Experimental and Clinical Psychopharmacology
2015, Vol. 23, No. 4, 255–264

1064-1297/15/$12.00 http://dx.doi.org/10.1037/pha0000021

Speech Volume Indexes Sex Differences in the Social-Emotional Effects of Alcohol

Catharine E. Fairbairn, Michael A. Sayette, Marlissa C. Amole, John D. Dimoff, Jeffrey F. Cohn, and Jeffrey M. Girard
University of Pittsburgh

Men and women differ dramatically in their rates of alcohol use disorder (AUD), and researchers have long been interested in identifying mechanisms underlying male vulnerability to problem drinking. Surveys suggest that social processes underlie sex differences in drinking patterns, with men reporting greater social enhancement from alcohol than women, and all-male social drinking contexts being associated with particularly high rates of hazardous drinking. But experimental evidence for sex differences in social-emotional response to alcohol has heretofore been lacking. Research using larger sample sizes, a social context, and more sensitive measures of alcohol's rewarding effects may be necessary to better understand sex differences in the etiology of AUD. This study explored the acute effects of alcohol during social exchange on speech volume—an objective measure of social-emotional experience that was reliably captured at the group level. Social drinkers (360 male; 360 female) consumed alcohol (.82 g/kg males; .74 g/kg females), placebo, or a no-alcohol control beverage in groups of 3 over 36-min. Within each of the 3 beverage conditions, equal numbers of groups consisted of all males, all females, 2 females and 1 male, and 1 female and 2 males. Speech volume was monitored continuously throughout the drink period, and group volume emerged as a robust correlate of self-report and facial indexes of social reward. Notably, alcohol-related increases in group volume were observed selectively in all-male groups but not in groups containing any females. Results point to social enhancement as a promising direction for research exploring factors underlying sex differences in problem drinking.

Keywords: alcohol, social context, sex, emotion science, speech volume

Researchers have a long history of using experimental methods to better understand the etiology of a variety of substance use disorders. Much of this laboratory research has targeted alcohol use disorder (AUD), and in particular, has examined alcohol-related emotional reinforcement as a potential mechanism underlying addiction (Conger, 1956). Countless studies have investigated the effects of alcohol on emotion, aiming to show that alcohol enhances positive affect and relieves negative affect (Fairbairn & Sayette, 2014; Marlatt, 1999; Sher, Wood, Richardson, & Jackson, 2005). This literature has not only focused on average alcohol response across drinkers, but has also examined how people differ in their responses to alcohol. Individuals vary in their sensitivity to alcohol's emotional rewards, and individual differences in alcohol reward[1] sensitivity have corresponded to individual differences in susceptibility to AUD (Sher & Levenson, 1982; Sher & Walitzer, 1986). As observed by Sher and Wood (2005), understanding alcohol response heterogeneity is useful in order to better understand the "risk processes underlying the development of alcohol use disorders" (p. 146).

Sex represents one of the most powerful and robust risk factors for AUD, with men being twice as likely to show symptoms of AUD compared with women (SAMHSA, 2012). Researchers have suggested that sex differences in drinking patterns are linked to sex differences in alcohol reward, hypothesizing that men gain more reward from alcohol than do women (Sher, 1987; Wilson, 1988). As a result, there has been interest in identifying sex differences in alcohol-related reinforcement.

Of note, prior laboratory-based studies have not succeeded in capturing sex difference in alcohol reward. While a handful of studies examining alcohol's effects on cognitive and motor per-

Catharine E. Fairbairn, Michael A. Sayette, Marlissa C. Amole, John D. Dimoff, Jeffrey F. Cohn, and Jeffrey M. Girard, Department of Psychology, University of Pittsburgh.

All authors contributed in a significant way to the manuscript, and all authors have read and approved the final manuscript. None of the authors have a conflict of interest with the present research. This research was supported by National Institutes of Health Grant (R01 AA015773) to Michael Sayette and National Science Foundation Graduate Research Fellowship (0753293-006) to Catharine Fairbairn. These funding sources had no role other than financial support. We thank Kasey Creswell, Thomas Kirchner, Michael Sayers, Bryan Heckman, and the students and staff at the Alcohol and Smoking Research Laboratory for assistance collecting and coding data. We also thank Drs. Richard Moreland and John Levine for helpful comments regarding the group formation paradigm.

Correspondence concerning this article should be addressed to Catharine E. Fairbairn or Michael A. Sayette, Department of Psychology, 3137 Sennott Square, University of Pittsburgh, 210 S. Bouquet St., Pittsburgh, PA 15260. E-mail: cef24@pitt.edu or sayette@pitt.edu

[1] Within the context of this article, *reward* is used as an umbrella term to refer to increases in positive affective states, decreases in negative affective states, as well as increases in pleasurable social experiences (King, de Wit, McNamara, & Cao, 2011).

formance have found a significant moderating effect of sex (Dougherty, Bjork, & Bennett, 1998; Mills & Bisgrove, 1983; Niaura, Nathan, Frankenstein, Shapiro, & Brick, 1987), studies examining alcohol's emotional rewards have not found significant differences in alcohol response according to sex (e.g., Breslin, Mayward, & Baum, 1994; Josephs & Steele, 1990; Levenson, Oyama, & Meek, 1987; Mulvihill, Skilling, & Vogel-Sprott, 1997; Sayette, Breslin, Wilson, & Rosenblum, 1994; Sayette, Martin, Perrott, Wertz, & Hufford, 2001; Steele & Josephs, 1988). A variety of explanations have been posited for these mixed findings, including concerns related to a) experimental context and b) the measurement of emotion. Below we explore each explanation in turn.

Experimental Context

Many previous alcohol administration studies have not incorporated key contextual factors into their designs (Sayette, Creswell, et al., 2012). In particular, a social drinking setting may be important to harnessing alcohol's emotional reward (Fairbairn & Sayette, 2014). In past laboratory studies, participants have typically consumed their study beverages while alone (Fairbairn & Sayette, 2014). In contrast, the overwhelming majority of drinking outside the laboratory occurs in social contexts (Cahalan, Cisin, & Crossley, 1969; Demers et al., 2002; Single & Wortley, 1993). Of note, alcohol administration studies comparing participants drinking in isolation with those drinking in social settings suggest that alcohol's rewards are significantly greater in social contexts (Doty & de Wit, 1995; Pliner & Cappell, 1974).

Social settings are not only well suited to capturing rewarding effects of alcohol, but also represent an important context in which to examine the effects of sex. Social psychologists have frequently observed that differences between sexes often emerge selectively in social settings (Eagly, 1995; Maccoby, 1990). These psychologists have identified "social interaction" as the context in which "the enactment of gender primarily takes place" (Deaux & Major, 1987, p. 370). Of note, social factors may underlie sex differences in alcohol problems. Across all drinking motives, social enhancement motives for drinking show the most consistent differences according to sex (e.g., Cooper, 1994; see Kuntsche, Knibbe, Gmel, & Engels, 2006), and rates of heavy drinking are particularly high in all-male drinking groups and all-male social organizations (Bartholow, Sher, & Krull, 2003; Bot, Engels, & Knibbe, 2005; Senchak, Leonard, & Greene, 1998; although see Rosenbluth, Nathan, & Lawson, 1978). Thus, social drinking paradigms might yield more consistent support for a mood-enhancing effect of alcohol, and might further serve to reveal sex differences in alcohol reward sensitivity.

Measurement of Emotion

A major challenge in alcohol-administration research is that of identifying reliable and valid measures of emotion. Challenges associated with the measurement of emotion loom particularly large when participants are observed within the context of social interaction, since emotions in social contexts can shift rapidly from one moment to the next and these emotions are further highly correlated across interaction partners. Physiological indexes such as heart rate have often been used to detect alcohol's anxiety-reducing effects (Sher, 1987), but these indexes may have limited utility since alcohol exerts direct pharmacological effects on these indexes independent of its effects on mood (see Sayette, 1993). Likewise, self-reports have often been used, but these measures require participants to impose language on what may be a nonverbal, visceral experience, and these measures may be vulnerable to distortions caused by self-presentational constraints such as those related to sex stereotypes (Schwarz, 1999). Indeed, past research has indicated that men do not reliably report the full range of their emotional experiences (Barrett, Robin, Pietromonaco, & Eyssell, 1998), suggesting that sole reliance on self-report measures may not be the best means by which to capture sex differences in mood.

Parameters of acoustic output have been reliably associated with internal affective state (Pittman & Scherer, 1993). When a colleague in the office next door is surprised by a pleasant phone call, we can clearly hear the enjoyment in her voice even when the words she speaks are indecipherable. Our emotions slip around our words, affecting our vocal apparatus and leaking into the sounds we make during speech. A variety of acoustic properties of speech have been researched in terms of their relationship to emotional experience (Juslin & Laukka, 2003), and scientists have even suggested that the voice may sometimes represent a more reliable index of emotion than the face (Juslin & Scherer, 2005). In particular, the volume of speech is one of the most widely researched elements of vocal output. As with many widely used nonverbal and also physiological indicators of emotion, speech volume alone cannot be used to infer emotion valence—it is believed to most directly index emotional arousal (Barrett, Mesquita, & Gendron, 2011). Importantly, however, when individuals are observed in a relatively pleasant, nonthreatening context, the volume of speech is associated with joy or happiness. The relationship between joy and volume has emerged using a range of experimental methods including studies involving actors who portray emotions (Scherer, Banse, & Wallbott, 2001), experiments testing correlations derived from natural speech samples (e.g., Greasley, Sherrard, & Waterman, 2000; Wrede & Shriberg, 2003), and also in experiments that use emotion induction procedures (e.g., Sobin & Alpert, 1999). Thus, speech volume has been found to be a reliable acoustic measure of positive affect (Johnstone & Scherer, 2000; Scherer, 1986, 2003). While an emerging literature is exploring the effects of alcohol intoxication on vocal parameters (Baumeister & Schiel, 2010; Bone, Li, Black, & Narayanan, 2014; Hollien, DeJong, Martin, Schwartz, & Liljegren, 2001; Pisoni & Martin, 1989), it is notable that no prior work has examined the impact of alcohol on the volume of naturalistic social interaction. Importantly, volume is an objective measure of emotion that can be assessed repeatedly and unobtrusively throughout the course of social interaction, and thus represents a promising means by which to explore the effects of alcohol and sex on social-emotional experience.

The Current Study: Assessing Emotion During Group Formation

In a recent study we examined the impact of alcohol on mood using multimodal assessment of emotional state (Sayette, Creswell et al., 2012). This study featured several characteristics that distinguished it from previous examinations of alcohol and mood including: a) use of a novel group formation paradigm—participants consumed their beverages within the context of a 36-min-long unstructured social exchange; and b) use of a sample of participants large enough to assess moderators of alcohol's effects at the level of the social group.

In our initial set of analyses examining this dataset, we found that groups consuming alcohol displayed more positive facial expressions, fewer negative expressions, briefer speech silences, and more self-reported reward than groups consuming placebo or control beverages (Sayette, Creswell et al., 2012). In these analyses—comparing mean levels of facial behaviors and silence duration as well as self-reports across conditions—we found no evidence of differential alcohol reward according to sex. In a subsequent study focused on facial dynamics, we found initial evidence for differential response to alcohol in male versus female drinking groups (Fairbairn, Sayette, Aalen, & Frigessi, 2014). In this latter study, we examined social dynamics by mapping the spreading of smiles from one group member to the next, and found that alcohol increased facial mimicry to a greater extent in male versus female drinking groups. Importantly, while nonverbal mimicry has been linked to social affiliation, the relationship between mimicry and affective states in social settings is not clear (Chartrand & Lakin, 2013) and, to our knowledge, mimicry has never previously been used to index reward. Replication of differential sex effects observed in this study is therefore indicated. Further, due to practical constraints associated with facial coding, our previous research examining differential alcohol effects according to sex (Fairbairn et al., 2014) was conducted on a purely between-subjects level and has not examined effects within subjects. Thus, this previous work did not examine how effects might vary as a function of time across the drink period and whether trajectories over time mirror what might be expected given progressive intoxication among participants consuming alcohol.

The current study thus sought to extend our previous work by mapping the effects of alcohol and sex on trajectories of vocal output over time. Vocal parameters have been widely researched as correlates of emotional experience, and we hypothesized that the voice would reveal sex differences in alcohol reward that we had previously only glimpsed in the face. More specifically, we focused on the effect of alcohol and sex on the volume of speech—a prosodic correlate of social reward that could be captured at the level of the group (Juslin & Scherer, 2005). We had three primary aims to the present research. First, we aimed to confirm that, consistent with previous examinations of vocal output in nonthreatening social contexts (Juslin & Scherer, 2005), group volume would emerge as an index of reward within our group drinking paradigm. Second, having established group volume as an objective, continuous, and reliable measure of momentary affective experience, we aimed to compare the impact of alcohol on the volume of social interaction across male and female drinking groups. Based on prior survey studies pointing to increased alcohol reward for men in social settings (Cooper, 1994; Kuntsche et al., 2006), we predicted that alcohol would increase the volume of speech to a greater extent in male groups compared with groups containing females. Third, we aimed to track changes over time in behavioral-affective display, exploring how alcohol and sex impact trajectories of group volume over the course of the 36-min social exchange.

Method

Participants

As detailed elsewhere (Sayette, Creswell et al., 2012), participants consisted of 720 healthy social drinkers aged 21–28[2] recruited via ads in local newspapers. Of these participants, 360 were male and 360 were female. Individuals who successfully completed an initial phone interview were invited to the Alcohol and Smoking Research Laboratory for a screening session. Following informed consent, exclusion criteria were assessed. Exclusion criteria included: medical conditions that contraindicated alcohol consumption; past alcohol abuse or dependence, as indexed by *DSM–IV*; pregnancy in females; not being within 15% of ideal weight for height[3]; and being uncomfortable with study drinking requirements. [Personality was also assessed during this screening session using the NEO-FFI (McCrae & Costa, 2004).] Eligible individuals were invited to participate in the experiment (83% European American, 11% African American, 1% Hispanic, 2.5% Asian, and 2.5% other). On average, participants reported drinking 2–3 times/week and consuming 4.29 ($SD = 1.89$) drinks/occasion.

Procedure

Participants were informed that the purpose of the study was to measure alcohol's impact on cognitive performance. They were instructed not to eat for 4 hours and not to drink alcohol for 24 hours prior to the experimental session. Participants were randomly assigned to groups of three, and groups were then assigned to an alcohol beverage (told alcohol, received alcohol), placebo beverage (told alcohol, received no alcohol), or control beverage (told no alcohol, received no alcohol) condition. All three group members were assigned to the same beverage condition. Within each of the three beverage conditions, groups were evenly distributed according to sex composition. Specifically, each beverage condition contained 20 all-female groups, 20 all-male groups, 20 groups with two females and one male, and 20 groups with two males and one female. Upon arriving in the lab, participants were casually and individually introduced to confirm that they were not previously acquainted (Kirchner, Sayette, Cohn, Moreland, & Levine, 2006). [Additional participants were invited to each session to ensure that the three selected participants were unacquainted (see Sayette, Creswell et al., 2012)]. Participants then provided a breath sample to assess blood alcohol content (BAC), indicated their subjective level of intoxication, and completed a variety of self-report mood and personality assessments [for example, Positive and Negative Affect Schedule; PANAS (Watson, Clark, & Tellegen, 1988)].

The three participants were next seated at equidistant intervals around a round table. A microphone was placed under a metal box in the center of the table equidistant from the three participants in

[2] A maximum age cutoff of 28 was selected for several reasons including: a) our aim of examining drinkers with as little prior exposure to alcohol as possible; and b) our aim of limiting variation according to age within the sample and thereby reducing "noise" associated with variables aside from those of primary interest.

[3] Weight restrictions were due to the fact that body weight was used as a proxy for body water in calculating alcohol doses. Such approximations are more accurate when weight is within normal limits.

order to record conversation (see also study measures section). Cameras were positioned in all corners of the room to monitor facial expressions. Participants were initially informed that the purpose of the microphone was to enable them to communicate with the experimenter in the next room, and that the cameras were intended to monitor their drink consumption (see comments on debriefing below). Participants were instructed not to move their chairs, the correct positions of which were demarcated by lines on the floor, under the pretext that to do so might obstruct the camera's view of their drinks.

Participants in the alcohol and placebo conditions were informed that they would be receiving alcohol and that the dose would be less than the legal driving limit. Drinks were mixed in front of all study groups (Rohsenow & Marlatt, 1981). The alcoholic beverage was 1 part 100 proof vodka and 3.5 parts cranberry juice cocktail. In the placebo group, the glass was smeared with vodka to increase credibility. We accounted for differences between men and women in rates of alcohol metabolism by adjusting the dose of alcohol according to sex. Males in the alcohol condition were administered a .82 g/kg dose, while females were administered a .74 g/kg dose of alcohol (Sayette, Martin, & Perrott, 2001). Participants remained seated for a total of 36 min while beverages were administered in three equal parts at 0 min, 12 min, and 24 min. Experimenters only entered the room three times to refill drinks. Participants were instructed to drink their beverages evenly over the 12-min intervals and refrain from discussing how intoxicated they felt. Participants were otherwise not given instructions relevant to the social interaction—participants were ostensibly seated in the same room to facilitate drink administration and communication with the experimenter.

After all study beverages had been consumed, participants completed measures of mood and social bonding and their BACs were recorded. Participants further reported on their subjective levels of intoxication and estimated the amount of vodka they believed they had consumed (see Table 1). Next they performed some additional cognitive tasks lasting approximately 40 minutes (see Sayette, Dimoff, Levine, Moreland, & Votruba-Drzal, 2012). After BAC was again assessed, placebo and control participants were debriefed, paid $60, and allowed to leave. Participants in the alcohol condition remained until their BACs dropped below .025%. Before leaving, participants were informed that their interactions had been recorded, and their consent to analyze the data was solicited (all participants agreed). See Figure 1 for a timeline of procedures and assessments during the experimental session.

Measures

Volume. Audio was recorded using a Shure SM57 microphone, a dynamic microphone with a frequency response range from 40 to 15,000 Hz. Since the focus of the study was on group-level activity and not individual responding, a single group-level microphone was sufficient for our purposes. Further, the use of a single concealed microphone had the advantage of circumventing the measurement effects that often arise through the use of individual microphones, whose true purpose in recording conversation would have been difficult to conceal from participants (see Frank, Juslin, & Harrigan, 2008 for a comparison of measurement issues accompanying "individual" vs. "room" microphones). Praat acoustic analysis software was used to extract intensity (volume) data at a sampling rate of 30 samples per second (Boersma & Weenink, 2014).

The volume of speech is notoriously difficult to capture reliably and can sometimes be confounded with other factors such as body position (Pittman & Scherer, 1993). We circumvented some of these issues in the current study by requiring participants to be seated and fixing the position of their chairs, thus limiting participants' distance from the microphone to a relatively restricted range. Nonetheless, we conducted analyses intended to examine whether participants' tendency to lean forward or backward in their chairs significantly impacted group volume. Study personnel measured overhead video images for the distance of each participant's head from the microphone. Three independent raters measured 60 overhead images drawn from 40 randomly selected groups ($\kappa = .87$). Importantly, across these 2,400 observations, mixed models produced no evidence of a relationship between participants' body posture (distance to the microphone) and the volume of their interaction as measured from the microphone, $p = .93$.

Facial coding and content-free speech. Video-recordings were coded according to the Facial Action Coding System (FACS; Ekman, Friesen, & Hager, 2002). In particular, we focused on the Duchenne smile—otherwise known as the "true" smile or the smile of enjoyment—as the most widely researched facial expression within FACS (Ekman & Rosenberg, 2005). In addition, observers coded the overall duration of speech by marking the beginning and end of each speaker's turn. Interrater reliability, evaluated based on 3 minutes of video tape drawn from a random subset of 72 participants, was excellent (Duchenne smile, $\kappa = .88$; Speech, $\kappa = .80$).

Table 1
Beverage Manipulation Check

	Alcohol *M* (*SD*)		Placebo *M* (*SD*)		Control *M* (*SD*)	
	Males	Females	Males	Females	Males	Females
BAC after drinking	0.057^{a} (0.012)	0.053^{b} (0.012)	0.001^{c} (0.001)	0.001^{c} (0.001)	0.001^{c} (0.001)	0.001^{c} (0.001)
BAC 40-min after drinking†	0.064^{a} (0.011)	0.061^{b} (0.011)	0.001^{c} (0.001)	0.001^{c} (0.001)	—	—
SIS after drinking	40.48^{a} (16.28)	36.52^{a} (18.14)	13.92^{b} (9.85)	15.89^{b} (10.94)	0.18^{c} (0.93)	0.23^{c} (1.89)
SIS 40-min after drinking†	36.83^{a} (15.10	33.40^{a} (18.43)	7.66^{b} (7.84)	10.14^{b} (13.02)	—	—
Vodka estimate	7.99^{a} (11.80)	6.25^{a} (7.41)	4.94^{b} (4.25)	4.33^{b} (6.42)	0.04^{c} (0.23)	0.07^{c} (0.57)

Note. Within each row, groups with different subscripts differed significantly ($p < .05$). BACs† control participants not asked to provide these data. BAC = blood alcohol concentration; SIS = subjective intoxication scale (scored on a scale ranging from 0 to 100). Vodka estimate = subjects' estimates of how many ounces of vodka they thought they had consumed.

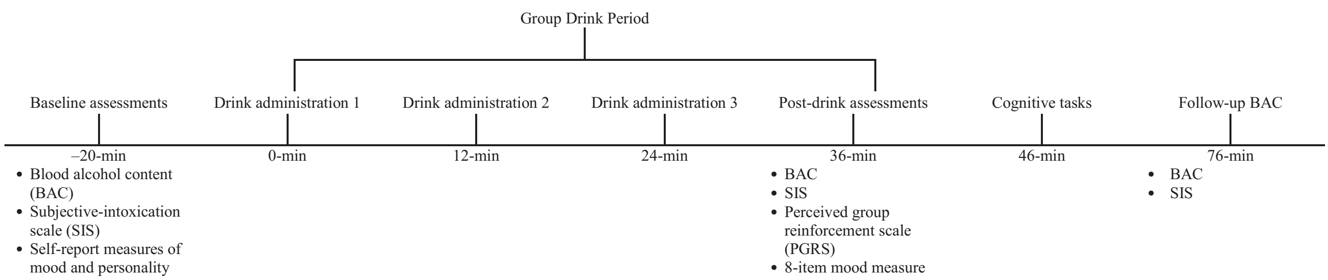

Figure 1. Timeline of procedures and assessments during the experimental session.

Self-reported reward. Consistent with our past research (Fairbairn & Sayette, 2013), we indexed reward using self-report measures of mood and social bonding administered immediately after the interaction. We assessed social bonding using the Perceived Group Reinforcement Scale (PGRS; Kirchner et al., 2006). The PGRS included 12 Likert-type items, such as "I like this group" and "The members of this group are interested in what I have to say," which were aggregated as a composite score (α = .90). We assessed mood using an 8-item mood measure. The mood measure assesses four negative mood states (annoyed, sad, irritated, bored) and four positive mood states (cheerful, upbeat, happy, content) selected to represent all quadrants of the affective circumplex (Russell, 2003). Participants reported the extent to which they felt each of these eight mood states using a 6-point Likert scale ranging from 0, *not at all*, to 5, *extremely*. We used this inventory to assess not only positive mood but also negative mood. Scores on the four positive items were averaged to create the positive mood subscale, and scores on the four negative items were averaged to create the negative subscale (Positive mood α = .87; Negative mood α = .70).

Data Analysis

There were three primary aims of data analysis: a) To examine the relationship between group volume and self-report and facial indexes of emotion; b) To examine how alcohol and sex impact mean levels of group volume; and c) To examine trajectories of group volume over the course of the social interaction.

Group volume was recorded continuously throughout the 36-min interaction with the exception of 2 minutes during which the experimenter entered the room to refill drinks. Hierarchical linear models were used to account for repeated observations over time within each group (Raudenbush & Bryk, 2002). To promote consistency with our prior work, primary analyses (i.e., analyses not explicitly mapping trajectories over time) focused on Minutes 12–36 of the 36-min group drink period, or the time period during which the effects of alcohol are more pronounced (Sayette, Creswell et al., 2012). Volume data, originally measured at every 1/30th of a second, was averaged into 10-second intervals for analysis (Fairbairn & Sayette, 2013). Four groups were excluded from analysis due to technical problems with audio files. The duration of speech was entered as a covariate in order to disentangle the amount of speech in groups from the volume at which this speech took place.

As in our previous work (Sayette, Dimoff et al., 2012), beverage condition was initially represented as a complete orthogonal set of contrast codes, the first ("placebo versus control") contrast comparing placebo and control conditions while the second ("Alcohol") contrast compares alcohol to both placebo and control conditions (Cohen, Cohen, West, & Aiken, 2003).

Results

Beverage Manipulation Check and Baseline Comparisons

BACs and measures of subjective intoxication appear in Table 1. Participants drinking alcohol were on the rising limb of the BAC curve with a BAC of just below .06% immediately following the interaction period. All placebo and alcohol participants estimated that they had consumed at least 1 oz. of vodka. Consistent with our prior studies (e.g., Sayette et al., 2001), placebo participants reported experiencing some level of intoxication, more than control participants and less than alcohol participants. These data indicate that, though participants drinking placebo felt less intoxicated than those drinking alcohol, the placebo led them to believe that they had drunk alcohol and were somewhat intoxicated, thus meeting the modest goals of the placebo manipulation (Martin & Sayette, 1993). Within the alcohol condition, women reached a slightly lower BAC immediately following drinking compared with men (difference between men and women, .004%),[4] a difference that decreased in magnitude as BAC's continued to ascend (.003% 40 minutes postdrink). Men and women did not differ in their subjective levels of intoxication.

Table 2 presents descriptive statistics for baseline mood and personality measures subdivided according to sex and beverage condition. Consistent with sex differences observed in previous studies of personality (Schmitt, Realo, Voracek, & Allik, 2008), female participants in the present study showed higher levels of extraversion, neuroticism, conscientiousness, and agreeableness than men, and further reported lower levels of baseline positive mood. There were no differences in personality or baseline mood variables across drink conditions.

[4] While BACs differed somewhat within the alcohol condition itself, and slight differences in BACs did emerge within the alcohol condition according to sex, the extent of variation in BACs among alcohol participants did not correspond with significant variation in group volume, p = .84. Thus, it is unlikely that sex differences in BACs account for differential sex effects of alcohol observed in this study.

Table 2
Personality, Baseline Mood, and Postdrink Mood According to Drink Condition and Sex

	Alcohol *M* (*SD*)		Placebo *M* (*SD*)		Control *M* (*SD*)	
	Males	Females	Males	Females	Males	Females
Personality (NEO-FFI)						
Neuroticism[G]	17.98 (7.18)	19.22 (7.77)	17.78 (7.44)	19.23 (6.52)	17.42 (7.71)	18.79 (8.34)
Extraversion[G]	31.51 (6.90)	32.18 (6.63)	31.97 (6.15)	32.66 (7.46)	31.14 (5.27)	33.25 (6.40)
Openness	32.18 (6.43)	31.49 (7.25)	30.33 (6.39)	31.01 (6.74)	31.60 (7.08)	30.59 (7.01)
Conscientiousness[G]	32.43 (6.74)	33.34 (6.94)	31.12 (7.63)	33.10 (7.55)	31.67 (7.32)	34.45 (6.38)
Agreeableness[G]	30.87 (5.62)	33.76 (5.98)	31.01 (6.18)	32.65 (6.37)	30.99 (6.93)	33.93 (6.47)
Baseline SR mood (PANAS)						
Positive mood[G]	27.40 (6.96)	24.80 (7.08)	25.82 (6.71)	25.76 (6.88)	25.71 (7.33)	24.23 (6.65)
Negative mood	11.76 (2.32)	11.86 (2.72)	11.94 (2.42)	12.08 (2.65)	11.64 (2.58)	11.34 (2.38)
SR mood immediately after group drink period*						
Positive mood[A,G]	3.44 (0.87)	3.62 (0.77)	3.08 (0.77)	3.35 (0.82)	3.19 (0.83)	3.44 (0.79)
Negative mood[A,G]	0.40 (0.47)	0.27 (0.36)	0.83 (0.72)	0.52 (0.46)	0.68 (0.65)	0.52 (0.52)
Social bonding[A,G]	7.02 (1.26)	7.42 (1.21)	6.49 (1.65)	6.98 (1.34)	6.89 (1.30)	7.25 (1.28)

Note. SR = Self-report. * See Method section for a description of the postinteraction mood measures used. Different mood measures were used before vs. after the social interaction to avoid anchoring effects. Superscripts: A = Main effect of alcohol; G = Main effect of sex. No significant interactions between alcohol and sex emerged with respect to any of the above variables.

Volume and Reward

First, we examined whether group volume was associated with reward in the present study. Group volume showed a significant positive relationship with self-reports of social bonding, $B = 1.48$, $t = 4.77$, $p < .0001$, positive mood, $B = 2.53$, $t = 6.45$, $p < .0001$, and an inverse relationship with negative mood, $B = -2.49$, $t = -3.92$, $p < .0001$. Increases in group volume corresponded with increases in social bonding and positive mood and decreases in negative mood. These significant associations remained unchanged even after controlling for overall speech duration (ps $< .002$). Thus it appears that volume has a relationship with self-reported reward that extends beyond overall speech duration. We also tested the relationship between group volume and facial indicators of reward. Specifically, we examined the relationship between group volume and the average number of group members smiling at each 10-second interval of the interaction. There was a strong relationship between Duchenne smiling and group volume, such that increases in group volume corresponded to increases in the number of group members displaying Duchenne smiles, $B = 3.39$, $t = 30.17$, $p < .0001$. Furthermore, the correlation between speech volume and self-report and facial indexes of reward did not vary according to group sex—the relationship between increases in speech volume and self-report and facial indexes of positive mood did not differ significantly across all-male, all-female, majority male, and majority female groups (all ps $> .3$).

Volume, Alcohol, and Sex

Findings revealed a significant main effect of alcohol on group volume. We found that alcohol significantly increased the volume of social interactions, $B = 1.81$, $t = 3.83$, $p = .0002$. More specifically, alcohol increased the volume of interactions by about 2 decibels, which, after accounting for the overall variance in the volume measure, corresponded to an effect that was medium in magnitude, $d = .53$. Of interest, this effect was not entirely accounted for by speech duration—alcohol increased volume over and above its tendency to increase speech duration, $B = 1.18$, $t = 2.87$, $p = .005$. There were no significant differences between placebo and control conditions in group volume, $p = .11$.

Of particular interest to the current study, findings further revealed a significant alcohol-by-group sex composition interaction, $B = .94$, $t = 2.24$, $p = .026$. The effect of alcohol on group volume increased as the number of men in the group increased. All-male groups showed the greatest effects of alcohol—all-male groups consuming alcohol were over 3 decibels louder than all-male groups consuming no alcohol, $B = 3.24$, $t = 4.10$, $p < .0001$. In contrast, all-female groups consuming alcohol were not significantly louder than all-female groups consuming no-alcohol, $p = .593$.[5] Further probes of simple contrasts suggested that this alcohol-by-group sex interaction was primarily driven by the distinction between all-male groups and groups that contained any females. Sober groups containing any women were significantly louder than sober male groups, $B = 1.93$, $t = 2.87$, $p = .005$, and alcohol consumption brought these male groups up to the level of women, $p = .23$. Groups with one versus two versus three females did not differ significantly from one another in their response to alcohol, ps $> .68$. Further, the effects of group sex did not vary depending on whether participants were assigned to placebo versus control conditions, $p = .31$.

Trajectories Over Time

Consistent with our prior work, the analyses above focus on Minutes 12–36 of the interaction. In our previous studies practical constraints prevented us from performing manual facial and speech duration coding for the full interaction (see Sayette, Creswell et al., 2012)—we instead focused our coding efforts on Minutes 12–36—while in the current study volume extraction was possible for the entire social interaction including Minutes 1–12. In this next section, we track trajectories of group volume over the course of the full 36-min interaction.

Across all groups, volume increased linearly, $B = .01$, $t = 10.67$, $p < .0001$, rising by about 2.2 decibels over the course of the 36-min interaction. A significant quadratic slope component also emerged, $B = -0.0001$, $t = -10.52$, $p < .0001$, indicating that the steepest increase in volume occurred near the beginning of the interaction, with increases in volume flattening off as the interaction progressed.

Analyses revealed a significant interaction between alcohol condition and the linear slope component, $B = 0.01$, $t = 7.85$, $p < .0001$. Differences between alcohol and no-alcohol conditions were nonsignificant at the beginning (Minute 0) of the interaction, $B = -0.295$, $t = -0.69$, $p = .49$, growing larger as the interaction progressed and expanding to nearly 3 decibels by the end (Minute 36) of the interaction, $B = 2.75$, $t = 5.09$, $p < .0001$. These overtime analyses also revealed significant differences between placebo and control conditions, $B = -0.004$, $t = -2.16$, $p = .03$, with the placebo group showing a significantly lower rate of increase in volume over time compared to the control condition. Of note, when compared individually with the alcohol condition, both placebo, $B = -0.016$, $t = -7.63$, $p < .0001$, and control conditions, $B = -0.012$, $t = -6.01$, $p < .0001$, showed significantly lower rates of volume increase over time. The quadratic time component did not interact with beverage condition. Finally, analyses revealed a significant three way interaction between time, alcohol condition, and group sex composition, $B = 0.008$, $t = 2.02$, $p = .04$. Linear increases in alcohol's effects over time were most pronounced in all-male groups, $B = 0.02$, $t = 5.53$, $p < .0001$, and less pronounced in groups containing women, $B = 0.01$, $t = 5.95$, $p < .0001$ (see Figure 2).

Discussion

> "*When he opened the door the buzz from the living room exploded into our faces. It seemed louder than before, if possible. About two drinks louder*." (Chandler, 1953, p. 177)

It has often been observed that alcohol increases the volume of social exchange. Intoxicated interactions tend to be noisy interactions. While this phenomenon is widely accepted, it is notable that the relationship between alcohol consumption and speech volume within unstructured social exchange has not, to our knowledge, been empirically examined. The current study produced evidence that alcohol increased the volume of social interaction over and above its tendency to increase the amount of speech within social exchange. Of particular importance, and consistent with previous research linking volume to happiness (Juslin & Scherer, 2005), we found a powerful and robust relationship between increases in group volume and facial and self-report indicators of positive mood.

This work introduces a new measure with potential to capture rewarding effects of alcohol within the context of pleasant social exchange. While on the rising BAC curve (when our participants were tested) there is good evidence for enhanced responding to alcohol to be linked to risk for AUD (see Sher & Wood, 2005 for a review). For instance, Sher and Levenson (1982) used a multimodal set of measures to show that those at increased risk for AUD, due to a family history of AUD as well as other factors, showed enhanced stress relief from alcohol. Accordingly we believe that insofar as a measure indexes hedonically rewarding effects of alcohol, then it may be a useful addition to the set of measures available to assess vulnerability to develop AUD. In the present study, we unobtrusively "listen in" on social exchange, employing continuous and objective measures of affect in order to index participants' level of reward. In particular, we focus on speech volume as a well-established indicator of positive affect (Scherer, 1986, 2003). We believe that a novel contribution of the present study is to offer speech volume as a measure capable of indexing in real-time alcohol sensitivity and thus a potential new approach to assessing risk for AUD.

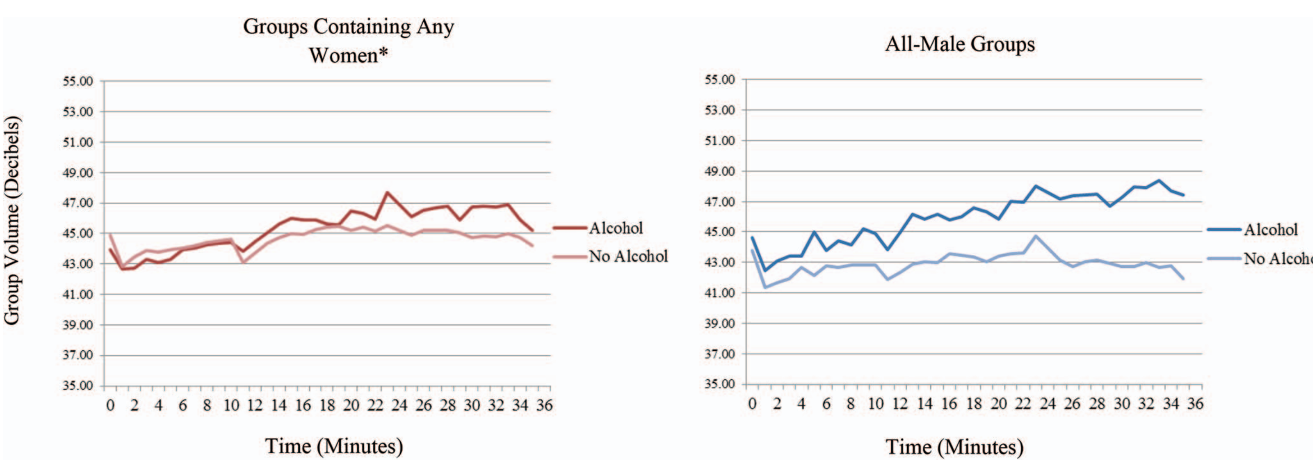

Figure 2. Group volume over time during the social drinking period according to alcohol condition and group sex composition. *Note.* Alcohol increased the volume of social exchange to a greater extent in all-male groups than in groups containing females. (Alcohol brought the volume of all-male group interaction up to the level of female groups). *Alcohol's effects on volume did not differ between groups containing one versus two versus three women. Consistent with our prior work (Fairbairn, Sayette, Aalen, & Frigessi, 2014) we found that the only significant interaction with alcohol emerged with respect to the distinction between groups that contained any women versus those with no women. See the online article for the color version of this figure.

Using a group drinking paradigm and an objective nonverbal index of affective experience, we found experimental evidence for alcohol reward sensitivity according to sex. While researchers have long theorized that acute response to alcohol may partially explain sex differences in problem drinking (Nolen-Hoeksema, 2004), prior research relying on asocial drinking paradigms has failed to find evidence for differential alcohol-reward sensitivity according to sex (e.g., Sayette et al., 1994). In the present study, we found that the volume of social interaction in male groups increased more with alcohol consumption than in groups containing females. Sober groups containing females were louder than sober male groups, and alcohol consumption brought the all-male groups up to the level of groups containing females. Thus, the current work points to significantly greater alcohol reward for male groups and thus identifies a mechanism that may support heavy drinking in male drinking contexts.

Our continuous measure of group volume also allowed us to track trajectories of expressed affect over the course of the 36-min interaction, mapping the effects of alcohol consumption over time. Thus, we could explore effects of alcohol on the within-subject level, which we had previously only examined between subjects (Sayette, Creswell, et al., 2012). We observed increases in group volume over the course of the 36-min social interaction across all groups, with the rate of linear increase in group volume in the alcohol condition being steeper than in both no-alcohol conditions. While alcohol participants showed the greatest rate of increase, those assigned to the control group showed a significantly higher rate of increase in group volume when compared with those assigned to the placebo condition, potentially reflecting unanticipated compensatory placebo effects (see Testa et al., 2006).

Limitations of this research should be noted. First, participants in this study were examined while on the ascending limb of the BAC curve. It would be interesting to see whether effects generalize to participants whose BACs are descending (Babor, Berglas, Mendelson, Ellingboe, & Miller, 1983). Second, studies of vocal output often examine effects across multiple acoustic parameters (e.g., f0, jitter, shimmer). Many of these prosodic features require an audio signal localized to a single speaker, which is difficult to do unobtrusively. Importantly, since acoustic signals were measured at the level of the group, and our research questions focused on group-level emotions, we focused solely on volume in the present study. Nonetheless, future studies examining alcohol's impact on individual-level vocal output might examine alcohol's effects across a range of acoustic parameters (Baumeister & Schiel, 2010; Bone et al., 2014; Hollien et al., 2001; Pisoni & Martin, 1989). Relatedly, similar to many physiological indexes of affect such as heart rate, the volume of speech most directly indexes emotional arousal, and without context cannot alone provide information concerning emotional valence. Thus, while within the context of our relatively pleasant social interaction volume manifested as a powerful correlate of reward, volume in other contexts can be associated with other emotions including anger, stress, and surprise (Juslin & Scherer, 2005). It would be interesting to see whether volume effects observed here generalize to other social interactions including those intended to elicit stress or competition. Third, reviews of the literature have established that, assuming one is using at least a moderate dose of an alcohol beverage yielding BACs $> .045\%$, it is virtually impossible to create a placebo beverage condition that would lead social drinking participants to estimate their level of intoxication to be equal to what they would have reported had they consumed the alcoholic beverage (see Martin & Sayette, 1993). Thus, participants in our placebo condition estimated that they had consumed some vodka but not as much as those in the alcohol condition. Therefore, consistent with the majority of prior alcohol-administration studies, we cannot entirely rule out the possibility that subtle differences in alcohol expectancies played a role in effects observed in this study. Finally, the present paradigm mirrors common real-world situations in which all members of a social group consume alcohol together. Future research would be indicated to extend these findings by varying drink condition within groups (e.g., Kirkpatrick & de Wit, 2013).

These issues notwithstanding, by using a much larger sample size than is customary in the alcohol administration research literature; by introducing a novel measure of group affect to the alcohol/emotion literature, which is notable for its ability to unobtrusively, reliably, and objectively assess moment-to-moment shifts in emotional experience; and by explicitly designing the study to permit a fine-grained analysis of the moderating impact of sex on the effects of alcohol, the present study reveals that alcohol affects men and women differently while they interact in groups. More generally, the present study offers new directions for understanding the complex interplay between sex and alcohol that may suggest social mechanisms underlying differential rates of AUDs among men and women.

References

Babor, T. F., Berglas, S., Mendelson, J. H., Ellingboe, J., & Miller, K. (1983). Alcohol, affect, and the disinhibition of verbal behavior. *Psychopharmacology, 80,* 53–60. http://dx.doi.org/10.1007/BF00427496

Barrett, L. F., Mesquita, B., & Gendron, M. (2011). Context in emotion perception. *Current Directions in Psychological Science, 20,* 286–290. http://dx.doi.org/10.1177/0963721411422522

Barrett, L. F., Robin, L., Pietromonaco, P. R., & Eyssell, K. M. (1998). Are women the "more emotional" sex? Evidence from emotional experiences in social context. *Cognition and Emotion, 12,* 555–578. http://dx.doi.org/10.1080/026999398379565

Bartholow, B. D., Sher, K. J., & Krull, J. L. (2003). Changes in heavy drinking over the third decade of life as a function of collegiate fraternity and sorority involvement: A prospective, multilevel analysis. *Health Psychology, 22,* 616–626. http://dx.doi.org/10.1037/0278-6133.22.6.616

Baumeister, B., & Schiel, F. (2010, July). *On the effect of alcoholisation on fundamental frequency*. Paper presented at the IAFPA Annual Conference, Trier, Germany.

Boersma, P., & Weenink, D. (2014). Praat: Doing phonetics by computer (Version 5.3.82) [Software]. Amsterdam, The Netherlands: Praat. Retrieved from http://www.praat.org/

Bone, D., Li, M., Black, M. P., & Narayanan, S. S. (2014). Intoxicated speech detection: A fusion framework with speaker-normalized hierarchical functionals and GMM supervectors. *Computer Speech & Language, 28,* 375–391. http://dx.doi.org/10.1016/j.csl.2012.09.004

Bot, S. M., Engels, R. C. M. E., & Knibbe, R. A. (2005). The effects of alcohol expectancies on drinking behaviour in peer groups: Observations in a naturalistic setting. *Addiction, 100,* 1270–1279. http://dx.doi.org/10.1111/j.1360-0443.2005.01152.x

Breslin, F. C., Mayward, M., & Baum, A. (1994). Effect of stress on perceived intoxication and the blood alcohol curve in men and women. *Health Psychology, 13,* 479–487. http://dx.doi.org/10.1037/0278-6133.13.6.479

Cahalan, D., Cisin, I. H., & Crossley, H. M. (1969). *American drinking practices: A national study of drinking behavior and attitudes*. New Brunswick, NJ: Rutgers Center of Alcohol Studies.

Chandler, R. (1953). *The long goodbye*. New York, NY: Vintage.

Chartrand, T. L., & Lakin, J. L. (2013). The antecedents and consequences of human behavioral mimicry. *Annual Review of Psychology, 64,* 285–308. http://dx.doi.org/10.1146/annurev-psych-113011-143754

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). *Applied multiple regression/correlation analysis for the behavioral sciences* (3rd ed.). Hillsdale, NJ: Routledge Academic.

Conger, J. J. (1956). Alcoholism: Theory, problem and challenge. II. Reinforcement theory and the dynamics of alcoholism. *Quarterly Journal of Studies on Alcohol, 17,* 296–305.

Cooper, M. L. (1994). Motivations for alcohol use among adolescents: Development and validation of a four-factor model. *Psychological Assessment, 6,* 117–128. http://dx.doi.org/10.1037/1040-3590.6.2.117

Deaux, K., & Major, B. (1987). Putting gender into context: An interactive model of gender-related behavior. *Psychological Review, 94,* 369–389. http://dx.doi.org/10.1037/0033-295X.94.3.369

Demers, A., Kairouz, S., Adlaf, E. M., Gliksman, L., Newton-Taylor, B., & Marchand, A. (2002). Multilevel analysis of situational drinking among Canadian undergraduates. *Social Science & Medicine, 55,* 415–424. http://dx.doi.org/10.1016/S0277-9536(01)00258-1

Doty, P., & de Wit, H. (1995). Effect of setting on the reinforcing and subjective effects of ethanol in social drinkers. *Psychopharmacology, 118,* 19–27. http://dx.doi.org/10.1007/BF02245245

Dougherty, D. M., Bjork, J. M., & Bennett, R. H. (1998). Effects of alcohol on rotary pursuit performance: A gender comparison. *The Psychological Record, 48,* 393–405.

Eagly, A. H. (1995). The science and politics of comparing women and men. *American Psychologist, 50,* 145–158. http://dx.doi.org/10.1037/0003-066X.50.3.145

Ekman, P., Friesen, W. V., & Hager, J. C. (2002). *Facial Action Coding System*. Salt Lake City, UT: Network Information Research.

Ekman, P., & Rosenberg, E. L. (2005). *What the face reveals: Basic and applied studies of spontaneous expression using the Facial Action Coding System* (FACS, 2nd ed.). New York, NY: Oxford University Press. http://dx.doi.org/10.1093/acprof:oso/9780195179644.001.0001

Fairbairn, C. E., & Sayette, M. A. (2013). The effect of alcohol on emotional inertia: A test of alcohol myopia. *Journal of Abnormal Psychology, 122,* 770–781. http://dx.doi.org/10.1037/a0032980

Fairbairn, C. E., & Sayette, M. A. (2014). A social-attributional analysis of alcohol response. *Psychological Bulletin, 140,* 1361–1382. http://dx.doi.org/10.1037/a0037563

Fairbairn, C. E., Sayette, M. A., Aalen, O. O., & Frigessi, A. (2014). Alcohol and emotional contagion: An examination of the spreading of smiles in male and female drinking groups. *Clinical Psychological Science*. Advance online publication. http://dx.doi.org/10.1177/2167702614548892

Frank, M. G., Juslin, P. N., & Harrigan, J. A. (2008). Technical issues in recording nonverbal behavior. In J. A. Harrigan, R. Rosenthal, & K. R. Scherer (Eds.), *The new handbook of methods in nonverbal behavior research* (pp. 449–470). New York, NY: Oxford University Press. http://dx.doi.org/10.1093/acprof:oso/9780198529620.003.0012

Greasley, P., Sherrard, C., & Waterman, M. (2000). Emotion in language and speech: Methodological issues in naturalistic approaches. *Language and Speech, 43,* 355–375. http://dx.doi.org/10.1177/00238309000430040201

Hollien, H., DeJong, G., Martin, C. A., Schwartz, R., & Liljegren, K. (2001). Effects of ethanol intoxication on speech suprasegmentals. *The Journal of the Acoustical Society of America, 110,* 3198–3206. http://dx.doi.org/10.1121/1.1413751

Johnstone, T., & Scherer, K. R. (2000). Vocal communication of emotion. In M. Lewis & J. M. Haviland-Jones (Eds.), *Handbook of emotions* (Vol. 2, pp. 220–235). New York, NY: Guilford Press.

Josephs, R. A., & Steele, C. M. (1990). The two faces of alcohol myopia: Attentional mediation of psychological stress. *Journal of Abnormal Psychology, 99,* 115–126. http://dx.doi.org/10.1037/0021-843X.99.2.115

Juslin, P. N., & Laukka, P. (2003). Communication of emotions in vocal expression and music performance: Different channels, same code? *Psychological Bulletin, 129,* 770–814.

Juslin, P. N., & Scherer, K. R. (2005). Vocal expression of affect. In J. A. Harrigan, K. R. Rosenthal, & K. R. Scherer (Eds.), *The new handbook of methods in nonverbal behavior research* (pp. 65–135). New York, NY: Oxford University Press.

King, A. C., de Wit, H., McNamara, P. J., & Cao, D. (2011). Rewarding, stimulant, and sedative alcohol responses and relationship to future binge drinking. *Archives of General Psychiatry, 68,* 389–399. http://dx.doi.org/10.1001/archgenpsychiatry.2011.26

Kirchner, T. R., Sayette, M. A., Cohn, J. F., Moreland, R. L., & Levine, J. M. (2006). Effects of alcohol on group formation among male social drinkers. *Journal of Studies on Alcohol, 67,* 785–793. http://dx.doi.org/10.15288/jsa.2006.67.785

Kirkpatrick, M. G., & de Wit, H. (2013). In the company of others: Social factors alter acute alcohol effects. *Psychopharmacology, 230,* 215–226. http://dx.doi.org/10.1007/s00213-013-3147-0

Kuntsche, E., Knibbe, R., Gmel, G., & Engels, R. (2006). Who drinks and why? A review of socio-demographic, personality, and contextual issues behind the drinking motives in young people. *Addictive Behaviors, 31,* 1844–1857. http://dx.doi.org/10.1016/j.addbeh.2005.12.028

Levenson, R. W., Oyama, O. N., & Meek, P. S. (1987). Greater reinforcement from alcohol for those at risk: Parental risk, personality risk, and sex. *Journal of Abnormal Psychology, 96,* 242–253. http://dx.doi.org/10.1037/0021-843X.96.3.242

Maccoby, E. E. (1990). Gender and relationships. A developmental account. *American Psychologist, 45,* 513–520. http://dx.doi.org/10.1037/0003-066X.45.4.513

Marlatt, G. A. (1999). Alcohol, the magic elixir? In S. Peele & M. Grant (Eds.), *Alcohol and pleasure: A health perspective* (pp. 233–248). Ann Arbor, MI: Taylor & Francis.

Martin, C. S., & Sayette, M. A. (1993). Experimental design in alcohol administration research: Limitations and alternatives in the manipulation of dosage-set. *Journal of Studies on Alcohol, 54,* 750–761. http://dx.doi.org/10.15288/jsa.1993.54.750

McCrae, R. R., & Costa, P. T., Jr.. (2004). A contemplated revision of the NEO Five-Factor Inventory. *Personality and Individual Differences, 36,* 587–596. http://dx.doi.org/10.1016/S0191-8869(03)00118-1

Mills, K. C., & Bisgrove, E. Z. (1983). Body sway and divided attention performance under the influence of alcohol: Dose-response differences between males and females. *Alcoholism: Clinical and Experimental Research, 7,* 393–397. http://dx.doi.org/10.1111/j.1530-0277.1983.tb05492.x

Mulvihill, L. E., Skilling, T. A., & Vogel-Sprott, M. (1997). Alcohol and the ability to inhibit behavior in men and women. *Journal of Studies on Alcohol, 58,* 600–605. http://dx.doi.org/10.15288/jsa.1997.58.600

Niaura, R. S., Nathan, P. E., Frankenstein, W., Shapiro, A. P., & Brick, J. (1987). Gender differences in acute psychomotor, cognitive, and pharmacokinetic response to alcohol. *Addictive Behaviors, 12,* 345–356. http://dx.doi.org/10.1016/0306-4603(87)90048-7

Nolen-Hoeksema, S. (2004). Gender differences in risk factors and consequences for alcohol use and problems. *Clinical Psychology Review, 24,* 981–1010. http://dx.doi.org/10.1016/j.cpr.2004.08.003

Pisoni, D. B., & Martin, C. S. (1989). Effects of alcohol on the acoustic-phonetic properties of speech: Perceptual and acoustic analyses. *Alcoholism: Clinical and Experimental Research, 13,* 577–587. http://dx.doi.org/10.1111/j.1530-0277.1989.tb00381.x

Pittman, J., & Scherer, K. R. (1993). Vocal expression and communication of emotion. In M. Lewis & J. M. Haviland (Eds.), *Handbook of emotions* (pp. 185–198). New York, NY: Guilford Press.

Pliner, P., & Cappell, H. (1974). Modification of affective consequences of alcohol: A comparison of social and solitary drinking. *Journal of Abnormal Psychology, 83,* 418–425. http://dx.doi.org/10.1037/h0036884

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods* (Vol. 2). Thousand Oaks, CA: Sage.

Rohsenow, D. J., & Marlatt, G. A. (1981). The balanced placebo design: Methodological considerations. *Addictive Behaviors, 6,* 107–122. http://dx.doi.org/10.1016/0306-4603(81)90003-4

Rosenbluth, J., Nathan, P. E., & Lawson, D. M. (1978). Environmental influences on drinking by college students in a college pub: Behavioral observation in the natural environment. *Addictive Behaviors, 3,* 117–121. http://dx.doi.org/10.1016/0306-4603(78)90034-5

Russell, J. A. (2003). Core affect and the psychological construction of emotion. *Psychological Review, 110,* 145–172.

Sayette, M. A. (1993). Heart rate as an index of stress response in alcohol administration research: A critical review. *Alcoholism: Clinical and Experimental Research, 17,* 802–809. http://dx.doi.org/10.1111/j.1530-0277.1993.tb00845.x

Sayette, M. A., Breslin, F. C., Wilson, G. T., & Rosenblum, G. D. (1994). Parental history of alcohol abuse and the effects of alcohol and expectations of intoxication on social stress. *Journal of Studies on Alcohol, 55,* 214–223. http://dx.doi.org/10.15288/jsa.1994.55.214

Sayette, M. A., Creswell, K. G., Dimoff, J. D., Fairbairn, C. E., Cohn, J. F., Heckman, B. W., . . . Moreland, R. L. (2012). Alcohol and group formation: A multimodal investigation of the effects of alcohol on emotion and social bonding. *Psychological Science, 23,* 869–878. http://dx.doi.org/10.1177/0956797611435134

Sayette, M. A., Dimoff, J. D., Levine, J. M., Moreland, R. L., & Votruba-Drzal, E. (2012). The effects of alcohol and dosage-set on risk-seeking behavior in groups and individuals. *Psychology of Addictive Behaviors, 26,* 194–200. http://dx.doi.org/10.1037/a0023903

Sayette, M. A., Martin, C. S., & Perrott, M. A. (2001). Effects of assessment frequency on subjective intoxication ratings after alcohol consumption. *Alcoholism, Clinical and Experimental Research, 25,* 844–846. http://dx.doi.org/10.1111/j.1530-0277.2001.tb02288.x

Sayette, M. A., Martin, C. S., Perrott, M. A., Wertz, J. M., & Hufford, M. R. (2001). A test of the appraisal-disruption model of alcohol and stress. *Journal of Studies on Alcohol, 62,* 247–256. http://dx.doi.org/10.15288/jsa.2001.62.247

Scherer, K. R. (1986). Vocal affect expression: A review and a model for future research. *Psychological Bulletin, 99,* 143–165. http://dx.doi.org/10.1037/0033-2909.99.2.143

Scherer, K. R. (2003). Vocal communication of emotion: A review of research paradigms. *Speech Communication, 40,* 227–256. http://dx.doi.org/10.1016/S0167-6393(02)00084-5

Scherer, K. R., Banse, R., & Wallbott, H. G. (2001). Emotion inferences from vocal expression correlate across languages and cultures. *Journal of Cross-Cultural Psychology, 32,* 76–92. http://dx.doi.org/10.1177/0022022101032001009

Schmitt, D. P., Realo, A., Voracek, M., & Allik, J. (2008). Why can't a man be more like a woman? Sex differences in Big Five personality traits across 55 cultures. *Journal of Personality and Social Psychology, 94,* 168–182. http://dx.doi.org/10.1037/0022-3514.94.1.168

Schwarz, N. (1999). Self-reports: How the questions shape the answers. *American Psychologist, 54,* 93–105. http://dx.doi.org/10.1037/0003-066X.54.2.93

Senchak, M., Leonard, K. E., & Greene, B. W. (1998). Alcohol use among college students as a function of their typical social drinking context. *Psychology of Addictive Behaviors, 12,* 62–70. http://dx.doi.org/10.1037/0893-164X.12.1.62

Sher, K. J. (1987). Stress response dampening. In H. T. Blane & K. E. Leonard (Eds.), *Psychological theories of drinking and alcoholism* (pp. 227–271). New York, NY: Guilford Press.

Sher, K. J., & Levenson, R. W. (1982). Risk for alcoholism and individual differences in the stress-response-dampening effect of alcohol. *Journal of Abnormal Psychology, 91,* 350–367. http://dx.doi.org/10.1037/0021-843X.91.5.350

Sher, K. J., & Walitzer, K. S. (1986). Individual differences in the stress-response-dampening effect on alcohol: A dose-response study. *Journal of Abnormal Psychology, 95,* 159–167. http://dx.doi.org/10.1037/0021-843X.95.2.159

Sher, K. J., & Wood, M. D. (2005). Subjective effects of alcohol II: Individual differences. In M. Earleywine (Ed.), *Mind altering drugs: The science of subjective experience* (pp. 135–153). New York, NY: Oxford University Press. http://dx.doi.org/10.1093/acprof:oso/9780195165319.003.0005

Sher, K. J., Wood, M. D., Richardson, A. E., & Jackson, K. M. (2005). Subjective effects of alcohol: Effects of the drink and drinking context. In M. Earleywine (Ed.), *Mind altering drugs: The science of subjective experience* (pp. 86–134). New York, NY: Oxford University Press. http://dx.doi.org/10.1093/acprof:oso/9780195165319.003.0004

Single, E., & Wortley, S. (1993). Drinking in various settings as it relates to demographic variables and level of consumption: Findings from a national survey in Canada. *Journal of Studies on Alcohol, 54,* 590–599. http://dx.doi.org/10.15288/jsa.1993.54.590

Sobin, C., & Alpert, M. (1999). Emotion in speech: The acoustic attributes of fear, anger, sadness, and joy. *Journal of Psycholinguistic Research, 28,* 347–365. http://dx.doi.org/10.1023/A:1023237014909

Steele, C. M., & Josephs, R. A. (1988). Drinking your troubles away. II: An attention-allocation model of alcohol's effect on psychological stress. *Journal of Abnormal Psychology, 97,* 196–205. http://dx.doi.org/10.1037/0021-843X.97.2.196

Substance Abuse and Mental Health Services Administration. (2012). *Results from the 2011 National Survey on Drug Use and Health: Summary of national findings* (NSDUH Series H-44, HHS Publication No. [SMA] 12-4713). Rockville, MD: Author. Retrieved from https://www.whitehouse.gov/sites/default/files/ondcp/policy-and-research/nsduhresults2011.pdf

Testa, M., Fillmore, M. T., Norris, J., Abbey, A., Curtin, J. J., Leonard, K. E., . . . Hayman, L. W., Jr. (2006). Understanding alcohol expectancy effects: Revisiting the placebo condition. *Alcoholism: Clinical and Experimental Research, 30,* 339–348. http://dx.doi.org/10.1111/j.1530-0277.2006.00039.x

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54,* 1063–1070. http://dx.doi.org/10.1037/0022-3514.54.6.1063

Wilson, G. T. (1988). Alcohol and anxiety. *Behaviour Research and Therapy, 26,* 369–381. http://dx.doi.org/10.1016/0005-7967(88)90070-8

Wrede, B., & Shriberg, E. (2003). Spotting "hot spots" in meetings: Human judgments and prosodic cues. In *Proceedings of the Eurospeech* (pp. 2805–2808). Geneva, Switzerland: ISCA.

Received February 8, 2015
Revision received May 7, 2015
Accepted May 9, 2015 ■