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Using Placebo Beverages in Group Alcohol Studies

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Abstract

Background.—Placebo beverage conditions remain a key element in the methodological toolkit for alcohol researchers interested in evaluating pharmacological and nonpharmacological factors influencing the effects of alcohol consumption. While interest in experimentally examining alcohol in social context is on the rise, there has been little research examining the effectiveness of placebo manipulations in group settings, when just one suspicious participant could potentially jeopardize the effect of the placebo on group members. Moreover, research has rarely considered the association between individual difference factors (e.g., gender) and placebo manipulation effectiveness. The present study, using an uncommonly large sample of placebo consuming participants, was well suited to investigate fundamental questions regarding placebo efficacy that have not been assessed previously. Specifically, we aimed to examine placebo efficacy and general processes of placebo functioning in a group context. We also assessed potential associations between a variety of individual difference factors and placebo response.

Methods.—240 participants (50% male) consumed placebo beverages during a triadic drinking period (across 80 three-person groups). Participants reported their subjective intoxication, stimulation, and sedation eight minutes following drink consumption and estimated the alcohol content of their drink at the end of the study.

Results.—Participants consuming placebo beverages in groups were nearly universal in reporting that they had consumed alcohol (>99%), and had experienced an increase in feelings of intoxication [$t(239) = 22.03$, $p < 0.001$] and stimulation [$t(239) = 5.53$, $p < 0.001$], levels that were similar to those observed in prior studies conducted with participants drinking placebos in isolation. Further, participants' placebo responses were independent of their two group members and were largely unaffected by a variety of individual difference factors.

Conclusions—Placebo response generally operated independently of group-member influences, suggesting that researchers can successfully conduct placebo beverage studies utilizing group drinking designs.

Keywords

Alcohol; placebo; social; group

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Introduction

Investigators have long been interested in disentangling pharmacological and nonpharmacological effects of drinking (Carpenter, 1967; Ross et al., 1962). To contrast these two factors, experimental research has evaluated the acute effects of alcohol by manipulating *dosage-set*, defined as participants' beliefs about the amount of alcohol they have consumed and their perceived degree of its effects (Martin & Sayette, 1993). [We distinguish dosage-set from *expectancy,* which denotes individuals' beliefs about the effects of alcohol on their emotions, cognitions, and behavior, often assessed via surveys.] Much of this research has been conducted using a placebo design, in which individuals consume a beverage that they are falsely told contains alcohol, and except for lacking ethanol, is designed to be otherwise similar to an alcoholic beverage. [1] Placebo beverages therefore aim to control for a host of variables associated with dosage-set, including sight, smell, initial taste, and belief that one is experiencing some effects of alcohol consumption (Martin & Sayette, 1993).

In the 1970's *balanced* placebo designs became popular, which included an anti-placebo deception condition in which alcohol was surreptitiously provided to participants while falsely telling them that they were receiving a non-alcohol control beverage. While such studies held great promise for orthogonally manipulating pharmacological and dosage-set influences, it eventually became apparent that with even modest doses of alcohol (e.g., 0.5g/kg), participants were unlikely to be deceived (Hull & Bond, 1986; Martin & Sayette, 1993; Ross & Pihl, 1989).

The traditional placebo beverage condition generally has fared better than the anti-placebo condition (Martin & Sayette, 1993). Some question, however, how well a placebo beverage controls for the nonpharmacological aspects of an alcoholic beverage, as opposed to generating a distinct set of "placebo" responses – e.g., compensatory physiological or behavioral responses in the opposite direction from what one would expect following alcohol consumption (Marczinski & Fillmore, 2005; Sayette, 1993; Testa et al., 2006). In some cases, investigators have decided that disentangling pharmacological and dosage-set effects is not worth the cost of adding a placebo condition to a study, instead contrasting alcohol to a no-alcohol control condition in which no deception is used (e.g., Curtin & Fairchild, 2003; Davis et al., 2007). Nevertheless, a wealth of data across numerous laboratories reveals that individuals receiving a placebo beverage nearly always believe that they have consumed at least some amount of alcohol (Martin & Sayette, 1993). Accordingly, though the placebo does not induce the same degree of perceived intoxication as do even moderate alcohol dose conditions (Martin & Sayette, 1993), it nevertheless may account for some of the effects of consuming alcohol and has been used in many seminal studies aimed at developing and testing alcohol theories (Hull, 1981; Sayette & Wilson, 1991; Sher, 1987; Steele & Josephs, 1990).

[1]This placebo deception manipulation differs from a no-information design, in which participants consume either alcoholic or nonalcoholic beverages without being informed what they will drink (Carpenter, 1968; Martin & Sayette, 1993).

Because placebo manipulations continue to appear in alcohol studies, research is still needed to examine processes underlying the placebo effect and to investigate factors affecting its successful manipulation. Certainly, there have been efforts to identify methodological features of placebo administrations (e.g., beverage content, information provided to participants, assessment of placebo deceit success) that influence placebo manipulation efficacy (Rohsenow & Marlatt, 1981; Martin & Sayette, 1993; Schlauch et al., 2010). Despite evidence that drug-related expectancies differ between individuals and across situations (Vogel-Sprott & Fillmore, 1999), there has been a surprising lack of research aimed at examining how individual and social factors may influence the degree to which participants are successfully deceived by placebos. As Sher (1985) noted, comprehensive understanding of the subjective effects of alcohol requires consideration of the drink, setting, individual's subjective state, and the drinker more generally, indicating a need to examine the influence of both inter- and intra-individual contextual factors on subjective experiences associated with placebo beverage consumption.

Placebos in Social Context

Placebo researchers have noted the potential for social setting to affect placebo manipulations (Marlatt & Rohsenow, 1980), yet investigations on this topic are scarce and extant findings are inconsistent. For example, while initial experimental research did not detect differences in reported drunkenness between participants who consumed a placebo beverage with others compared to those who drank alone (Sher, 1985), recent research found social setting to enhance aspects of subjective experiences of placebo-group participants (e.g., feeling "high" and "friendly") (Kirkpatrick & de Wit, 2013). Unfortunately, examination of placebos in social settings has been limited by the relative lack of alcohol administration studies that incorporate social context (Sayette et al., 2015). Recently, however, there has been a push to integrate social context into alcohol studies (Fairbairn & Sayette, 2014; Corbin et al., 2015; Kirkpatrick & de Wit, 2013; Leeman et al., 2009; Winograd et al., 2017). Concomitant with this rising interest is the need to more comprehensively assess the functioning of placebo beverages in group contexts.

While research to date suggests that mean subjective effects of placebo consumption are similar in group settings and individual settings (Corbin et al., 2008; Corbin & Cronce, 2017; Sayette et al., 2012a), by itself a mean value does not permit examination of the role of group contagion in these subjective experiences. Because social interactions foster potential for contagion of subjective states via nonverbal cues (Barsade, 2002), when placebos are administered in group settings, group members may reciprocally influence each other's subjective intoxication experiences. That is, placebo manipulations may function more similarly among members of the same group than they do between members of different groups. This within-group "contagion" would be a particular concern if one group member failed to be deceived by the manipulation and in turn "pulled down" the subjective intoxication of the other group members, thereby diminishing the placebo efficacy for the entire group.Contagion might also work to the experimenter's advantage; if one participant experienced substantial subjective intoxication, he/she could enhance the manipulation efficacy among the other group members. Such processes specific to a placebo condition have yet to be explored.

In addition to the potential impact of general group processes on placebo manipulations, more complex dynamics related to specific characteristics of group members may influence placebo effectiveness. Of particular relevance to group dynamics in alcohol research is gender, as gender roles and interactions are inextricably linked with drinking practices (Room, 1996). One's gender can affect naturalistic drinking practices and response to experimental manipulations of alcohol consumption (Borsari & Carey, 2001; Marlatt & Rohsenow, 1980; Rohsenow & Marlatt, 1981). Moreover, gender composition of drinking groups can alter alcohol consumption experiences (Bot et al., 2005; Room, 1996; Rosenbluth et al., 1978; Sykes et al., 1993). The interplay between individual and group-member gender may influence the drinking experiences of individuals who believe they are consuming alcohol, even when they are in fact consuming non-alcoholic beverages.Consequently, gender warrants consideration in assessing efficacy of placebo manipulation in group contexts.In addition to gender, a variety of traits (e.g., alcohol expectancies, extraversion, impression management, sensation seeking, drinking history, and self-consciousness) (Christiansen et al., 1989; Fairbairn et al., 2015; Hull et al., 1986; Sayette et al., 1990; Scott and Corbin, 2014; Viken et al., 2003) and temporary states (e.g., stimulation, mood) (Marczinski, 2011; Swendsen et al., 2000) have been associated with problematic alcohol use and response to drinking.To date, gender and many other individual differences that might influence placebo responding in a social context generally have not been evaluated, in part due to the absence of placebo group studies offering sufficient power to provide sensitive tests

Present Study

The present study examined the response to placebo manipulation in 240 social drinkers, split into 80 three-person drinking groups. Participants were recruited as part of a broader examination of alcohol and social responding (Sayette et al., 2012a). To our knowledge, this is the largest test of placebo responding in a group context, and perhaps in any context, which allowed us to comprehensively examine placebo functioning. Our primary aim was to assess placebo efficacy and general processes of placebo functioning among placebos administered to participants in group contexts. In addition, we examined a host of individual difference factors – at both the individual- and group-level – that could potentially influence placebo response.

Materials and Methods

Design

The parent investigation employed a single factor (*drink:* alcohol, placebo, no-alcohol control) between-subjects design. Participants were randomly assigned to three-person drinking groups, which were randomly assigned to one of three drink conditions. [See Sayette et al., 2012a for details regarding the investigation of all three drink conditions.] The present study focuses on those participants randomly assigned to consume a placebo beverage while drinking in three-person groups.

Participants

Healthy moderate drinkers between the ages of 21 and 28 were recruited via local newspaper ads.As detailed in Sayette et al. (2012a), participants were screened for the study's exclusion criteria after providing informed consent.Participants were required to be within 15% of the ideal weight for their height, have no medical conditions that contradicted alcohol consumption (e.g., pregnancy for females), and have no history of alcohol abuse or dependence as indexed by DSM-IV.Additionally, participants were required to affirm that they could comfortably consume at least three drinks within 30 minutes. The final sample consisted of 240 participants (120 men, 120 women; 81.3% European American, 14.6% African American, 0.8% Hispanic, 3.3% other). Participants reported drinking on average 3.67 (*SD* = 0.99) times per week and consuming 4.25 (*SD* = 1.92) drinks per occasion.

Procedure

The University of Pittsburgh's Institutional Review Board approved the study. Prior to screening for exclusion criteria, participants were informed that the purpose of the study was to examine alcohol's impact on cognitive performance. Those who provided informed consent and passed the screen for exclusion criteria were invited to the lab for a full screening session, wherein they completed various self-report assessments (*see measures)* and were randomly assigned to three-person groups. Twenty groups of each of four possible gender compositions (three males; two males and one female; one male and two females; three females) were assigned to the placebo beverage condition.

Participants returned to the lab for a second session, such that all members of the three-person drinking group completed the second session simultaneously. Prior to the start of the drink period, participants were casually and individually introduced to assure that they were not previously acquainted (Kirchner et al., 2006). [Four or five participants were invited to each experimental session to ensure composition of a group of three strangers.] Participants were immediately escorted to separate rooms, rinsed their mouths with mouthwash, and a few minutes later provided a blood alcohol concentration (BAC) breath sample to confirm sobriety by a zero reading. Participants were told the mouthwash was to ensure an uncontaminated BAC reading, when in fact it served to reduce taste sensitivity (Rohsenow & Marlatt, 1981). Participants then completed various self-report assessments (*see measures*) prior to convening for the drink consumption period.

Placebo beverages were mixed individually in front of each participant. Drinks were mixed by pouring 1 part chilled flattened tonic water out of a Smirnoff's vodka bottle (Norwalk, Connecticut), followed by 3.5 parts cranberry-juice cocktail, into a pitcher. Next, one third of the beverage was poured into a drinking glass. To further enhance deception, the rim of the glass had been smeared with vodka (Abrams & Wilson, 1979; Sayette & Wilson, 1991; Steele & Josephs, 1988). Participants were told that their drinks contained a dose of alcohol that was less than the legal limit to drive. After the drink was mixed, participants were escorted to the group drinking room where the remainder of their drink was placed in a refrigerator (this was done to keep the drinks chilled and to ensure that drinks were never out of participants' sight).

The three-person group was seated equidistantly around a circular table for the drinking period. Participants were instructed that they would have 36 minutes to consume their drinks, prior to separating and completing several tasks (the ostensible purpose of the study). [Participants were told that they were seated in the same room to facilitate drink administration and communication with the experimenter.] Once all three participants had entered this room, they were asked to consume their first glass evenly over 12 minutes, as long they were not feeling uncomfortable. Participants were told they were free to talk about whatever they wished, except that they were to refrain from discussing their perceived intoxication. Participants were informed that cameras permitted the experimenter to observe whether they were drinking at the proper pace. Experimenters entered the room only to refill drinks. Participants were provided with the second and third portions of their beverage at minutes 12 and 24, respectively, such that each participant drank the entire beverage evenly over 36-minutes.

After completion of the drink period, participants' BACs were measured. To help control for dosage set, participants were presented with randomly assigned BAC readings that ranged from 0.041% to 0.043%, as this BAC is about the highest credible reading for participants in alcohol studies who have been given placebo beverages (Martin & Sayette, 1993). Participants were asked to report their perceived intoxication eight minutes after the drink consumption period ended. Participants then completed multiple mood and social bonding measures and performed some cognitive and emotional tasks (see Sayette et al., 2012b; Sayette et al., in press), which are irrelevant to the current study. Participants were debriefed, paid $60, and permitted to leave.

Measures

Placebo response

Efficacy of placebo response has traditionally been assessed two ways, both of which were used here. First, to assess whether or not participants believed they had consumed alcohol, they completed a post-experimental questionnaire (210 minutes post-drink) that asked them to estimate how many ounces of vodka they had consumed.[2] Second, to determine the extent to which the manipulation was effective, directly prior to the drink consumption period and then about eight minutes after the drink period ended, participants reported their level of intoxication and degree of stimulation and sedation. Specifically, participants reported their subjective intoxication using a Subjective Intoxication Scale (SIS), ranging from 0 (*not at all intoxicated*) – 100 (*the most intoxicated I have ever been*). Responses of zero on the pre-drink SIS would ensure that post-drink responses were not driven by pre-drink subjective experiences. Responses to the post-drink SIS were used in analyses to explore placebo effectiveness based on group member and individual-difference influences. The Biphasic Alcohol Effects Scale (BAES) was used to assess stimulation and sedation. Pre- to post-drink changes in stimulation and sedation provided indication of placebo effectiveness (while pre-drink scores represented markers of individual state differences – see below). The

[2]Previous research has suggested that simply asking how much alcohol was consumed (using a scale that includes zero) elicits less experimental demand than does asking participants first to indicate whether or not they thought they had consumed alcohol (yes/no), followed by rating how much was consumed (see Hull & Bond, 1986).

end of session ounce estimation, SIS, and BAES have all been used previously to assess effectiveness of placebo manipulations (Corbin et al., 2008; Kirchner et al., 2006).

Individual trait differences.

Alcohol expectancy questionnaire (AEQ)

The AEQ measures beliefs people have regarding the effects of alcohol on affect and behavior (Brown et al., 1987). We assessed general alcohol expectancies using the global subscale (α = .84).

NEO-five factor inventory

The NEO-five factor inventory is an abbreviated 60-item version of the revised NEO Personality Inventory, which assesses the five domains of adult personality (Costa & MacCrae, 1992). For the present study, we focused on extraversion (α = .81).

Balanced inventory of desirable responding (BIDR)

The BIDR measures the tendency to give self-reports that are honest but positively biased and to present oneself in a deliberate manner to an audience (Paulhus, 1991). The full-scale score was analyzed in the present study (α = .80).

Impulsivity/sensation seeking scale (ISSS)

The ISSS assesses impulsivity and sensation seeking (Zuckerman, 1994). We utilized the full-scale score in the present study (α = .80).

Drinking history

Drinking history was assessed with respect to frequency of drinking occasions per week (“How often do you currently drink alcohol?”) and typical quantity consumed per occasion (“When you drink, how many drinks do you have on average”).

Self-consciousness scale-revised (SCS-R)

The SCS-R measures (a) *private self-consciousness* – the degree to which an individual directs attention toward private aspects of the self that are more hidden from the evaluation of others; (b) *public self-consciousness* – the degree to which an individual focuses on public aspects of the self, such as behaviors or mannerisms that can be judged by others; and (c) *social anxiety* – considered as a specific type of reaction to public self-consciousness, such that it is an awareness of the public-self combined with concern about others’ evaluations of one’s self-presentation (Scheier & Carver, 1985). Separate scores were calculated for each of the three subscales (private: α = .71; public: α = .80; social anxiety: α = .80).

Individual state differences

Positive and negative affect scale (PANAS)

The PANAS comprises two independent affect scales assessing current experiences of positive and negative affect (Watson et al., 1988). It was used to assess subjects' affect *prior* to the drinking period. Separate scores were calculated for both affect subscales (positive: α = .86; negative: α = .67).

Biphasic alcohol effects scale (BAES)

The BAES measures stimulatory (e.g., "Energized," "Excited") and sedative (e.g., "Heavy Head," "Difficulty Concentrating") state experiences (Martin et al., 1993). Separate scores were calculated for the stimulatory and sedative effects participants reported experiencing both prior to and after the drinking period (pre-drink stimulation: α = .90; pre-drink sedation: α = .83; post-drink stimulation: α = .92; post-drink sedation: α = .84).

Data Analytic Plan

All analyses were conducted using IBM SPSS Statistics 24 and HLM 7. First, we assessed participants' estimates of the number of ounces of vodka they had consumed to determine whether or not they believed that had consumed any alcohol. Next, we examined mean level of pre-and post-drink SIS and BAES scores (and to provide additional context we also report our prior findings with our alcohol-group condition) (Creswell et al., 2012; Sayette et al., 2012a). We also ran paired samples *t*-tests to assess the degree to which the placebo manipulation induced feelings of intoxication in participants. For the placebo response measures – SIS, BAES stimulation, BAES sedation – that demonstrated sensitivity to the manipulation (i.e., significant change from pre- to post-drink), subsequent analyses were conducted (see below).

Placebo response contagion

To test for potential placebo response contagion within groups, we computed intraclass correlation coefficients (ICCs), which are widely used to assess the magnitude of group effects (Bliese, 1998). Individual participants' data, identified by the three-person drinking groups to which they belonged, were entered into HLM 7 to derive the level-1 (σ^2) and level-2 ($\tau 00$) variance statistics needed to calculate the ICC. ICC values range from zero to one, with values closer to one signifying that substantial variance is accounted for by group membership (Anderson, 2012). Separate ICCs were calculated for each relevant placebo response measure (i.e., each measure that demonstrated sensitivity to the manipulation).

The effect of group- and individual-level variables on placebo response

The next set of analyses was based on two-level hierarchical linear models that aimed to assess potential factors that might predict the degree of manipulation effectiveness for individual participants. For each analysis, an initial null (intercept only) two-level model was run to establish a deviance statistic for comparison of model fit with the subsequent model. In the full models (i.e., wherein all effects were entered), the level-2 intercept was modeled as a random effect and all other effects were modeled as fixed. Deviance statistic

comparisons were based on full maximum likelihood estimation. Coefficients reported were based on restricted maximum likelihood estimation (Raudenbush, 2004).

Gender

Because our study systematically manipulated group gender composition, we were able to assess the complex interplay between individual and group-member gender. A group actor-partner interdependence model (GAPIM) approach (Kenny & Garcia, 2012) was used to assess the influence of gender (represented by four unique effects) – individual participant's gender (actor effect), average gender of the other group members (others' effect), similarity of the actor's gender to the average gender of the others in the group (actor similarity), and similarity of the gender of the others in the group to each other (others' similarity) – on placebo response.[3] Separate models were run for each relevant placebo response measure.

State and trait individual differences

The large sample also offered a prime opportunity to evaluate potential individual difference variables (in addition to gender) – at both the individual- and group-level – that might influence placebo effectiveness.We examined the effect of four pre-drink state and nine trait variables on placebo response (see above for list). Individual-level group mean centered variables were entered at level one and group means were entered at level 2 (Feaster et al., 2011). Two models – with state and trait variables, respectively – were analyzed for each relevant placebo response measure.

Results

With one exception, all 237 participants reported having consumed a positive (nonzero) amount of vodka ($M = 4.64$ ounces, $SD = 5.44$).[4] We next examined pre- and post-drink assessments of placebo response. To offer context for evaluating the placebo responses, we also report response measures for groups of participants assigned to the alcohol condition (see Table 1). Pre- to post-drink change in sedation among placebo-consuming participants was 24.0% (in the opposite direction) of that demonstrated by alcohol-consuming participants.[5] Subjective intoxication and stimulation, however, increased among participants in both conditions. Specifically, post-drink subjective intoxication and change in stimulation among placebo-consuming participants was 38.5% and 39.3% that of alcohol-consuming participants. This level of response relative to alcohol consuming participants is consistent with what has been observed in previous studies testing individuals consuming placebos in isolation (Sayette et al., 2005). Subsequent analyses are limited to placebo-consuming participants.

A paired samples t-test indicated pre- and post-drink SIS responses differed significantly: $t(239) = 22.03$, $p < 0.001$). All but two participants (99%) reported zero intoxication on the

[3]In a full model containing the four gender effects, the actor effect can be interpreted as the interaction between individual- and group-member gender, which indicates whether the effect of similarity between individual- and group-member gender differs for males and females, respectively (Garcia et al., 2015).

[4]Three participants failed to report data on estimated ounces consumed.

[5]Four participants' responses to the sedation measure were outliers. These responses were removed in calculating the percentage change in sedation of placebo vs. alcohol consuming participants.

pre-drink SIS, indicating that any degree of intoxication reported on the post-drink SIS could reasonably be attributed to the drink manipulation.[6] Pre- and post-drink stimulation scores differed significantly, $t(239) = 5.53$, $p < 0.001$, whereas sedation scores did not, $t(239) = -0.83$, $p = 0.41$.[7] Taken together, the non-zero estimates of ounces consumed, the relative response to alcohol-consuming participants, and the pre- to post-drink changes in reported subjective intoxication and stimulation suggest that the placebo manipulation conducted in this group design generated similar levels of effectiveness compared to prior individually-administered placebo studies. Because the placebo manipulation specifically affected SIS and BAES stimulation scores, subsequent analyses further explored the functioning of placebo response as assessed by these two measures.[8]

Placebo Response Contagion

Despite the similar overall placebo response scores in this study compared to prior studies administering placebos in isolation, response variability left open the possibility that participants with extreme scores still might affect placebo efficacy for their group members. Both the SIS ICC (.06) and BAES stimulation ICC (.04) approached zero (Garson, 2013). Thus, these data indicate that even when placebos are administered in a group setting, participants' reported placebo responses operate fairly independently of one another.[9]

The Effect of Participant Variables on Placebo Response

Gender

GAPIM analyses were conducted to assess the effect of individual- and group-member gender on placebo response. Data were analyzed using hierarchical linear modeling to account for interdependence of between-subjects data in spite of the low ICC identified in the earlier analysis, as dependence of scores based on group-membership can increase with additional predictors (Anderson, 2012). While results of the full SIS model hinted at a potential actor effect [$B = -0.20$, $t(156) = -2.05$, $p = 0.04$, $d = -0.28$], the effect approached conventional cutoffs for significance (Cohen, 1994) (see Table 2 for full model results).[10] Further, the likelihood ratio test, which compared deviance statistics between the null and full model, was not significant [$X^2(4) = 6.45$, $p = 0.17$], indicating that the null model fit the data just as well as the full model.[11] Relatedly, none of the gender effects nor the likelihood ratio test [$X^2(4) = 5.64$, $p = 0.23$] were significant in the full model assessing pre- to post-

[6]We ran subsequent SIS analyses with the two participants who reported non-zero pre-drink SIS scores removed. Results did not meaningfully differ from when all data were included, thus, analyses including all participants are presented in text and tables.
[7]Responses to the pre- and post-drink sedation measures were positively skewed. Thus, the t-test assessing change in sedation utilized log-transformed scores, which corrected for skew and outliers in the raw data.
[8]In addition to the primary analyses conducted with SIS measured at eight minutes post-drink (as reported below), subsequent analyses were conducted utilizing SIS scores measured at 52 minutes post-drink. Results did not meaningfully differ from those reported below, suggesting further social interaction did not alter the magnitude of group- or individual-level effects on participants' subjective intoxications.
[9]Notably, ICCs for SIS and BAES responses were similarly low among alcohol-consuming groups (ICCs ≤ .01).
[10]When the null SIS model was initially run, the test of homogeneity of level-1 variance was significant [$X^2(79, 240) = 123.50$, $p < .01$], indicating that the residual variances differed significantly across drinking groups (Garson, 2013). Thus, the SIS scores were transformed using a square-root function, as graphical inspection of the data and the subsequent homogeneity test indicated the transformation produced homogenous variance: $X^2(79, 240) = 51.12$, $p > 0.50$. The transformed score was used in all subsequent SIS analyses.
[11]Sequentially removing non-significant gender effects from the model did not result in better fit.

drink change in stimulation (Table 2). Thus, neither individual gender, group-member gender, nor their interaction, seemed to meaningfully influence participants' placebo response.

State and trait individual differences

We next examined the effect of four pre-drink state and nine trait variables on placebo response.To reduce the likelihood of Type I error, we utilized Bonferroni corrections in assessing significance by dividing the standard significance cutoff ($p = 0.05$) by the number of predictors for each analysis (Cabin & Mitchell, 2000; Keppel & Wickens, 2004).

Pre-drink states

In the model assessing the effect of pre-drink states on SIS, none of the individual- or group-level predictors, nor the likelihood ratio test [X^2 (8) = 7.99, $p > 0.50$], were significant (see Table 3).In contrast, when assessing pre- to post-drink change in stimulation, the full model exhibited significantly better fit than the null model [X^2 (6) = 38.94, $p < 0.01$].Specifically, significant positive associations were observed between stimulation change and pre-drink individual-level sedation ($d = 0.63$), individual-level positive affect ($d = 0.56$), and group-level positive affect ($d = 0.52$), respectively. Additionally, there was a significant negative association between stimulation change and pre-drink individual-level negative affect ($d = -0.63$).

Traits

Assessment of the effect of traits on SIS did not yield any significant predictors and the likelihood ratio test [X^2 (18) = 20.74, $p = 0.29$] was not significant (see Table 4).Similarly, in assessing the effect of traits on pre- to post-drink change in stimulation, no predictors were significant, nor was the likelihood ratio test significant [X^2 (18) = 13.27, $p > 0.50$].[12] Thus, the effectiveness of the placebo beverage manipulation among groups of strangers apparently was not linked to any of the individual trait difference measures that we posited to be candidates for such an association.

Discussion

As research interest in the effects of alcohol in group contexts increases (Fairbairn & Sayette, 2014; Kirkpatrick & de Wit, 2013; Leeman et al., 2009), investigators must be confident that placebo manipulations traditionally used with participants in isolation also can be implemented in group designs. Indeed, prior to embarking on our group drinking research program, our chief concern was how well our placebo manipulation would function in a group setting. In particular, we worried that one participant's suspicion about the drink content would contaminate the manipulation for the other two group members. Such a finding would call into question the presumed feasibility of using placebo beverages in group contexts.[13] The large sample in the present study offered sufficient power to comprehensively evaluate this concern, and permitted examination of the effect of other

[12]Eight participants failed to report necessary data on trait measures, thus, trait analyses were limited to 232 participants.
[13]We thank Drs. Kim Fromme and Chris Martin for their suggestions on this matter.

group processes and individual differences on placebo responding, in order to inform future placebo administration research.

Placebo Efficacy

The present analyses suggest that concern that drinking studies using groups of strangers threaten conventional placebo efficacy may be unwarranted Nearly every participant reported consuming some amount of alcohol, a finding that is all the more encouraging given the time elapsed following drinking and the conservative nature of the efficacy measure used (Hull & Bond, 1986) In addition, the average placebo response observed in the sample just following beverage consumption was comparable to what prior placebo administration studies have demonstrated among participants drinking in isolation.For instance, in the two prior studies from our laboratory that administered a placebo beverage to participants alone using similar participant demographics and methods (including similar efforts to execute the placebo deception and similar time interval between eating and beverage administration), scores on the same SIS measure as used in this study were 11 and 19 (Sayette et al., 2005; Sayette et al., 2009), values that are comparable to the 14.9 observed here. Of course, future research may benefit from more direct comparisons of responding to placebos administered in isolation vs. groups (Kirkpatrick & de Wit, 2013; Sher, 1985).

While our lab has generally employed consistent procedures for inducing placebo deception across studies, there is indeed a range of options available to experimenters with respect to the degree to which deception is used, including no information (participants are told nothing about their drink content), partial information (participants are told their drink may or may not contain alcohol), and false information (participants are falsely told their drink contains alcohol) designs (see Martin and Sayette, 1993).The present study utilized a false information design, based on recommendations outlined by Rohsenow and Marlatt (1981). Our approach of utilizing as many tactics as possible to help participants buy into the deception (e.g., taste sensitivity manipulation, false BAC reading, visual cues) appeared profitable, as participants reported believing they had consumed an average of 4.64 ounces of alcohol. The extent to which group processes would affect placebos under alternative deception conditions remains to be tested.

While the present study's deception approach successfully manipulated participants' experiences of subjective intoxication and stimulation, it failed to yield significant change in sedation from pre- to post-drink. The lack of sedation change should be considered in the context of the amount of alcohol participants were led to believe they consumed, as well as the timing of the assessment. With regard to amount of alcohol, a BAC reading of about .04% was shown to participants to enhance the credibility of the deception (as noted above, this level is about the maximum that placebo-consuming participants appear to believe; see Martin & Sayette, 1993). Because sedative effects are more likely to be anticipated for consumption of high doses of alcohol (Earleywine & Martin, 1993), the BAC reading, which was intended to enhance the deception on the whole, may have reduced the likelihood that participants would report sedative effects. Nonetheless, even if participants had not viewed

the BAC reading, we might still expect minimal sedative effects to be reported due to the timing of the assessment.

Participants reported their sedation about 8 minutes post-drink, a time point at which placebo-consuming participants would likely expect to be feeling stimulated, rather than sedated, were they consuming alcohol (as they were led to believe). Research suggests that the effects of placebos tend to be short-lived, making it difficult to test over extended periods of time (Martin & Sayette, 1993). Nevertheless, were placebo effects able to be maintained for longer periods, then assessment of placebo response at alternative time points would be warranted in future research. In theory, assessing whether placebo-consuming participants demonstrate a shift in endorsing stimulant effects to sedative effects over repeated measures – and, specifically, whether the pattern of these effects would mirror the typical limb effects observed among alcohol-consuming participants – would be of interest, especially if individual variability in such response could be linked back to etiologically significant markers (Newlin, 1985; Sayette, 1993). The most common approach to date, however, has been to assess placebo response soon after the drinking period has ended, and present results suggest that participants experience significant subjective intoxication and stimulation at that time.

Placebo Response Contagion

While prior work has indicated that, on average, placebo responses are similar in group- and individual-designs, these data do not rule out the possibility that large group contagion effects still might be present. That is, there may be some groups in which all members report very low placebo response and others in which all members report very high responses. In this case, the mean level of response would appear similar to that observed with individually-administered placebos and yet the underlying contagion would necessarily complicate interpretation of this beverage comparison condition. The present study found no evidence that participants who experience substantially low (or high) subjective intoxication or stimulation diminish (or enhance) placebo effectiveness for their group members, as the ICC values confirmed the independence of each group member's placebo response experience. While we were somewhat surprised that social context exerted such minimal effects on placebo response, these data are reassuring to researchers aiming to execute placebo administrations using group designs. Importantly, this independence of placebo responding may reflect our aim of *minimizing* within-group contagion of placebo efficacy. As noted above, prior to the drinking period, we instructed participants that they were not permitted to discuss their perceived intoxication. Alternative instructions that fail to prohibit mention of perceived intoxication might yield greater within-group dependence of placebo effectiveness. Future researchers aiming to create group-based manipulations comparable to those conducted with participants in isolation may benefit from adopting similar instruction procedures as those utilized in the present study.

Another factor that may have preserved the independence of placebo responding was the recruitment of groups of strangers. Studies employing other social contexts (e.g., friends, romantic partners) may generate greater within-group dependence of placebo response, as participants familiar with their partners likely would be more attuned to each other's

experiences than would strangers (Acevedo Bianca P. et al., 2014; Sternglanz & DePaulo, 2004). Further, it would be interesting to examine whether drink response contagion differs between those in groups that all consume the same type of beverage (as was done in the present study) and those in groups where the type of beverage varies (e.g., alcohol, placebo). It may be that an alcohol-consuming group member would be more likely to enhance the drink response of a placebo-consuming participant than would a fellow placebo-consuming group member, as initial evidence suggests (Kirkpatrick & de Wit, 2013). To date, however, the majority of group-based alcohol administration research has relied on examining groups of strangers assigned to the same beverage condition (Fairbairn, 2017), and the take-home message from the present study is that placebos can be effectively administered to individuals in these social contexts with minimal placebo response covariation among group members.

Participant Variables and Placebo Response

Whether administered in groups or in isolation, one might expect individual traits and pre-drink states to contribute to variability in placebo effectiveness. There is some evidence that an individual's pre-drink feeling states (e.g., higher sedation, higher positive affect, lower negative affect) influence the degree to which the placebo generates an experience of stimulation, though not subjective intoxication. In addition, those who were in a group with higher average pre-drink positive affect experienced greater change in stimulation from pre- to post-drink. These disparate findings notwithstanding, there was a general lack of correspondence between placebo response and the various individual differences we investigated, which is notable (and somewhat unexpected). Perhaps the structure of a lab-based drinking protocol precluded individual difference factors from influencing perceived intoxication. Under more naturalistic conditions, the influence of individual differences such as gender and alcohol expectancies on placebo response may be observed.

Conclusion

The present study sought to assess the ability to successfully administer a placebo beverage using a group drinking design. Data indicate that group placebo consumption led to similar responses to those found in studies in which participants drank alone and that placebo effectiveness operated independently across group members. Further, placebo response following beverage consumption largely functioned similarly across a variety of individual difference measures. Although results may not generalize to studies conducted in naturalistic settings, using groups of acquainted participants, or employing alternative deception procedures, the present study offers compelling support for the feasibility of administering group-based placebos in the typical studies involving previously unacquainted group members. As such group studies become increasingly common, this information may be reassuring to investigators interested in employing a placebo beverage condition.

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Table 1.

Pre- and Post-Drink Drink Response Measures

	Placebo Pre-Drink Mean (SD)	*Placebo Post-Drink Mean (SD)*	*Alcohol Pre-Drink Mean (SD)*	*Alcohol Post-Drink Mean (SD)*
SIS	0.08 (0.79)	14.90 (10.44)	0.00 (0.00)	38.50 (17.31)
BAES Stimulation	3.77 (1.90)	4.30 (1.97)	3.85 (1.89)	5.20 (2.02)
BAES Sedation	1.71 (1.36)	1.62 (1.28)	1.52 (1.29)	1.77 (1.38)

Note. SIS = Subjective intoxication scale. BAES = Biphasic alcohol effects scale.

Table 2.

GAPIM Summary: Effect of Gender on Placebo Response

	Subjective Intoxication				***Stimulation***			
	Est	***Dev***	***t-ratio***	***p-value***	***Est***	***Dev***	***t-ratio***	***p-value***
Fixed Effect		*(SE)*				(*SE)*		
Intercept	3.53	0.09	39.26	< 0.01 *	0.61	0.12	5.31	< 0.01 **
Actor Effect	−0.20	0.10	−2.05	0.04	−0.09	0.10	−0.92	0.36
Others' Effect	0.24	0.13	1.81	0.07	−0.08	0.12	−0.61	0.54
Actor Similarity	0.15	0.14	1.06	0.29	−0.23	0.14	−1.63	0.10
Others' Similarity	−0.03	0.10	−0.26	0.79	−0.03	0.10	−0.32	0.75
Variance Components		*(SD)*				*(SD)*		
Intercept	0.01	.10		>0.50	.01	.09		>0.50

Note. GAPIM = Group actor-partner interdependence model. Est = Estimate. Dev = Deviance.

* $p < 0.01$,

** $p < 0.001$.

Table 3.

Multi-Level Model Summary: Effect of State Variables on Placebo Response

	Subjective Intoxication				***Stimulation***			
	Est	***Dev***	***t-ratio***	***p-value***	***Est***	***Dev***	***t-ratio***	***p-value***
Fixed Effect		*(SE)*				*(SE)*		
Intercept	1.95	0.86	2.26	0.03	−1.67	0.77	−2.19	0.03
Pre-Drink Stimulation	0.06	0.09	0.68	0.50	-	-	-	-
Pre-Drink Stimulation Mean	0.00	0.11	0.04	0.97	-	-	-	-
Pre-Drink Sedation	0.08	0.10	0.80	0.42	0.27	0.09	3.02	<0.01 *
Pre-Drink Sedation Mean	0.15	0.13	1.20	0.23	0.29	0.11	2.58	0.01
Pre-Drink Positive Affect	0.17	0.20	0.85	0.40	0.40	0.12	3.24	<0.01 *
Pre-Drink Positive Affect Mean	0.38	0.24	1.58	0.12	0.58	0.20	2.86	<0.01 *
	0.08	0.25	0.32	0.75	−0.70	0.18	−3.80	<0.01 **
Pre-Drink Negative Affect	0.18	0.23	0.79	0.43	−0.28	0.22	−1.29	0.20
Pre-Drink Negative Affect Mean								
		(SD)				*(SD)*		
	0.01	0.07		>0.50	0.01	0.09		>0.50
Variance Components								
Intercept								

Note. Est = Estimate. Dev = Deviance. Pre-drink stimulation scores were not entered in the stimulation model as the dependent variable (a pre- to post-drink change score) already accounted for pre-drink stimulation. Based on Bonferroni corrections, the significance cutoff was set as $p = 0.01$.

* $p < 0.01$,

** $p < 0.001$

Table 4.

Multi-Level Model Summary: Effect of Trait Variables on Placebo Response

	Subjective Intoxication				*Stimulation*			
	Est	***Dev***	***t-ratio***	***p-value***	***Est***	***Dev***	***t-ratio***	***p-value***
Fixed Effect		*(SE)*				*(SE)*		
Intercept	6.20	1.69	3.67	<0.01*	-	1.92	−0.01	0.10
					0.01			
Global Alcohol Expectancies	0.04	0.02	1.69	0.09		0.03	0.46	0.64
Global Alcohol Expectancies Mean	−0.03	0.04	-	0.49	0.01	0.04	0.53	0.60
			0.69		0.02			
Extraversion	0.03	0.02		0.23		0.02	0.16	0.87
Extraversion Mean	0.02	0.03	1.21	0.59	0.00	0.04	0.73	0.47
			0.54		0.03			
Socially Desirable Responding	0.07	0.03		0.04		0.04	1.53	0.13
Socially Desirable Responding Mean	−0.06	0.05	2.13	0.22	0.06	0.04	−0.89	0.38
	−0.00	0.04	-	0.97	-	0.04	−0.51	0.61
Impulsivity/Sensation Seeking	−0.04	0.04	1.25	0.30	0.04	0.04	−1.44	0.16
Impulsivity/Sensation Seeking Mean	−0.04	0.12	-	0.78	-	0.11	0.36	0.72
	−0.14	0.16	0.04	0.40	0.02	0.16	−0.25	0.81
			-		-			
Drinking History Frequency	−0.15	0.06	1.04	0.01	-	0.06	0.18	0.86
Drinking History Frequency Mean	−0.02	0.08		0.78	0.05	0.08	−0.39	0.70
			-					
Drinking History Quantity	0.16	0.30	0.28	0.58	0.04	0.23	0.34	0.74
Drinking History Quantity Mean	−0.10	0.31	-	0.74	-	0.38	1.92	0.06
Private Self-Consciousness	−0.37	0.23	0.85	0.11	0.04	0.23	0.32	0.75
Private Self-Consciousness Mean	−0.05	0.29	-	0.86	0.01	0.35	−0.38	0.71
Public Self-Consciousness	0.34	0.20	2.64	0.09	-	0.22	0.98	0.33
Public Self-Consciousness Mean	−0.16	0.26	-	0.53	0.03	0.30	0.82	0.41
Social Anxiety		*(SD)*	0.28		0.08	*(SD)*		
Social Anxiety Mean	0.21	0.04	0.55	0.36	0.72	0.09		>0.50
Variance Components			-		0.07			
Intercept			0.34		-			
			-		0.13			
			1.62		0.21			
			-		0.25			
			0.18					
			1.69		0.01			
			-					
			0.63					

Note. Est = Estimate. Dev = Deviance. Based on Bonferroni corrections, the significance cutoff was set as $p = 0.003$.

* $p < 0.003$