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# Alcohol and Group Formation: A Multimodal Investigation of the Effects of Alcohol on Emotion and Social Bonding

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## Abstract

We integrated research on emotion and on small groups to address a fundamental and enduring question facing alcohol researchers: What are the specific mechanisms that underlie the reinforcing effects of drinking? In one of the largest alcohol-administration studies yet conducted, we employed a novel group-formation paradigm to evaluate the socioemotional effects of alcohol. Seven hundred twenty social drinkers (360 male, 360 female) were assembled into groups of 3 unacquainted persons each and given a moderate dose of an alcoholic, placebo, or control beverage, which they consumed over 36 min. These groups' social interactions were video recorded, and the duration and sequence of interaction partners' facial and speech behaviors were systematically coded (e.g., using the Facial Action Coding System). Alcohol consumption enhanced individual- and group-level behaviors associated with positive affect, reduced individual-level behaviors associated with negative affect, and elevated self-reported bonding. Our results indicate that alcohol facilitates bonding during group formation. Assessing nonverbal responses in social contexts offers new directions for evaluating the effects of alcohol.

## Keywords

social interaction, emotions, facial expressions, interpersonal interaction, social behavior

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Researchers have long been interested in explicating the reinforcing effects of alcohol (Conger, 1956). Specifically, many studies have tested the ability of alcohol to reduce negative affect or enhance positive affect, and some research has suggested that a high degree of sensitivity to these effects indicates risk for developing alcoholism. Unfortunately, this experimental literature has yielded inconsistent findings regarding the effects of alcohol on affect (see Sayette, 1993). Although the participants recruited for laboratory studies on the effects of alcohol typically tend to drink in social settings (Bachman, Johnston, O'Malley, & Schulenberg, 2006), these social drinkers are nearly always tested in isolation (Kirchner, Sayette, Cohn, Moreland, & Levine, 2006). Even alcohol studies designed to induce social anxiety often require participants to drink and complete assessments alone (e.g., Sayette & Wilson, 1991). Accordingly, most alcohol studies create atypical conditions for social drinkers and do not assess group-level processes that may be crucial to understanding why people drink alcohol. It is unsurprising that, without considering social context, investigators have struggled to explain the

effects of alcohol on affect and the mechanisms underlying these effects.

Given the widespread use of alcohol in social situations, it is notable that both alcohol researchers and social psychologists have generally neglected the effects of alcohol on social bonding. Across cultures, humans possess a powerful need to belong and to develop relationships with others (Baumeister & Leary, 1995; Levine & Kerr, 2007). Drinkers expect alcohol to enhance their social interactions (e.g., Brown, Goldman, Inn, & Anderson, 1980), and these beliefs predict actual alcohol use (Smith, Goldman, Greenbaum, & Christiansen, 1995). These findings converge with observations of alcohol's role in facilitating cohesion in social gatherings, rituals, and celebrations across diverse cultures (MacAndrew & Edgerton, 1969). Such observations are in accord with Hull's (1987)

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self-awareness model, which posits that alcohol reduces the processing of self-relevant information, thereby enhancing empathy and feelings of closeness with others (J. G. Hull, personal communication, November 13, 1998).

To date, the few studies of alcohol's effects on groups have provided mixed findings (cf. Fromme & Dunn, 1992; Sher, 1985), a fact that is likely due in part to methodological limitations. Researchers have often ignored advances in small-groups research, arbitrarily varied group size, and failed to confirm that group members were unacquainted. In addition, alcohol studies have lacked adequate power to account for group-level processes, ignored the hierarchical structure of group data, and failed to include appropriate control conditions (i.e., both a placebo-beverage and a nonalcoholic-beverage condition; see Martin & Sayette, 1993) to examine both pharmacological and expectancy-based effects of drinking. Moreover, prior studies have often relied exclusively on self-report assessments, which can be problematic (Sayette, 1993).

Observational measures are a useful alternative to self-report measures. Although early observational methods used crude coding schemes of unknown reliability (e.g., Rohrberg & Sousa-Poza, 1976), recent advances have allowed for the precise and reliable capture of multiple streams of ongoing behavior (Bakeman, 1999). In particular, these newer methods permit the measurement of group-level, interactive responses, in addition to individual-level responses.

In the research reported here, we focused on facial expressions and speech patterns. Anatomically based coding systems, such as the Facial Action Coding System (FACS; Ekman, Friesen, & Hager, 2002), can be used to identify expressions (called action units, or AUs, in FACS) related to specific emotions (Ekman & Rosenberg, 2005). FACS, which we used in our study, is the most comprehensive facial coding system and has good psychometric properties. It allows for unobtrusive assessments of facial expressions in real time. Content-free speech patterns can also be utilized to infer affective states and social processes, such as bonding. For instance, individuals enjoy being in groups in which participation in conversation is evenly distributed (Dabbs & Ruback, 1984, 1987; Oetzel, 2001). Moreover, silence (which we assessed by measuring the duration of participants' speech during group interactions) is an indicator of negative affect, because it is linked to social discomfort (Leary & Kowalski, 1995).

Interactions among individuals produce not only individual-level responses but also group-level responses, which provide unique information about group communication and bonding. Dabbs and Ruback (1987) likened group processes to chess, because understanding either depends on understanding the sequence, rather than the frequency, of moves or actions. Research has suggested a link between behavioral coordination and the development of social bonds (e.g., Chartrand & Bargh, 1999), and groups with high levels of rapport are characterized by behavioral coordination (Levine & Moreland, 1998).

We operationalized group-level positive affect (bonding) as simultaneous triadic smiling among all 3 members of a given group (i.e., "golden moments" when all group members displayed Duchenne smiles, which involve contractions of both the zygomaticus major and obicularis oculi muscles; see Fig. 1). We assumed that co-occurring, mutually responsive smiling reflects shared affiliative intentions and positive affect among group members. Another indicator of group bonding is coordinated speech, which involves individuals speaking in turns during group interactions. Accordingly, we operationalized speech-related bonding as a group-level event during which all 3 members of a given group spoke sequentially (Dabbs & Ruback, 1984).

A considerable amount of drinking occurs in groups, and these interactions affect group members' behavior, thoughts, and feelings. No studies have yet provided an adequate assessment of the impact of alcohol and dosage set (the belief that one is consuming alcohol; see Martin & Sayette, 1993) on social bonding and social discomfort for both men and women, despite the importance of this influence for understanding the motivations behind drinking. We investigated the effects of alcohol on social integration (see Moreland, 1987) by focusing on the initial stage of social integration, when group members are unacquainted. Investigating alcohol's effects on group formation is valuable because this phase of social integration is characterized by self-awareness, self-presentational concerns, and social anxiety (Leary & Kowalski, 1995; Tuckman, 1965) but also moments of enjoyment (Kirchner et al., 2006). Accordingly, studying group formation provides fertile ground for assessing both positive and negative emotional states. The study reported here was motivated by the results of an all-male preliminary study, in which alcohol enhanced social bonding (Kirchner et al., 2006).

We hypothesized that alcohol would enhance self-reported bonding and displays of positive affect and would reduce displays of negative affect. Moreover, we hypothesized that, controlling for individual responding, alcohol would promote the development of group-level positive affect and mitigate group-level negative affect. Thus, we predicted that groups drinking alcohol would show more behavioral coordination (both in their facial expressions and in their speech patterns) than would groups consuming placebo or control beverages.

## Method

### Participants

Healthy male and female social drinkers between the ages of 21 and 28 were recruited via newspaper ads. Those who successfully completed an initial phone screening were invited to the Alcohol and Smoking Research Laboratory at the University of Pittsburgh for another screening session. After we obtained informed consent, we determined whether these individuals met any of the study's exclusion criteria, which



**Fig. 1.** Time-locked screenshots illustrating simultaneous triadic smiling (this study's measure of group-level positive affect) during a group interaction. The close-ups show that all 3 participants displayed Duchenne smiles at the time of the screenshot of the group at the lower right. All participants shown in this figure consented to having their pictures used.

included medical conditions contraindicating alcohol consumption, past alcohol abuse or dependence (as indexed by the fourth edition of the *Diagnostic and Statistical Manual of Mental Disorders*; American Psychiatric Association, 1994), pregnancy, body weight more than 15% above or below ideal weight for height (Harrison, 1985), and discomfort with the drinking requirements of the study. Participants also had to affirm that they could comfortably drink at least three drinks in 30 min. After we excluded ineligible individuals, our sample comprised 720 participants (360 men, 360 women; 83% European American, 11% African American, 2.5% Asian, 1% Hispanic, 2.5% other). Participants reported drinking two to three times per week and consuming an average of 4.29 drinks ( $SD = 1.89$ ) each time they drank.

### **Predrink assessment**

Participants were randomly assigned to groups of 3 unacquainted persons (see Kirchner et al., 2006); each group was randomly assigned to drink an alcoholic beverage, a placebo beverage, or a nonalcoholic control beverage (isovolumic across conditions). Twenty groups representing each of four

gender compositions (0 females and 3 males, 1 female and 2 males, 2 females and 1 male, 3 females and 0 males) were assigned to each beverage condition. Before group formation, participants completed an initial assessment that included measures of personality and state affect. (A complete list of measures is available from the first author.) We obtained a blood alcohol content (BAC) breath sample from all participants and had them complete a subjective-intoxication scale (SIS), on which they rated their perceived level of intoxication from 0, *not at all intoxicated*, to 100, *the most intoxicated I have ever been*.

### **Drink administration**

Participants in each group were informed that they would consume their drinks together over a 36-min period before completing several tasks (the ostensible purpose of the study). Dosing followed guidelines used in prior work (e.g., Kirchner et al., 2006). Each participant's drink was mixed in front of him or her. The alcoholic beverage was 1 part vodka and 3.5 parts cranberry-juice cocktail (a 0.82-g/kg dose of alcohol for males and a 0.74-g/kg dose of alcohol for females). For

participants drinking this moderate dose of alcohol, the vodka bottle contained 100-proof vodka; for participants drinking the placebo beverage, the vodka bottle contained flattened tonic water. To increase credibility in the placebo-beverage condition, we smeared participants' glasses with vodka before they were brought into the room. These procedures provided a successful placebo manipulation, leading participants in the placebo-beverage condition to believe they had consumed alcohol (Martin & Sayette, 1993; Sayette, Martin, Perrott, Wertz, & Hufford, 2001). Participants in the control-beverage condition were told that they would not receive alcohol and were given cranberry-juice cocktail.

After being seated equidistantly around a circular table, participants in each group were given one third of their drink every 12 min and asked to consume it evenly across these time periods. They were also asked not to discuss their level of intoxication. (For additional details about the procedure, see the Supplemental Material available online.) Each drink-administration session was video recorded at 30 frames per second using a digital video-control system. Video cameras were visible in the experimental room; participants were informed that the cameras were in the room so the experimenters could monitor drink-consumption rates from an adjoining room.

### Postdrink assessment

After the drink administration, we again assessed participants' BAC and had them complete the SIS measure. To help control for dosage set, we presented participants in the placebo-beverage group with BAC readings that ranged from 0.041% to 0.043% (randomly assigned; 0.043% is about the highest credible reading for participants in alcohol studies who have been given placebo beverages; Martin & Sayette, 1993). Participants then completed the Perceived Group Reinforcement Scale (PGRS; Kirchner et al., 2006; details about the PGRS are provided in the Self-Reported Bonding section). After listening to a 5-min comedy clip, participants completed a decision-making task (Sayette, Dimoff, Levine, Moreland, & Votruba-Drzal, in press); then (40 min after they had finished drinking), we again recorded the BACs of participants in the alcoholic- and placebo-beverage conditions and had them complete the SIS measure. (Participants in the control-beverage condition did not have their BACs recorded or complete the SIS measure at this time because they had already been told that they had not received any alcohol and had undergone one postdrink BAC assessment to confirm their sobriety.) Participants in the placebo-beverage condition were presented with BAC readings between 0.037% and 0.039%—values consistent with their probable perceived intoxication levels at this time (Martin & Sayette, 1993).

After these assessments, participants completed a postexperimental questionnaire that assessed their perceived level of maximum intoxication (rated on a scale similar to the SIS

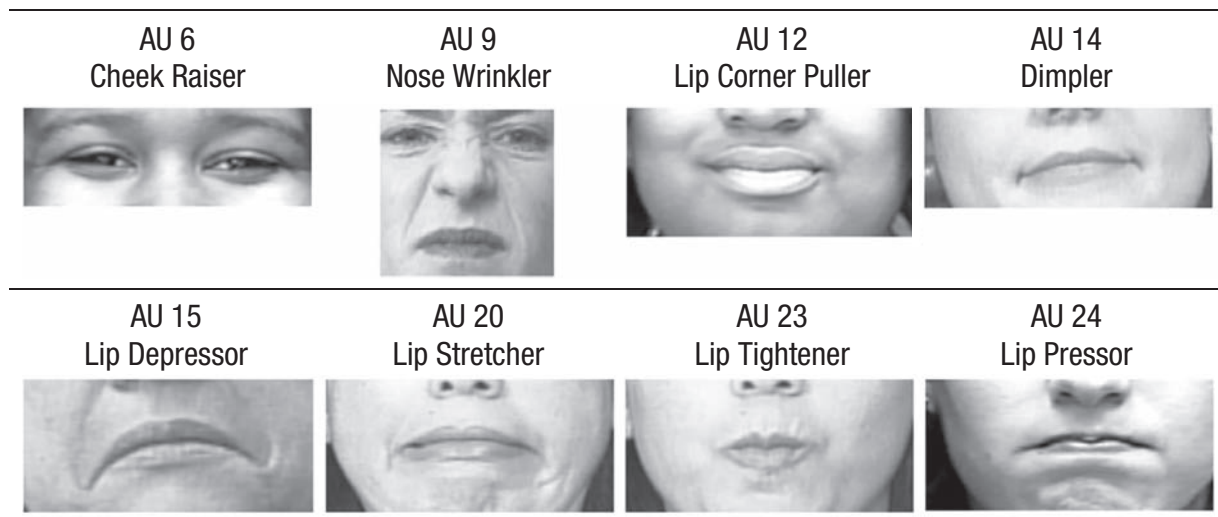
scale) and estimated vodka consumption. Participants in the placebo- and control-beverage conditions were then debriefed. Participants in the alcoholic-beverage condition had their BACs recorded, ate a light meal, relaxed, and were debriefed when their BACs dropped below 0.025%. Following debriefing, participants were paid \$60 and permitted to leave (those who had consumed alcohol were forbidden to drive).

### Data coding

We assessed both individual-level and group-level interaction using observational measures of facial expressions and speech behavior, as well as self-reports. In our analysis of facial-expression and speech data, we used Observer Video-Pro software (Version 5, Noldus Information Technology, Wageningen, The Netherlands) to code time-locked video footage. The software synchronized group members' data according to the vertical interval time code stamped on each videotape. This method permitted independent coding of data for each participant, while preserving the sequential structure of each group interaction. Facial expressions and speech behavior in each video recording were coded on a frame-by-frame basis. Coders of each participant's behavioral data were blind to beverage condition and to the behavior of other group members.

**Facial coding.** Durations (i.e., frame counts) of selected AUs that had occurred during the drink-administration session were coded by FACS-certified coders. Figure 2 presents illustrations of the AUs coded for in our study. To assess negative affect, we coded *smile controls* (e.g., Reed, Sayette, & Cohn, 2007), which we defined as AU 12 in combination with AU 14, 15, 23, or 24. In addition, we coded AUs 9, 14, 15, and 20 separately; these AUs have been linked to disgust, contempt, sadness, and fear, respectively (e.g., Ekman, Friesen, & Ancoli, 1980; Ekman, Friesen, & O'Sullivan, 1988). We also created a composite negative-affect index, which comprised these four AUs. We measured individual-level positive affect by assessing the duration of participants' Duchenne smiles (defined by the combination of AUs 6 and 12; Ekman, 1989; if AU 12 appeared before AU 6, the expression initially was scored as a social smile in the process of transitioning into a Duchenne smile; for additional details about the coding procedure, see the Supplemental Material). At the group level, we examined triadic Duchenne smiling as our index of positive affect (Kirchner et al., 2006).

**Speech.** Speech behavior was coded according to Dabbs and Ruback's (1987) Grouptalk model. Within this model, an individual *turn* consists of one speaker's *vocalizations* and *pauses* (the cutoff for a pause was 3.1 s, the median length of pauses in the data set). A pause that ends a speaker's turn is a *switching pause*. Thus, we examined both the amount of time each group member spoke<sup>1</sup> and triadic sequential speech.



**Fig. 2.** Action units (AUs) coded for in the study. These AUs are derived from the Facial Action Coding System (Ekman, Friesen, & Hager, 2002). These images were adapted from “Comprehensive Database for Facial Expression Analysis,” by T. Kanade, J. F. Cohn, and Y. Tian, 2000, *Proceedings of the Fourth IEEE International Conference on Automatic Face and Gesture Recognition*, 4, pp. 46–53. Copyright 2000 by IEEE Conference Publications. Adapted with permission.

**Interrater agreement.** The reliability of coding for facial and speech data for a random subset of 72 participants was assessed (for additional details, see the Supplemental Material). There were good levels of agreement for AUs associated with positive affect ( $\kappa = .88$ ) and negative affect ( $\kappa = .73$ ) and for speech behavior ( $\kappa = .80$ ). Because coders were unable to reliably differentiate between AUs 14 and 15, they were coded as the same category.

**Self-reported bonding.** The PGRS consists of 12 Likert-type items, including “I like this group” and “The members of this group are interested in what I have to say”; responses were made on scales from 1, *strongly agree*, to 9, *strongly disagree*. Each participant’s responses to these items were summed to create a composite score ( $\alpha = .90$ ). In a prior study, participants’ scores on the PGRS correlated with nonverbal measures of social bonding (Kirchner et al., 2006).

## Analyses

**Data processing.** To determine that groups in the three beverage conditions did not differ on these variables at the beginning of the interactions (i.e., before much alcohol was absorbed), we coded and analyzed facial expressions and speech behaviors during the first 3 min of the drink-administration period for all groups. No differences emerged during this period. Facial-expression and speech data during this baseline period were entered as covariates in all models examining behavioral outcomes. We then used the videos to code consumption of the second and third portions of the drink (Minutes 13–36 of the

interactions) continuously, with the exception of a brief interval during which the investigator entered the room to refill drinks.<sup>2</sup> Approximately 34.9 million video frames of behavioral data were coded. One participant was excluded from analysis for technical reasons.

**Primary analyses.** Because of the nested structure of the data, we used hierarchical linear modeling to account for the interdependence of within-subjects and between-subjects data. Because facial-expression and speech-production variables were not normally distributed, we used hierarchical generalized linear modeling with Poisson-distributed errors to examine behavioral outcomes (for additional details, see the Supplemental Material). For all models, overdispersion of Level 1 variance was measured and accounted for. We report only results from models with robust standard errors to protect against potential violations of model assumptions. We report results from models using a complete, orthogonal set of contrast codes comparing the placebo-beverage condition with the control-beverage condition and comparing the alcoholic-beverage condition with both no-alcohol conditions. Unless indicated otherwise, all the significant findings we report also reached significance ( $p < .01$ ) when the placebo- and control-beverage conditions were independently compared with the alcoholic-beverage condition.

Controlling for individual-level baseline behavior, we examined all individual-level behavioral responses in models that included three levels of analysis; these models accounted for time at Level 1, individual-level variables (e.g., gender) at Level 2, and beverage condition (group-level predictor) at

Level 3. Because groups were composed of 3 members, models examining cross-level interactions between individual- and group-level variables estimated Level 3 slopes as fixed, modeling the interdependence of groups in the random variation of the intercepts (Kenny, Mannetti, Pierro, Livi, & Kashy, 2002). Individual-level self-report responses (i.e., PGRS scores) were examined in two-level models, with group-level predictor variables (e.g., beverage condition) entered at Level 2.

Group-level behavioral outcomes were examined in two-level models, with group-level baseline behavior entered as a covariate, time accounted for at Level 1, and group-level predictor variables (i.e., beverage condition and group gender composition) entered at Level 2.

## Results

### Individual differences

There were no differences on variables measured in the initial assessment (e.g., demographics, alcohol use, personality, affect) among the three beverage conditions.

### Manipulation check

Mean BACs and measures of subjective intoxication appear in Table 1. Participants in the alcoholic-beverage condition were on the ascending limb of the BAC curve, with a mean BAC of about 0.06% immediately after the interaction period. All participants in the placebo- and alcoholic-beverage conditions estimated that they had consumed at least 1 oz of vodka. As in our prior studies (e.g., Sayette et al., 2001), participants in the placebo-beverage condition reported feeling more intoxicated than participants in the control-beverage condition did but less intoxicated than participants in the alcoholic-beverage condition did.

### Main effects of beverage condition on individual-level responses

**Facial expressions.** During the interaction, participants drinking alcohol displayed Duchenne smiles for significantly longer<sup>3</sup> amounts of time and expressed negative affect (as assessed by the composite negative-affect index) for significantly shorter amounts of time than did participants drinking nonalcoholic beverages (see Table 2). AUs 9 and 14/15 occurred significantly less often in the alcoholic-beverage condition than in the two other beverage conditions. (AU 20 was the only negative AU not significantly affected by alcohol, a result that may have been due to its rare occurrence in our study.) Placebo-beverage participants tended to spend less time displaying Duchenne smiles than control-beverage participants did ( $p = .07$ ), but there were no differences between the placebo-beverage and control-beverage conditions in the time spent displaying negative AUs.

**Speech behaviors.** Participants who drank alcohol spent significantly more time talking than did participants who did not drink alcohol (see Table 2). There were no differences between placebo- and control-beverage participants in the amount of time spent talking.

**Self-reported social bonding.** Participants in the alcoholic-beverage condition had significantly higher PGRS scores than did participants who did not consume alcohol, and control-beverage participants had significantly higher PGRS scores than placebo-beverage participants did (see Table 2). Follow-up contrast analyses showed that alcoholic-beverage participants' PGRS scores ( $M = 7.22$ ) were higher than those of placebo-beverage participants ( $M = 6.74$ ),  $p < .001$ , but PGRS scores did not differ significantly between alcoholic-beverage and control-beverage ( $M = 7.07$ ) participants ( $p = .27$ ).

**Table 1.** Mean Blood-Alcohol-Content (BAC) Levels and Measures of Subjective Intoxication

Variable	Alcoholic-beverage condition	Placebo-beverage condition	Control-beverage condition	F
BAC postdrink	0.055 <sub>a</sub> (0.012)	0.001 <sub>b</sub> (0.001)	0.001 <sub>b</sub> (0.001)	$F(2, 717) = 4,825.72^{***}$
BAC 40 min postdrink	0.062 <sub>a</sub> (0.011)	0.001 <sub>b</sub> (0.001)	—	$F(1, 358) = 7,116.15^{***}$
SIS score postdrink	38.50 <sub>a</sub> (17.31)	14.90 <sub>b</sub> (10.44)	0.20 <sub>c</sub> (1.49)	$F(2, 717) = 647.7^{***}$
SIS score 40 min postdrink	35.12 <sub>a</sub> (16.90)	8.90 <sub>b</sub> (10.80)	—	$F(1, 358) = 410.12^{***}$
Maximum level of intoxication	43.53 <sub>a</sub> (18.71)	16.15 <sub>b</sub> (11.11)	0.61 <sub>c</sub> (3.19)	$F(2, 717) = 698.07^{***}$
Estimated volume of vodka consumed (ounces)	7.11 <sub>a</sub> (9.85)	4.64 <sub>b</sub> (5.44)	0.05 <sub>c</sub> (0.43)	$F(2, 714) = 70.80^{***}$

Note: The subjective-intoxication scale (SIS) and maximum-intoxication scales ranged from 0 to 100, with higher values indicating greater intoxication. Data for 3 participants in the control-beverage condition were removed because the number of ounces they reported having consumed appeared to reflect the volume of the beverage they consumed rather than the amount of vodka it contained (i.e., a vodka estimate of 24–36 oz when all 3 members of the group reported 0s for their postdrink SIS and 40-min-postdrink SIS). Participants in the control-beverage condition were not required to have their BAC measured or to complete the SIS 40 min after drinking. Within each row, groups with different subscripts differed significantly ( $p < .05$ ).

\*\*\* $p < .001$ .

**Table 2.** Individual-Level Effects

Measure	$\beta^a$	$t(237)$	Event rate ratio <sup>b</sup>
Alcoholic-beverage condition vs. placebo- and control-beverage conditions			
Duchenne smile	0.82 (0.10)	8.35***	2.28
Smile control	-0.62 (0.10)	-6.38***	0.54
AU 9	-0.49 (0.18)	-2.80**	0.61
AU 14 or 15	-0.52 (0.10)	-5.05***	0.59
AU 20	0.31 (0.18)	1.70	1.36
Composite negative-affect index	-0.48 (0.10)	-4.95***	0.62
Speech	0.22 (0.04)	5.96***	1.25
PGRS score	0.42 (0.15)	2.75**	—
Placebo-beverage condition vs. control-beverage condition			
Duchenne smile	-0.15 (0.10)	-1.68	0.86
Smile control	-0.03 (0.08)	-0.43	0.97
AU 9	-0.05 (0.17)	-0.30	0.95
AU 14 or 15	0.06 (0.07)	0.83	1.06
AU 20	0.10 (0.15)	0.62	1.10
Composite negative-affect index	0.07 (0.07)	0.99	1.07
Speech	-0.08 (0.05)	-1.70	0.93
PGRS score	-0.33 (0.14)	-2.33*	—

Note: Duchenne smiles were defined as combinations of action units (AUs) 6 and 12. Smile controls were defined as AU 12 accompanied by AU 14, 15, 23, or 24. The composite negative-affect index comprised AUs 9, 14, 15, and 20. Values for AU 9 and AUs 14 or 15 reflect results for those AUs coded in the absence of AU 12. Our measure of speech was the number of frames each participant spoke in video recordings of the group interactions. PGRS = Perceived Group Reinforcement Scale (Kirchner, Sayette, Cohn, Moreland, & Levine, 2006).

<sup>a</sup>Coefficients represent the natural logarithm of the event rate ratio.

<sup>b</sup>The event rate ratio refers to the duration of the indicated behavior in one group relative to the duration of that behavior in the other group.

\* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$ .

### Main effects of gender on individual-level responses

During group interactions, women spent more time expressing both positive and negative AUs than men did: Relative to male participants, female participants displayed Duchenne smiles for 34% longer,  $t(478) = 5.42, p < .001$ ; smile controls for 89% longer,  $t(478) = 7.816, p < .001$ ; and negative AUs for 69% longer,  $t(478) = 4.67, p < .01$ . Women also reported higher mean levels of social bonding than men did,  $t(478) = 3.307, p < .001$ . Beverage condition did not interact with gender for any individual-level outcome. That is, both women and men showed differential outcomes across beverage conditions, but women's reactions to alcohol were similar to those of men.

### Main effects of beverage condition on group-level responses

**Facial expressions.** Groups drinking alcohol spent more time engaging in triadic Duchenne smiling than did groups not

drinking alcohol (i.e., groups consuming placebo or control beverages; see Table 3). There were no differences between the placebo-beverage and control-beverage participants in this measure.

**Speech behaviors.** As Table 3 shows, groups that drank alcohol had significantly more triadic sequential-speech events than did groups that did not drink alcohol. (Each instance in which 3 different speakers spoke in succession was counted as a new triadic speech event.) There were no differences between the placebo- and control-beverage conditions in the frequency of triadic sequential-speech events.

### Main effects of group gender composition

Group gender composition was a significant predictor of behaviors associated with both positive and negative affect. Each additional female member in a group was associated with a corresponding 22% increase in triadic speech events,  $t(237) = 3.287, p < .001$ , and a 0.21-point increase in mean PGRS scores,  $t(239) = 4.23, p < .001$ . Group gender



**Table 3.** Group-Level Effects

Measure	$\beta^a$	$t(236)$	Event rate ratio <sup>b</sup>
Alcoholic-beverage condition vs. placebo- and control-beverage conditions			
Triadic Duchenne smiling	0.60 (0.12)	4.87***	1.81
Triadic sequential speech	0.39 (0.11)	3.72***	1.48
Placebo-beverage condition vs. control-beverage condition			
Triadic Duchenne smiling	-0.11 (0.11)	-1.03	0.89
Triadic sequential speech	0.04 (0.10)	0.43	1.04

Note: *Triadic Duchenne smiling* refers to moments in which all 3 group members simultaneously displayed Duchenne smiles, defined as action units (AUs) 6 and 12. *Triadic sequential speech* refers to events in which all 3 members of a group spoke in succession.

<sup>a</sup>Coefficients represent the natural logarithm of the event rate ratio.

<sup>b</sup>The event rate ratio refers to the duration of a given behavior in one group relative to the duration of that behavior in the other group.

\*\*\* $p < .001$ .

composition was not significantly associated with triadic Duchenne smiling, and it did not interact with beverage condition in predicting group-level outcomes.

### Correlations across response domains

Correlations among triadic Duchenne smiling, triadic sequential speaking, and mean PGRS scores for each group were examined. PGRS scores were positively correlated with both triadic Duchenne smiling ( $r = .20, p = .002$ ) and triadic sequential speech ( $r = .21, p = .001$ ). Triadic Duchenne smiling and triadic sequential speech were not significantly correlated.

### Discussion

It is usually taken for granted that people drink to reduce stress or enhance positive feelings (Brown et al., 1980). Such assumptions are held by the majority of clinicians and researchers (Sayette, 1993). These hedonic effects presumably underlie the initiation and maintenance of drinking even in the face of harmful consequences. It is therefore striking that experimental evidence supporting these effects has been equivocal. Indeed, dozens of studies have shown that alcohol consumption often fails to reduce negative affect or stimulate positive affect (Sayette, 1993). Even studies that have found statistically significant effects of alcohol on mood have often reported effects that are modest in magnitude. It is in this context that our findings' robust support for alcohol's enhancement of positive affect and reduction of negative affect across modalities must be considered.

Our results indicate that a moderate dose of alcohol exerts a powerful effect (as indicated by the event rate ratios presented in Tables 2 and 3) on both male and female social

drinkers. During group formation, alcohol-consuming groups experienced more social bonding than did groups consuming nonalcoholic beverages. These effects were consistent across several measures: participants' facial expressions, speech behavior, and self-reports at both individual and group levels of analysis. At the individual level, alcohol was linked to increases in Duchenne smiles and reduced displays of negative AUs, including those associated with sadness, contempt, and disgust. In addition, alcohol consumption increased the time participants spent speaking to one another (and reduced moments of silence) and self-reported bonding.

The group-formation paradigm also allowed us to examine how group members coordinated their behaviors. Controlling for the amount of overall smiling, we found that alcohol consumption enhanced triadic smiling. Similarly, alcohol consumption increased the likelihood that all 3 members of a group would speak sequentially. Notably, self-reported bonding was correlated with triadic Duchenne smiling and triadic sequential speech. Results also suggested that the pharmacological effects of alcohol trumped the effects of dosage set, because the placebo and control groups tended to show similar responses that differed from those of the alcoholic-beverage groups. In this respect, our findings mirror those highlighting the pharmacological impact of alcohol ingestion on aggression (see Bushman & Cooper, 1990).

We believe that our findings' solid support for alcohol's rewarding effects is attributable to several distinct elements of our research methods. First, we tested our participants, who were social drinkers, in a social context. We focused on initial group formation, which, as noted earlier, often elicits both positive and negative emotional states. We therefore ensured that none of the group members was acquainted with the others before the study began (for details, see Kirchner et al., 2006).

Second, both positive and negative states arose naturally in our paradigm. Our approach to emotion induction contrasts with that of most alcohol research, which uses artificial stimuli (e.g., electric shock, self-disclosing speeches); such stimuli may not reflect the typical experiences of social drinkers.

Third, our use of observational measures permitted us to unobtrusively capture moment-to-moment fluctuations in emotional responses, which is crucial when studying dynamic, coordinated social interaction. Although self-reports can be valuable, questionnaires are typically administered postmanipulation and require participants to aggregate their subjective experiences over time and to impose language on what may have been nonverbal experiences. Self-reports are thus vulnerable to distortions and biases (Schwarz, 1999).

Fourth, our large sample provided the statistical power needed to conduct both individual-level and group-level analyses that accounted for the interdependence of group members. We also had the power to ensure that equivalent numbers of groups with each of four possible gender distributions were assigned to each beverage condition. This aspect of our procedure proved important, because bonding significantly increased with the number of women in a group (cf. Wheeler, Reis, & Nezlek, 1983). Our planned future work will explore the interaction between individual-level traits and characteristics of social contexts, using actor-partner analyses to isolate the influence of an individual's gender from the influence of the gender of fellow group members. It also would be useful to evaluate the length of each speaker's utterances, as well as verbal content.

The data from our study support the validity of our group-formation paradigm for detecting the effects of alcohol consumption in social contexts. Our work sets the stage for further research to evaluate potential associations between socioemotional responses to alcohol and individual differences in personality, alcohol expectancies, family history of alcoholism, and genetic vulnerability in a social context. Laboratory studies can uncover responses to alcohol that predict alcohol dependence (Schuckit & Smith, 2001). It will also be important to determine whether alcohol sensitivity across a range of doses (some doses may not enhance mood) in this paradigm indicates risk for developing drinking problems.

Although the use of observational measures is labor intensive (e.g., FACS certification requires about 100 hr of training, and completing the observational coding took approximately 2,500 hr), automated computer-vision approaches are likely to enhance its feasibility in the near future (Cohn & Sayette, 2010).

Forming social bonds is a fundamental human motivation, and people value behaviors that facilitate interpersonal relationships (Baumeister & Leary, 1995; Levine & Kerr, 2007). Our paradigm provides a group-level perspective on the hedonic effects of alcohol, in contrast to the approaches used in past work, which have relied on the individual as the unit of analysis. Through transdisciplinary methods that integrate social psychology, emotion science, and addiction theory, we

demonstrated the socially reinforcing effects of alcohol consumption in men and women during group formation.

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### Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

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### Supplemental Material

Additional supporting information may be found at <http://pss.sagepub.com/content/by/supplemental-data>

### Notes

1. Because our measure of silence highly overlapped with our measure of speech duration ( $r = -.98$ ), we report results for only the latter measure.
2. Prior work indicated that beverage condition would not affect our key variables during the initial third of the drinking interaction (Kirchner et al., 2006).
3. Alcohol consumption also was linked to greater non-Duchenne, "social" smiling, although the effect was far more pronounced for Duchenne smiling (event rate ratio for Duchenne smiles = 2.28; event rate ratio for non-Duchenne smiles = 1.28). Because we coded for social smiles "on their way" to a peak Duchenne smile, however, this finding is unsurprising.

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