47	0.43	-0.28	0.91	-0.43	1.00						
5. Positive Affect	2.52	0.76	0.30	0.09	0.54	0.02	1.00					
6. Negative Affect	1.27	0.25	0.34	-0.40	0.05	-0.31	-0.23	1.00				
7. Number of Friends	3.22	3.55	0.20	-0.50	0.08	-0.49	0.34	0.03	1.00			
8. Number of Drinks	2.76	1.55	-0.35	0.62	-0.02	0.39	-0.15	-0.41	-0.40	1.00		
9. Negative Consequences	0.33	0.37	0.32	0.25	0.57	0.03	-0.02	0.21	-0.50	0.53	1.00	
10. eBAC	0.039	0.037	0.02	0.46	0.20	0.23	-0.27	0.08	-0.48	0.83	0.86	1.00

Table 6

Intraclass Correlations and Within-Person Pearson Correlations

	ICC	1	2	3	4	5	6	7	8	9	10
1. BSM Coworkers	0.75	1.00									
2. BSM Family	0.56	0.36	1.00								
3. BSM New Peers	0.40	0.38	0.06	1.00							
4. BSM Friends	0.50	0.34	0.88	0.06	1.00						
5. Positive Affect	0.46	0.52	0.31	0.00	0.37	1.00					
6. Negative Affect	0.11	-0.36	-0.59	-0.31	-0.53	-0.26	1.00				
7. Number of Friends	0.13	0.04	0.66	-0.21	0.61	0.18	-0.23	1.00			
8. Number of Drinks	0.31	-0.17	0.03	0.38	-0.01	-0.36	0.13	0.18	1.00		
9. Negative Consequences	0.15	-0.30	-0.05	-0.14	-0.24	-0.43	0.19	0.02	0.44	1.00	
10. eBAC	0.45	-0.15	0.04	0.09	0.00	-0.25	0.19	0.22	0.82	0.53	1.00

Aim 3: Associations between alcohol administration and daily diary outcomes

Table 7 includes between-participant correlations of number of drinks consumed during ad-lib, changes in BART scores, alcohol use during diary assessments, and negative alcohol consequences. Interestingly, number of drinks consumed in the bar lab and increases in BART scores were both negatively correlated with average alcohol use and consequences based on moderate effect sizes of $r^2 > 0.09$. However, the limited sample size makes it plausible this may be an artifact of some outliers in the data.

Table 7

Between Person Means, Standard Deviations, and Correlations

	M	SD	1	2	3	4	5	6	7
1. Number of Drinks Ad-Lib	3.44	0.73	1.00						
2. Peak BrAC	0.084	0.025	0.48	1.00					
3. Changes in BART (Baseline to Pre-Alcohol)	12.70	18.20	0.56	0.48	1.00				
4. Changes in BART (Baseline to Post-Alcohol	26.32	20.94	0.65	0.67	0.60	1.00			
5. Number of Drinks Diaries	2.77	1.55	-0.38	-0.15	-0.43	-0.66	1.00		
6. Negative Consequences	0.33	0.36	-0.41	0.38	-0.33	-0.17	0.53	1.00	
7. eBAC	0.039	0.037	-0.56	0.18	-0.47	-0.40	0.83	0.86	1.00

Chapter 4: Study 3
Daily Diary Procedures Only

Methods

Study 3 was developed as a remote-only option during the COVID-19 pandemic to supplement data collection from study 2 after the university and lab closures. Although procedures were similar overall to the proposed daily diary procedures for study 2, there were differences in eligibility criteria (due to no alcohol administration restrictions), screening and recruitment procedures, and some assessment procedures; thus, a full description of the methodology for study 3 is provided below.

Participants

Students (N=60) enrolled in university between 18-24 years old were recruited. Students (N = 381) were screened and 193 were eligible. Ninety-three participants were eligible and completed baselines assessments. The large drop off between screening & baseline was attributed to two factors: 1) this study was conducted over a short period of time to compensate for data lost during COVID-19 and thus, screening follow-ups were not as extensive and 2) the baseline survey did not include a withdraw button, so those who changed their minds about participating did not have a convenient way to inform the study team. Of those eligible, 21 did not schedule their zoom training session, 10 had scheduling issues and were not rescheduled before the study ended, and 2 withdrew from the study after the training. Thus, a total of 60 participants were enrolled in the daily diary assessments. Participants were on average 19.85 (SD = 1.55) years old, 65.6% assigned female at birth, 98% cisgender, 95% Non-Hispanic ethnicity, 62.3% White, 16.4% Asian, 1.6% Hawaiian/Pacific Islander, and 19.7% mixed race. Participants reported a drinking frequency of at least once per week and were

excluded if they previously participated in another UW alcohol study. In our software program for study 3, surveys could only be texted to the participants and completed via mobile phone, thus, participants were also excluded if they did not consent to receiving study text messages.

Procedures

Participants were recruited through direct outreach to UW students over the age of 18 obtained via the UW Registrar's directory list, as well as community flyers distributed at colleges in the local area, online advertisements, and word of mouth. Participants completed a short screener (~5-10 minutes) online. Based on their responses to the brief screening questions, eligible participants were automatically redirected to a baseline survey, which took approximately 30 minutes to complete. After completing baseline, participants were asked to schedule a 15-minute zoom training to train them on daily diary procedures. A HIPAA-compliant zoom link was provided by email and participants were compensated $20 via electronic gift card for the baseline survey and zoom meeting. Daily diary measures were programmed in DatStat, started on Thursday following each participant's zoom appointment, and were collected for potential drinking events on Thursday, Friday, and Saturday over the following four consecutive weeks. The first Tuesday prior to starting daily diary assessments, participants received an email reminder of the follow-up period. Each week on Wednesday, participants received a text message reminder that the weekend surveys would begin the next day.

Each assessment day, participants were notified of surveys by text message at 4 pm (Thursday, Friday and Saturday) and the following morning at 11am (Friday, Saturday, and Sunday) for a total of 24 assessments. Surveys were available for 2 hours and reminders were sent via text 30 minutes before closing if assessments had not been completed. Afternoon assessments took

approximately 5 minutes and measured prospective drinking and social plans for the evening (See Measures for details of all assessments). Morning assessments took approximately 5-7 minutes to complete and assessed retrospective recall of the previous night's drinking and social activities. Participants were compensated $2 per survey, and received bonus payments for completing 5/6 surveys each week. The bonus payments increased over time, where participants earned $2 the first week for meeting the bonus criteria, then $4 in week 2, $6 in week 3 and $8 in week 4. Upon completion, participants were sent an email reviewing payment details and were instructed to contact the study team for any discrepancies. Participants earned up to $88 depending on number of assessments completed and were compensated with electronic gift cards the Monday after procedures were completed. Participants took approximately 5 weeks to complete all procedures.

Measures

Baseline. The baseline survey was administered in Qualtrics and could be completed on the participant's phone or computer.

TLFB. The Time-Line Follow Back (TLFB; Sobell & Sobell, 1992) online version was adapted into Qualtrics to collect details of drinking events over the past month. Participants were shown a dated calendar and asked to select days they drank in the past month. For each drinking day, participants were asked about the number of standard drinks they consumed and the time spent drinking. A standard drink was defined for the participants as 1.5 oz of 40% alcohol-by-volume (ABV) liquor, 5 oz of 12% ABV wine, or 12 oz of 5% ABV beer. Frequency (i.e., number of drinking days), average quantity of alcohol use, and frequency of binge drinking days (i.e., 4+/5+ drinks over a 2 hour period for women/men) were calculated for use in analyses.

Negative Alcohol Consequences. The Young Adult Alcohol Problem Screening Test (YAAPST; Hurlbut & Sher, 1992) includes 27 items measuring frequency of experiencing negative alcohol consequences typically reported by young adults over the past year. Participants reported on consequences at baseline assessments. All items have the response options 0 = "No, never" and 1 = "Yes, but not in the past year" and past year response options vary by item. The first eight items are consequences that may occur regularly such as "Have you ever driven a car when you knew you had too much to drink to drive safely?" Past year response options ranged from 2 = "1 time" to 9 = "40 or more times". The next twelve questions represent consequences that may not happen every time the participant drinks such as "Have you ever received a lower grade on an exam or paper than you should have because of your drinking?" Past year response options range from 2 = "1 time" to 4 = "3 or more times". Finally, the last seven items assess rarely occurring consequences related to stopping or cutting down such as "Have you ever gone to anyone for help to control your drinking?" Past year response options were only 2 = " Yes, in the past year". A sum score of the past year response options (excluding 0s and 1s) was created as a consequence severity score.

Drinking Motives. The Drinking Motives Questionnaire (DMQ; Cooper, 1994) was measured at baseline and uses 20 items to capture how much participants drink for different reasons within four motivation domains (5 items each). Social motives reflect external positive reinforcement motives, which describe how much individuals drink to facilitate social engagement. An example item is "To celebrate a special occasion with friends". Enhancement motives reflect internal positive reinforcement motives, which describe individuals drinking to enhance positive moods. An example item is "Because it gives you a pleasant feeling". Conformity motives reflect external negative reinforcement motives, which describe drinking to remove social awkwardness and fit in. An example item is "So you won't feel left out". Finally, coping motives reflect internal negative reinforcement

motives, which describe drinking to alleviate negative moods. An example item is “To forget your worries”. All items were assessed on a 5 point Likert scale ranging from 0 = “Almost never/Never” to 4 = “Almost always/Always”. Sum scores for each of the four factors were used to indicate drinking motives.

Alcohol Norms. As in study 2, descriptive and injunctive drinking norms captured perceptions of normative drinking behavior for college students (Baer et al., 1991). Items reflect quantity and frequency of drinking to obtain scores of 1) the perceived frequency (or perceived acceptable frequency) of typical college drinking per month, 2) the perceived average number of drinks (or perceived acceptable average number of drinks) on drinking days and 3) the perceived frequency (or perceived acceptable frequency) of “binge” drinking (consuming 4+ drinks for women or 5+ for men on a single occasion) per month. A quantity X frequency indicator of perceived total drinks per month was obtained by multiplying the perceived average number of drinks by the perceived frequency of monthly drinking.

State Affect. The state version of the Positive and Negative Affect Scale (PANAS; Watson, Clark, & Tellegen, 1988) assessed affect at baseline. The PANAS is a 20-item measure which asks participants to indicate the extent to which they currently feeling each of a list of adjectives. All adjectives reflect positive (e.g., excited) or negative (e.g., hostile) feeling words. Response options are rated on a 5-point Likert scale from 0 = “Very slightly or not at all” to 4 = “Extremely”. Sum scores for positive and negative affect were calculated separately.

Broad Social Motives. Broad social motives (BSM) were assessed consistent with the measure used in study 2. BSM captures sensitivity to social rewards and proposes motives may vary by types of relationships. Items were combined from the new BSM measure and the Social Reward

Questionnaire (Foulkes et al., 2014). The full measure assessed BSM for close friends (21 items), co-workers (20 items), strangers (20 items), and family (21 items). Response options ranged from 0 = "Strongly disagree" to 4 = "strongly agree".

Diaries. Daily diary measures were programmed in DatStat and surveys were sent directly to the participant's phone via a text-message link.

Broad Social Motives. Broad social motives were assessed during Daily Afternoon surveys using the same measure developed during study 2. Five items per relationship type were assessed for a total of 20 items. Response options were rated on the same 5-point Likert scale from 0 = "Strongly Disagree" to 4 = "Strongly Agree".

Drinking Motives. The Drinking Motives Questionnaire (Cooper, 1994) was modified to assess drinking motives during Daily Afternoon assessments, using a brief prospective measure consistent with modifications used in other studies (Dvorak, Pearson, & Day, 2014). Participants were asked to rate how much they would drink that evening for the following reasons. An example of a modified item is "If someone encourages me to drink, I will" rather than "because my friends pressured me to drink". Most items required no modification such as "to forget my worries" and "because it's fun". Each factor (social, enhancement, coping and conformity) was assessed by three items each for a total of 12 items. Items were selected because they did not need to be modified or were easily modified to assess prospective motives. All items were assessed using a 5-point Likert scale ranging from 0 = "Strongly Disagree" to 4 = "Strongly Agree". A sum score for each factor was used in analyses.

Reasons Not to Drink. Reason not to drink were assessed prospectively on the Daily Afternoon assessments with a measure developed from the Reasons for Abstaining or Limiting Drinking scale (Epler, Sher, & Piasecki, 2009). Participants were asked to rate how much they agreed 12 items reflected reasons they would avoid drinking that evening. Six items reflect Losing Control, and six items reflect Adverse Consequences. Sample items include "I don't want to lose control of myself" and "I don't want to spend money" for each factor respectively. Items are rated on a 5-point Likert scale from 0 = "Strongly Disagree" to 4 = "Strongly Agree". A sum score for each factor was calculated to indicate motives for not drinking.

State Affect. The state version of the Positive and Negative Affect Scale (PANAS; Watson et al., 1988) assessed affect during the Daily Afternoon assessments. The measure was not modified for daily diary measures. Sum scores for both positive and negative affect were used.

Social Plans. During Daily Afternoon assessments, participants were asked if they had any social plans for the evening. If they indicated yes, they were asked "Where do you plan on spending the evening tonight?" and responses were multiple-selection categorical responses. Response options were "my house", "someone else's house", "the movies", "a bar or club", "a restaurant or café", "a mall or retail store", "school", "at extracurricular activities", "work or volunteering", "outdoors", "at religious services or groups", and "other". Participants were also asked "What is the relationship you have to the majority of your social group for tonight's plans?" and participants were required to select only one option. Response options included "close friends", "acquaintances or new friends", "school/extracurricular peers", "work colleagues", "family", "religious peer group", "strangers or meet-up group", and "other".

Alcohol Use. Alcohol use was reported retrospectively at Daily Morning assessments and asked about the previous nights' drinking. First, participants were asked a yes or no question about whether they drank or not. If they indicated yes, they were asked the number of standard drinks they consumed and the time they spent drinking. An estimated BAC was calculated using their sex, and weight.

Negative Alcohol Consequences. Participants reported on negative consequences they experienced if they drank at Daily Morning assessments; 15 items regarding consequences from the YAAPST (Hurlbut & Sher, 1992) that could occur after only one drinking occasion were rates as "yes" they occurred or "no" they did not. A count of all negative consequences that occurred was used.

Social Group. Participants reported whether they actually engaged in social activities at Daily Morning assessments. If they indicated yes, participants were asked how many different TYPES of social groups they were with last night. TYPES of social groups were defined for participants: A different social group is classified as being in a group where the majority of the people have a different relationship to you than the last group you were with. For example, if you were at a bar with work colleagues and then went to a party where most people were acquaintances that would count as 2 social groups. However, if you were at a restaurant with mostly close friends and more friends joined you later in the evening that would still count as 1 social group because the majority of people were close friends even though the size of the group changed.

For each peer group reported (up to five groups), participants reported the following characteristics of the group: a) size of the group was indicated by the total number of people the participants were with; (b) peer relationships was indicated by the number of people with the

participant who were considered “close friends”, “acquaintances or new friends”, “school/extracurricular peers”, “work colleagues”, “family”, “religious peer group”, “strangers or meet-up group”, and “other”; (c) sex composition of the group was based on sex assigned at birth rather than gender composition and was a categorical response of “same-sex”, “same-sex, but of the opposite sex to you” or “mixed sex”; (d) time spent with each group was reported in hours; and finally (e) if participants indicated they drank alcohol that evening, they were asked if they consumed alcohol with each group and the number of standard drinks consumed while with each group.

Analytic Plan

Preliminary Analyses.

Descriptives. Descriptive statistics were summarized by frequency distributions, means and standard deviations of all variables. Intraclass correlations (ICCs) are reported for all variables to describe within- and between-person variability. Descriptive statistics regarding alcohol events were summarized including the number of drinking days, average number of drinks, proportion of drinking events with each social group (friends, family, co-workers etc.), and average consequences reported. Multilevel modeling was used to investigate any trends in alcohol use over time (Peugh, 2010). Time trends were controlled as a covariate in final analyses.

Broad Social Motives Measurement. Based on findings of study 1, the BSM measure was modified for studies 2 and 3. Confirmatory factor analyses (CFA) were used to further investigate the four-factor structure of BSM with co-workers, close friends, strangers, and family using baseline measures (N = 93) in study 3. CFA models were fit using the *lavaan* package in R. Global fit was assessed by χ^2 test of model fit, RMSEA, CFI, and TLI. Local fit was assessed by the number of

standardized residuals greater than 2. Additionally, high correlations among the estimates were investigated to determine redundancy among the items. Finally, modification indices were used to determine residual item correlations. Reliability estimates of each of the four factors were assessed using the *psych* package in R. Additional psychometric analyses were not indicated due to limited sample size.

Primary Analyses. Multilevel modeling was completed in the *lme4* package in R with robust maximum likelihood estimation (robust to non-normal data) and full information maximum likelihood for missing data.

Aim 2. Main effects of Broad Social Motives, Social Context, and Interactive Effects: Multilevel modeling with daily diary data was used to predict BSM and number of close friend drinking companions while controlling for the nested nature of the data. Participants reported on the number of drinks consumed with each social group. Thus, a three-level model was built with level 1 (group-level) number of close friends and level 2 (daily-level) BSM, and their interaction predicting number of drinks. Level 1 potential covariates were sex-composition and size of the group, level 2 (daily-level) covariates were drinking motives, affect, and time, and level 3 (person-level) covariates were TLFB past 30-day use, sex, age, race and ethnicity. Non-significant covariates and interactions were dropped from the final model reported. Number of consequences and estimated BAC were reported at the daily level, therefore, two-level models were used with level 1 (daily-level) and level 2 (person-level). Further, consequences was recoded as binary, yes or no, and predicted using logistic multilevel modeling due to a small number of individuals endorsing any consequences. On 13% of drinking events participants reported drinking with more than 1 social groups; for these models the group with whom participants drank the most was used for analyses. Level 1 (daily-level) predictors

were BSM and number of close friend drinking companions. Level 1 covariates were sex-composition of drinking companions, size of social group, drinking motives, affect, and time. Level 2 (person-level) covariates were TLFB-30-day alcohol use, sex, age, race, ethnicity. H1: On days when individuals' BSM is higher than their average BSM, participants will consume more alcohol, and report more consequences. Again, covariates correlated with outcomes greater than .3 were included in final analyses. H2: On days when most drinking companions are close friends, compared to new peers, participants are more likely to consume more alcohol and experiencing more consequences. H3: On days when more drinking companions are close friends compared to new peers and BSM are higher, participants are more likely to consume more drinks and experience more consequences, than when BSM are lower.

Example using formula of 2-level analyses from McNeish and Stapleton (2016):

$$AlcoholUse_{ij} = \beta_{0j} + \beta_{1j} * BSM_{ij} + r_{ij}$$

$$\beta_{0j} = \gamma_{00} + \gamma_{01} * PeerGroup_j + \gamma_{02} * GSize_j + \gamma_{03} * GSex_j + u_{0j}$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11} * PeerGroup_j + u_{1j}$$

Results

Preliminary Analyses

Descriptives. Participants (N = 60) completed on average 84.4% of assessments. Participants reported an average of 4.9 drinking events across the 12 assessment days. A small number of participants (N=4) did not report any drinking during the study window and were excluded from main analyses, which assessed drinking days only. Means, standard deviation, skew and kurtosis were evaluated for distributions of all items. One variable, the size of the social groups, had two outliers of

drinking events with over 100 people present. While plausible for a large event, it was unlikely individuals interacted with all people present at these events. These outliers were recoded to be the next highest group size, equal to 40 people. Table 8 summarizes drinking events reported across participants including daily alcohol use, consequences and number of drinking events with different social groups. Finally, alcohol outcomes did not change over time, but time was still controlled in the final models.

Table 8

Description of drinking events during daily diary assessments

	Median	Mean	SD	Min	Max
All Events					
Drinking Days	5.00	5.25	3.55	1.00	13.00
Number of Drinks	3.00	4.32	3.41	1.00	15.00
eBAC	0.04	0.06	0.06	0.00	0.28
Number of Consequences	0.00	0.62	1.01	0.00	5.00
Events by Social Group					
Friends	2.00	2.67		0.00	11.00
New Peers	0.00	0.60		0.00	4.00
Coworkers	0.00	0.90		0.00	3.00
Family	0.00	0.40		0.00	3.00
Strangers	0.00	0.13		0.00	2.00

Broad Social Motives Measurement. Baseline data (N = 93) was used to assess the measurement of BSM. Insufficient number of assessments meant the long version of BSM was unable to be assessed in a single model. CFA was conducted for the 20 items chosen to be included in the daily diary assessments. The model did not fit the data well $\chi^2 = 719.176$ (df = 190), $p < .001$, CFI = 0.714, TLI = 0.668, RMSEA = 0.100. Residuals revealed 9% of covariances were not adequately accounted for by the four-factor model. Investigating modification indices suggested some items for a given relationship were correlated more strongly than the latent variable accounted for. For example,

the top modification suggestion was adding a residual correlation between “I enjoy family gatherings” and “I value relationships with my family most in life”. Additionally, modification indices suggested residual correlations among the item stem “I enjoy making _____ feel happy” across all relationship types, and this was the lowest loading item on each factor. Other items did not seem to cut across relationship types. A single factor structure was considered but fit the data poorly. Reliability estimates for each of the four-factors were also modest with coworkers $\alpha = .71$, friends $\alpha = 0.59$, strangers $\alpha = 0.71$, and family $\alpha = 0.86$. However, analyses suggested reliability would not be improved by dropping the “I enjoy making ____ feel happy item” from any of the factors. Nor did it suggest dropping other items to improve reliability. It did reveal, however, that item responses on all items were heavily skewed towards agreeing with statements. Participants rarely endorsed “1, Strongly Disagree” for any items, with some items never being endorsed at a 1 or 2 response. Unfortunately, item selection for daily diaries was performed conceptually and based on EFA from study 1, and the present sample lacks power to account for the residual correlations with a latent variable model. Thus, analyses proceeded with mean scores of BSM items by relationship type. Results are interpreted considering the limitations of the measure used.

Primary Analyses

Three multilevel models using REML estimation and bootstrapped confidence intervals with 5,000 iterations were built for each of the primary outcomes tested: number of drinks consumed, number of consequences, and estimated BAC. Further, BSM of friends was most strongly correlated with outcomes. The other three BSM factors were not significant predictors of alcohol outcomes across all models and thus were dropped from the final models. The pattern of results did not change after excluding BSM of coworkers, strangers, and family and AIC and BIC indicated this improved model fit. For number of drinks consumed, ICC indicated the majority of variance in alcohol use is

attributable to within-person variation and only 35.4% of variance was explained by between-person differences. Sex composition of the group, social drinking motives, and TLFB average drinks were covaried in the final model based on significance testing and model fit. Sex composition was not significant after considering bootstrapped confidence intervals, however, AIC and BIC suggested model fit was poorer when excluded. There was a significant interaction between BSM of friends and the number of friends predicting estimated BACs. On days when individuals had higher than typical BSM for friends and the greater number of friends present in their social group, the more alcohol they consumed with those groups. While the main effect of number of friends was not significant, this is because it is quantified by the interaction and represents the effect of friends when BSM = 0. Examining the interaction plot in Figure 6 revealed across average levels of BSM, and both 1 standard deviation above and below the mean on BSM, there was a positive effect of number of friends. When socializing with groups, the higher number of friends present, the more alcohol individuals consumed. BSM for friends was also unrelated to number of drinks consumed when groups had 0 friends present. Model results are reported in Table 9.

Table 9

Multilevel regression analyses for number of drinks

Predictor	Estimate	SD/SE	t-value	p-value	95% CI lower	95% CI upper
Random Effects						
Intercept (person)	0.20	0.44				
Intercept (day)	0.48	0.69				
Fixed Effects						
Intercept	-0.57	2.29	-0.25	0.803	-5.13	4.01
BSM*Friends Interaction	0.18	0.09	2.09	0.037*	0.01	0.35
BSM for Friends	-0.20	0.50	-0.40	0.688	-1.18	0.78
Number of Friends	-0.54	0.38	-1.41	0.161	-1.31	0.22
Group Sex Composition						

Same-sex (ref)						
Opposite-sex	-0.37	0.52	-0.72	0.470	-1.42	0.66
Mixed-sex	0.68	0.34	1.98	0.049*	-0.01	1.36
Social motives	0.46	0.12	3.90	<.001***	0.23	0.69
Past 30-day mean drinks	0.33	0.08	4.17	<.001***	0.17	0.48

Note: SD = standard deviation of random effects, SE = standard error of fixed effects, CI = bootstrapped confidence interval. Significance level *** p < .001, ** p <.01, * p< .05, ^ p< .10.

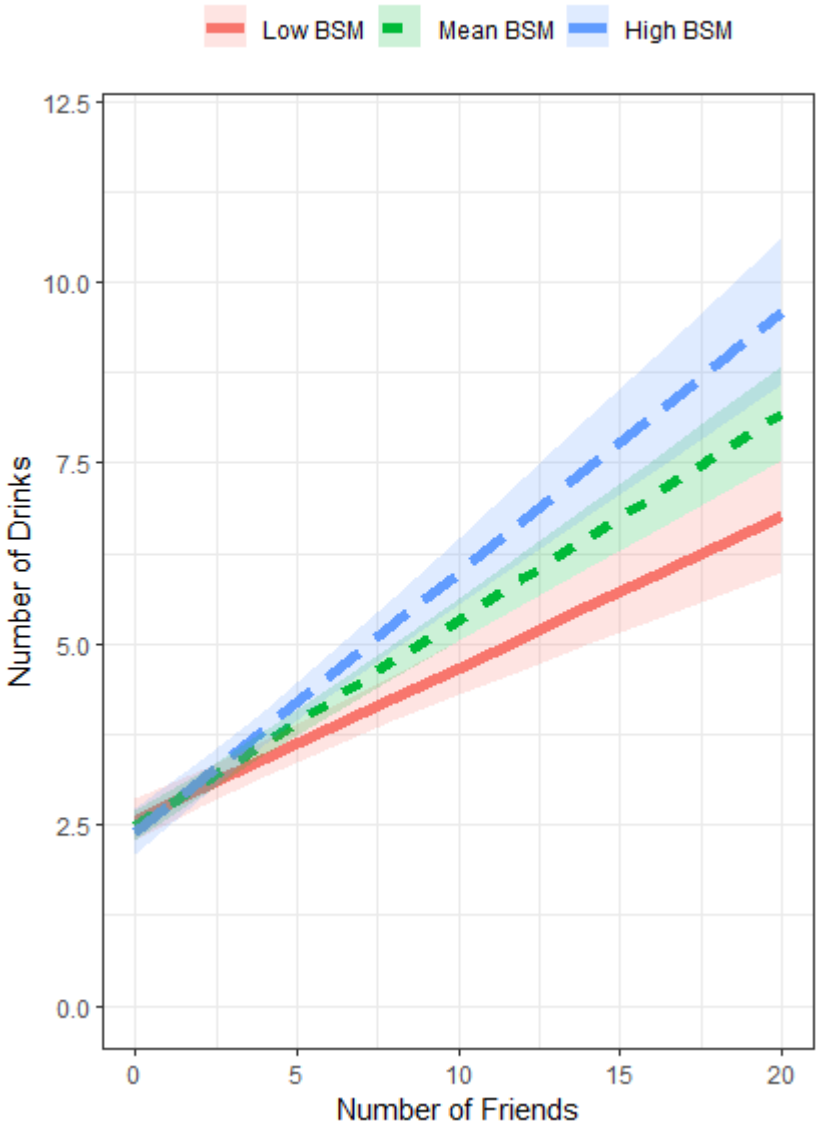

Figure 6. Interaction between daily BSM and the number of friends present in social groups predicting the number of drinks consumed with that social group.

About half (49%) of the variance for estimated BAC was attributed to between-person differences. Time, size of the group, social drinking motives, TLFB max BAC, sex, race and ethnicity were covaried. There was a significant interaction between BSM of friends and the number of friends predicting estimated BACs. On days when participants had higher than average BSM, drinking with more close friends was associated with a higher eBAC that evening. However, on days where participants had lower than average BSM, eBAC did not change depending on the number of friends present that day. See Figure 7. Model results are reported in Table 9.

Table 9

Multilevel regression analyses for estimated BAC

Predictor	Estimate	SD/SE	t-value	p-value	95% CI lower	95% CI upper
Random Effects						
Intercept	0.0005	0.023				
Fixed Effects						
Intercept	0.085	0.057	-1.49	0.139	-0.197	0.025
BSM*Friends interaction	0.004	0.002	2.39	0.018*	0.001	0.008
BSM for friends	0.013	0.011	1.18	0.241	-0.009	0.036
Number of friends	-0.019	0.008	-2.30	0.022*	-0.035	-0.003
Day number	0.0001	0.0009	0.17	0.868	-0.002	0.002
Group size	0.001	0.0005	2.46	0.015*	0.0002	0.002
Social motives	0.01	0.003	4.27	<.001***	0.006	0.016
Past 30-day max BAC	0.01	0.002	4.34	<.001***	0.006	0.015
Sex						
Female (ref)						
Male	0.029	0.01	2.81	0.008**	0.009	0.050
Race						
White (ref)						
Asian	0.056	0.015	3.84	<.001***	0.028	0.086
Mixed race	0.008	0.011	0.70	0.489	-0.014	0.029
Ethnicity						
Hispanic/Latinx (ref)						
Non-Hispanic/Latinx	-0.05	0.002	-2.41	0.021*	-0.092	-0.011

Note: SD = standard deviation of random effects, SE = standard error of fixed effects, CI = bootstrapped confidence interval. Significance level *** p < .001, ** p <.01, * p< .05, ^ p< .10.

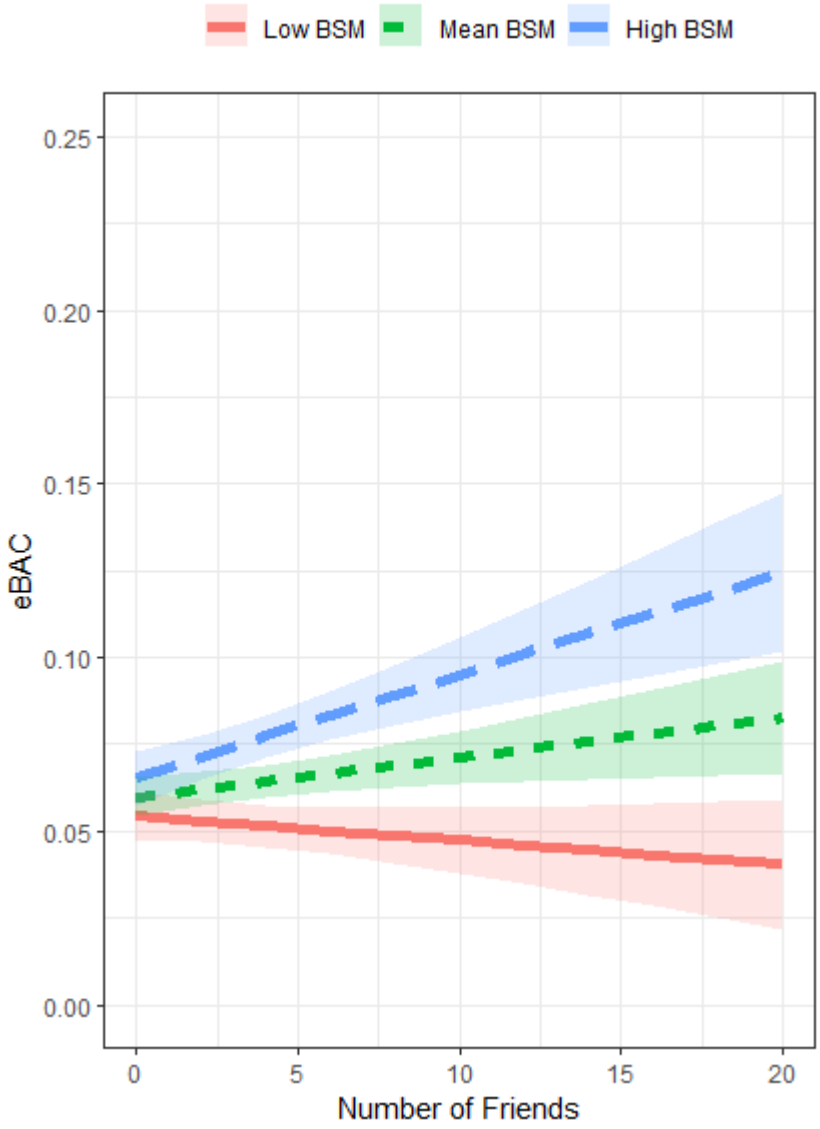

Figure 7. Interaction between daily broad social motives and the number of friends present predicting daily estimated blood alcohol concentration.

Alcohol consequences largely varied within person as well with 12.5% of variance being attributed to between-person differences. Time, TLFB past 30-day drinking, and ethnicity were covaried in the final model based on correlations and model fit. Only alcohol use was a significant predictor of alcohol consequences. On days when participants consumed more alcohol, they were more likely to experience more negative consequences. BSM of friends and number of friends were both not significant predictors of alcohol consequences. Model results are reported in Table 10.

Table 10

Multilevel logistic regression analyses for alcohol consequences

Predictor	Estimate	OR	SD/SE	t-value	p-value
Random Effects					
Intercept	0.14		0.38		
Fixed Effects					
Intercept	1.95	0.87	2.18	0.89	0.372
BSM Friends	-0.19	0.45	0.42	-0.45	0.653
Number of friends	0.06	0.51	0.04	1.64	0.101
Day Number	-0.03	0.49	0.05	-0.63	0.525
Past 30-day mean drinks	0.18	0.55	0.09	2.07	0.038*
Ethnicity					
Hispanic/Latinx (ref)					
Non-Hispanic/Latinx	-2.65	0.07	1.12	-2.38	0.017*

Note: SD = standard deviation of random effects, SE = standard error of fixed effects. Significance level *** p < .001, ** p <.01, * p< .05, ^ p< .10.

Chapter 4: Discussion

Conclusion

The current study was designed to investigate how individual's broad social motives (BSM) interact with different peer types to influence risk-taking and alcohol use in both a laboratory and naturalistic setting. We sought to address three main aims: 1) investigate the measurement of BSM, 2) evaluate the interaction between BSM and the presence of friends predicting alcohol and other risk-taking and 3) compare alcohol use during experimental and naturalistic observations among the same sample. While limited sample size hinders interpretation of aim 3, hypotheses for aim 1 and aim 2 were partially supported.

It was anticipated BSM would vary depending on relationship type and items selected would produce an adequate measure of social reward sensitivity. While all analyses were largely consistent with BSM varying by relationship type, exploratory and confirmatory analyses did not completely agree on the adequacy of the factor structure for the measure. As expected, all three EFAs produced factors largely related to relationship type. This suggests participants did respond to items consistently within each relationship type and similar items assessed across multiple relationships were distinguished in participant responses. The exception was similarities between school peers and close friends in the 5-factor model, suggesting overlap between these two peer groups. College students often meet many close friends through courses or seek out classes to take with their existing friend group, which may make these relationship types redundant. Even though not all school peers are close friends, the school peers they socialize with the most will likely be close friends and most social activities are likely school-related (e.g., Greek student life, sporting events, school clubs). Thus, school peer items were dropped in favor of the more specific close friends' factor and the final

4-factor model of BSM with close friends, coworkers, strangers, and family was accepted based on statistical and conceptual fit. However, similarities between school peers and friends should be replicated in future studies involving students. CFA in study 3 suggested certain items selected for the daily diary assessments were more similar across relationship types. Based on self-report, those who enjoyed making their friends happy, also consistently enjoyed making their family, coworkers, and strangers happy as well. Additionally, the range of BSM captured by this measure was limited due to limited variability in responses, with most participants agreeing with statements. Analyses are still overall consistent with BSM varying depending on the relationship type, however, further psychometric work is needed to select items that adequately vary by relationship type and capture subtle differences in BSM, which is a ubiquitously endorsed motivation. For the purposes of this study, the best measure available at the time was chosen and items were selected to fit with conceptual theories, yet, results should still be interpreted in light of limitations with measurement development.

Still, important differences in BSM became apparent in study 3. Consistent with Social Action Theory (Ewart, 1991), the presence of friends was found to interact with BSM to influence alcohol consumption, but this was not the case for alcohol consequences. On days when BSM were higher than typical for an individual, participants consumed more drinks and reached a higher BAC with their social group as the number of friends present increased. On days with lower than typical BSM, estimated BAC was unaffected by the presence of more friends. Overall, when participants were in groups with more of their friends, they also consumed more alcohol. These effects are not likely to be solely related to large drinking events such as parties, as the size of the social group overall was unrelated to alcohol outcomes. Importantly, these findings were also robust when controlling for social and enhancement motives for drinking, suggesting an important distinction between social

drinking motives and broader social motivation. Social drinking motives are thought to be a more proximal predictor of drinking and was shown in one study to mediate the association between BSM and alcohol use (Canning et al., 2016). Research should investigate how the activation of BSM by the presence of friends increases social drinking motives to in turn predict drinking. Notably, the drinking motives measure used by this study was a prospective measure and was captured at the same time as BSM, thus we are unable to adequately address the question of mediation. Overall, these findings support the importance of the interaction between BSM and the presence of friends predicting alcohol consumption behavior. Importantly, these findings do not demonstrate causal relationships. Additional research is needed to investigate why the presence of friends is associated with alcohol use, as increased risk taking due to rewarding social interactions is not the only potential explanation for these findings. On days when individuals want to drink more, they may be more likely to plan a large social gathering and invite more friends. Alternatively, more friends may present more opportunities for buying or offering drinks for others, or individuals may feel pressure to keep up their drinking pace with all the friends at events.

Nonetheless, These findings are consistent with previous research on Risk Shift (Stoner, 1961) and research showing college students report drinking more with friends compared to other types of peers (Varela & Pritchard, 2011; Cullum et al., 2012). At the same time, these findings do not support experimental research showing no impact of friends (Overbeek et al., 2011; Fromme & Dunn, 1992). While unable to interpret the experimental data from study 2, the pattern of results brings into question the robustness of these findings and warrants further investigation. Further research is needed to investigate how increased risky behavior in social groups contributes to drinking behavior and whether this demonstration of risk shift can be replicated in controlled experimental designs. If experimental studies are unable to demonstrate the influence of friends on drinking behavior, it is

likely either survey studies have yet to account for an important third variable, which better explain this phenomenon or there are limitations to ad-lib paradigms that do not allow risk shift to occur. This is complicated by the unique challenge of recruiting friends for alcohol administration research. Given the significant safety restrictions required to serve participants alcohol in a controlled setting, a large recruitment effort is needed to recruit enough participants both willing to refer friends and have a sufficient number of referrals to get eligible friends. Replicating this type of study requires close attention to recruitment and screening procedures to not introduce bias between experimental conditions. For example, it was noted in study 2 that after recruiting friends, those assigned to the new peer condition were upset they would not be participating with their friends. While naturalistic assessment seems to consistently demonstrate the phenomenon of risk shift, a series of carefully designed studies will likely be required to understand if this can be replicated in a lab setting.

Additionally, the lack of findings related to alcohol consequences brings into question whether increases in drinking were related to risk shift (e.g., increases in risk-taking behaviors broadly). BSM and the presence of friends were consistently unrelated to alcohol consequences despite increased levels of alcohol use. Potentially, social context may not consistently contribute to harmful experiences from alcohol use. The experience of negative consequences from alcohol is known to be related to more than simply the amount of alcohol consumed. Even when controlling for alcohol consumption, individuals may experience a greater range of consequences when drinking alone (Hultgren et al., 2022), drinking to cope, and experiencing greater negative affect (Dvorak et al., 2014). Consistent with this prior literature, the occurrence of consequences in both study 2 and study 3 was relatively low. Thus, further research is needed to understand when experiencing risk shift in social groups is likely to contribute to alcohol use interfering with daily life and health. It is also plausible the presence of friends is more likely to contribute specifically to individuals consuming

more alcohol than they typically would, however, it does not increase other risky behaviors as easily such as choosing to drink in a dangerous area.

Limitations

The present study has important limitations to consider when interpreting results. While unable to determine if differences are statistically significant, participants randomized to the Close Friends and New Peers condition seemed to differ both on BSM measures and anxiety at baseline. This may reflect a self-selection bias where only socially motivated individuals were willing to recruit and participate with their friends. For this reason, early in recruitment, protocols were switched to require participants to nominate friends before randomization (such that all participants had to nominate friends, even if friends might not be approached ultimately) and these differences may have dissipated with a larger sample size. Additionally, anxiety was quite low for the entire sample and did not appear to be related to any alcohol outcomes in the sample.

Further, there was a significant loss during recruitment related to friend recruitment, with 76% of eligible participants not recruiting enough eligible friends. This likely produces a selection bias for the entire sample where only participants with large groups of friends who drink alcohol were interested in the study. However, while it is likely possible to screen participants without friends out sooner by making the friend recruitment more explicit, it may be challenging to design a study where those with few friends would be eligible. Still, this lead to bias in the sample at scheduling between conditions. Notably, the imbalance in sample size came from participants exclusively assigned to the new peer condition no showing or not scheduling their appointments. In fact, one participant contacted us to inform the study team she was not interested in the study any longer because she was not randomized to drink with her friends. Unfortunately, those who do take the time to refer their

friends who drink are extremely interested in participating with their friends. While this may have partially been due to health concerns with the COVID-19 pandemic, this did occur pre-pandemic as well. Perhaps recruitment and bias between conditions would be improved with a repeated measures design where all participants are required to recruit friends, and then all participants drink with their friends on one day and new peers on a second day. Thus, changes in drinking behavior would also be compared within the sample individuals and the required sample size may be reduced as well.

Participants in the close friend condition were likely influenced by both peer type and friends' drinking. Research shows individuals have a tendency to match the drinking of those around them, when one person drinks their partner tends to also drink (Peterson et al., 2005). While confederates were instructed to match the participant's drinking behavior, we could not control friends' drinking behavior. Thus, participants in the close friend condition may have drank more simply because of trying to keep up with their friends either implicitly or explicitly. Alternative approaches were considered and the safest approach following NIAAA alcohol administration guidelines was chosen. This could be addressed in future large scale research to disentangle influences of peer drinking and the presence of certain peers.

Further, during alcohol administration the use of confederate peers in the New Peer condition limits the natural behavior of the drinking group. The Confederates were 1) not drinking real alcohol, 2) instructed to match the participant's drinking, and 3) aware of study procedures. As mentioned previously, drink matching was used as a safety precaution, as we did not want participants attempting to keep up with confederates consuming placebo beverages. Confederates were also trained in alcohol expectancies and expected behavior changes after consuming alcohol (e.g., being friendly, louder) in order to act as if they had consumed alcohol. There were a small number of

incidents where confederates forgot to behave as naïve participants (e.g., behaving as if they were familiar with the lab/lab mates). Upon debriefing participants, no participants expected their peers were confederates. Still, larger studies should follow up with both confederate and naive participant New Peer conditions to better investigate the influence of unfamiliar same-aged peers in drinking groups.

This study was limited by collecting next-morning retrospective reports of drinking and social groups. Event contingent (i.e. change in peer group) responses using EMA have poor response compared to signal contingent (i.e., text reminder) responses. In one study, 66% of participants did not initiate any EMA surveys even though the target event had been reported (Litt & Cooney, 1998). Thus, signal contingent assessments in the afternoon before and morning after drinking were utilized. Two surveys a day was chosen over a single survey to get more proximal estimates of behavior. Further, this design reduced participant burden by limiting each survey to approximately 5 minutes, which resulted in good adherence similar to other diary studies with 86% of surveys complete (Fairlie et al., 2016). Nonetheless, some limitations of this approach included possible difficulties with recall of social groups and alcohol consumption, particularly for those whose alcohol consumption may have been higher the night before. Further, a limitation of daily dairy assessments overall includes the need to use very brief measures of key constructs, which could affect our ability to detect some effects.

The measurement of BSM was also significantly hindered by a lack of psychometrically validated measures. Thus far, only one measure of sensitivity to social reward, the Social Reward Questionnaire (Foulkes et al., 2014), has undergone some psychometric testing. However, the SRQ does not specify motivation for different relationship types, which was a primary focus of this study.

It is unknown whether BSM varies by relationship type, which this study sought to investigate. Unfortunately, due to the limited data collection, preliminary analyses on the full list of potential BSM items was not possible. Additionally, the measure chosen for daily diaries did not fit the data well. Items were chosen conceptually due to a lack of a validated measure. Based on CFA and reliability testing, items capturing BSM at low levels on the factor need to be added to the measure to adequately capture a range of BSM. Finally, individual items need to be investigated for which ones very by relationship type, as one item, "I enjoy making _____ feel happy", tended to be consistent across relationships.

Significance

The current study was timely in investigating social group influences, currently expanding as a research area. However, it was perhaps ill-timed in light of the Covid-19 pandemic, which not only substantially interfered with collection of the lab-based data for study 2 but also affected the nature and social context of drinking by college students for an extended period of time (Hultgren et al., 2022). Nonetheless, while interpretation of findings is necessarily limited, the pattern of results does indicate the importance of investigating the influence of relationship with drinking companions on individual alcohol use. This study does highlight important questions still left unaddressed to explore in future research. Due to the complex nature of research with friends, our understanding of social group influences on drinking is very limited compared to other risk-factors. Thus, on-going research should seek to validate results utilizing several different methodologies; multimethod studies specifically may improve our understanding of how individual behavior changes within the experimental context. Continuing this line of research may improve our ability to prevent and intervene with high-risk drinking among college students. For example, perceptions of drinking behavior is well understood and can be leveraged in prevention and intervention programs, but

typically only challenge perceptions of general college student drinking. By understanding how students drink in various peer groups, norms challenges may be improved by addressing these distinct groups and incorporating friend behavior into the intervention. Further, individuals sensitive to social group influences may benefit most from Substance-Free Reinforcement Sessions, which utilize motivational interviewing to encourage social engagement without the use of alcohol (Murphy et al., 2012). Overall, this study expands on research on alcohol use and risk-taking and highlighted crucial areas for further research to advance our understanding of social influences on drinking.

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Appendix A

Procedure to Predict BAC

This study uses a formula from Curtin and Fairchild (2003), which is a modification of the Widmark equation (Watson, Watson, & Batt, 1981). The dose of alcohol in grams is a function of the target blood alcohol level (BAL), total body water (TBW), proportion of alcohol by volume (ABV) for the liquor, duration of drinking period (DDP), time to peak BAL (TPB), and alcohol metabolism rate (MR). The formula used to estimate BAC during alcohol adminsitration procedures is as follows:

$$Alc(g) = ((10 * BAL * TBW)/0.8 * ABV) + \big(10 * MR * (DDP + TPB)\big) * (TBW/0.8 * ABV)$$

Where,

Alcohol is in grams

BAL is in g/100 ml (i.e., .12g/100 ml)

DDP and TPB are in hours

TBW is in liters

MR is 0.015 g/100 ml per hour

ABV is a proportion (i.e., 0.40)

Additionally, TPB is assumed to be 0.5 hours after the drinking period.

TBW is estimated by gender-specific regression equations.

$$Males: TBW(l) = 2.447 - 0.09516 * Age(yr) + 0.1074 * Height(cm) + 0.3362 * Weight(kg)$$

$$Females: TBW(l) = -2.097 + 0.1069 * Height(cm) + 0.2466 * Weight(kg)$$

Finally, the grams of alcohol is divided by the density of alcohol at $24°C$ to convert grams to milliliters. The total milliliters is divided by 50 to determine the number of standard drinks a participant can safely consume before exceeding the BAL limit .12 g/100 ml.

Appendix B

Broad Social Motives – STUDY 1

Response Options 1 = "Strongly Disagree" to 5 = "Strongly Agree"

The following statements are about interacting with your CO-WORKERS. Please rate how strongly you agree or disagree with each statement.

1. At work, I am motivated to develop many personal friendships.
2. I prefer to work with a team, rather than by myself.
3. I value going out with co-workers after work to relax.
4. At work, I liked participating in sports teams or social groups.
5. I miss spending time with my former coworkers.
6. If my coworker was feeling down, it would be important for me to make them feel better.
7. I enjoy participating in work-related events.
8. I cherish the moments when I say or do something to make my coworkers smile.

The following statements are about interacting with your CLOSE FRIENDS. Please rate how strongly you agree or disagree with each statement.

1. My social life is very important to me.
2. I get excited and energized when making plans with my friends.
3. If my best-friend was feeling down, it would be important for me to make them feel better.
4. If I were to settle down, I would miss the excitement of my social life.
5. I appreciate the time I spend out with friends.
6. I cherish the moments when I say or do something to make my friends smile.
7. If I moved, I would miss my social network here.
8. I value my relationships with friends most in life.
9. I enjoy a movie more if I'm watching it with friends.
10. It is important for me to always be involved in one or more group for social engagement (clubs, sports, activity groups, meetups, etc.).

The following statements are about interacting with NEW PEOPLE. Please rate how strongly you agree or disagree with each statement.

1. I enjoy meeting new and exciting people.
2. I feel energized when I'm in a group of people.

3. I appreciate random conversations with strangers in public.
4. When I meet new people, I am motivated to develop personal friendships
5. I appreciate being introduced to new people.
6. I enjoy making friends anywhere I go.
7. If I moved, it would be important for me to create new social bonds.
8. If a stranger was feeling down, it would be important for me to make them feel better.

The following statements are about interacting with your FAMILY. Please rate how strongly you agree or disagree with each statement.

1. I enjoy family gatherings
2. I value my relationships with family most in life.
3. I cherish the moments when I reconnect with distant relatives.
4. If I moved, I would miss my family here.
5. I get excited and energized when planning family outings or vacations.
6. If a family member was feeling down, it would be important for me to make them feel better.
7. I appreciate moments when I say or do something to make my family smile
8. I miss spending time with my family.
9. I enjoy a meal more when having a family dinner.

The following statements are about interacting with your SCHOOL PEERS. Please rate how strongly you agree or disagree with each statement.

1. In school, I liked participating in clubs, school events, or intramural sports.
2. In school, I enjoyed interacting with my peers.
3. I appreciated school courses where we were encouraged to interact with peers.
4. I miss spending time with my former classmates.
5. In school, I am motivated to develop many personal friendships.
6. I value hanging out with my peers after class.
7. If my classmate was feeling down, it would be important for me to make them feel better.
8. I enjoyed a class more when I had friends in the class.
9. I get excited and energized when making plans with my peers for school activities.

BSM Long Version – Study 2 & 3

The following statements are about interacting with your CO-WORKERS. Please rate how strongly you agree or disagree with each statement.

1. I value my relationships with co-workers most out of life
2. I prefer to work with a team, rather than by myself.
3. I value going out with co-workers after work to relax.
4. At work, I liked participating in sports teams or social groups.
5. I miss spending time with my former coworkers.
6. If my coworker was feeling down, it would be important for me to make them feel better.
7. I enjoy participating in work related events
8. I cherish the moments when I say or do something to make my coworkers smile.
9. I enjoy being around co-workers who think I am an important, exciting person
10. I enjoy treating my co-workers fairly
11. I enjoy going to parties with my co-workers
12 I enjoy feeling emotionally connected to my co- workers
13. I enjoy it if my co- workers look up to me
14. I enjoy being a member of a work group
15. I enjoy being around co-workers who are impressed with who I am and what I do
16 I enjoy many of my co-workers wanting to invite me to their social events
17. I enjoy keeping promises I make to my co-workers
18. I enjoy achieving recognition from my co- workers
19 I enjoy it if my co- workers accept me as I am, no matter what
20. I enjoy making my co-workers feel happy

The following statements are about interacting with your CLOSE FRIENDS. Please rate how strongly you agree or disagree with each statement.

1. My social life is very important to me.
2. I get excited and energized when making plans with my friends.
3. If my best- friend was feeling down, it would be important for me to make them feel better.

4. If I were to settle down, I would miss the excitement of my social life.
5. I appreciate the time I spend out with friends.
6. I cherish the moments when I say or do something to make my friends smile.
7. If I moved, I would miss my social network here
8. I value my relationships with friends most in life.
9. I enjoy a movie more if I'm watching it with friends.
10. I appreciate the time I spend out with friends
11. I enjoy being around friends who think I am an important, exciting person
12. I enjoy treating my friends fairly
13. I enjoy participating in social events with my friends
14. I enjoy feeling emotionally connected to my friends
15. I enjoy it if my friends look up to me
16. I enjoy being around friends who are impressed with who I am and what I do
17. I enjoy many of my friends wanting to invite me to their social events
18. I enjoy keeping promises I make to my friends
19. I enjoy achieving recognition from my friends
20. I enjoy it if my friends accept me as I am, no matter what
21. I enjoy making my friends feel happy

The following statements are about interacting with NEW PEOPLE. Please rate how strongly you agree or disagree with each statement

1. I enjoy the time I spend meeting new people
2. I feel energized when I'm in a group of people.
3. I appreciate random conversations with strangers in public.
4. I value forming new relationships most in life.
5. I appreciate being introduced to new people.
6. I enjoy making friends anywhere I go.
7. If I moved, it would be important for me to create new social bonds.
8. If a stranger was feeling down, it would be important for me to make them feel better.
9. I enjoy being around strangers who think I am an important, exciting person

10. I enjoy treating strangers fairly
11. I enjoy going to events and meeting new people
12. I enjoy feeling emotionally connected to new people I meet
13. I enjoy it if strangers look up to me
14. I enjoy being a member of a group to meet new people
15. I enjoy being around strangers who are impressed with who I am and what I do
16. I enjoy many new people I meet wanting to invite me to their social event
17. I enjoy keeping promises I make to strangers
18. I enjoy achieving recognition from new people
19. I enjoy it if strangers accept me as I am, no matter what
20. I enjoy making strangers feel happy

The following statements are about interacting with your FAMILY. Please rate how strongly you agree or disagree with each statement.

1. I enjoy family gatherings
2. I value my relationships with family most in life.
3. I cherish the moments when I reconnect with distant relatives.
4. If I moved, I would miss my family here.
5. I get excited and energized when planning family outings or vacations.
6. If a family member was feeling down, it would be important for me to make them feel better.
7. I appreciate moments when I say or do something to make my family smile
8. I appreciate the time I spend with family.
9. I enjoy a meal more when having a family dinner.
10. I enjoy being around family who think I am an important, exciting person
11. I enjoy treating my family fairly
12. I enjoy feeling emotionally connected to my family
13. I enjoy going to parties with my family
14. I enjoy it if my family looks up to me
15. I enjoy being a member of my family
16. I enjoy being around family who are impressed with who I am and what I do

17. I enjoy many family members wanting to invite me to their social events
18. I enjoy keeping promises I make to my family
19. I enjoy achieving recognition from my family
20. I enjoy it if my family accepts me as I am, no matter what
21. I enjoy making my family feel happy

BSM Short Version – STUDY 2 & 3

Response options 1 = "Strongly Disagree" to 5 = "Strongly Agree"

The following statements are about interacting with your CO-WORKERS. Please rate how strongly you agree or disagree with each statement.

1. I value going out with co-workers after work to relax.
2. I enjoy participating in work related events.
3. I enjoy being a member of a work group
4. I value my relationships with co-workers most in life
5. I enjoy making my co-workers feel happy

The following statements are about interacting with your CLOSE FRIENDS. Please rate how strongly you agree or disagree with each statement.

1. I appreciate the time I spend out with friends.
2. I enjoy participating in social events with friends
3. I enjoy being a member of my friend group
4. I value my relationships with friends most in life.
5. I enjoy making my friends feel happy

The following statements are about interacting with NEW PEOPLE. Please rate how strongly you agree or disagree with each statement.

1. I enjoy the time I spend meeting new people.
2. I enjoy going to events and meeting new people
3. I enjoy being a member of a group to meet new people
4. I value forming new relationships most in life
5. I enjoy making strangers feel happy

The following statements are about interacting with your FAMILY. Please rate how strongly you agree or disagree with each statement.

1. I appreciate the time I spend with family

2. I enjoy family gatherings

3. I enjoy being a member of my family

4. I value my relationships with family most in life

5. I enjoy making my family feel happy