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Extraversion and the Rewarding Effects of Alcohol in a Social Context

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Abstract

The personality trait of extraversion has been linked to problematic drinking patterns. Researchers have long hypothesized that such associations are attributable to increased alcohol-reward sensitivity among extraverted individuals, and surveys suggest that individuals high in extraversion gain greater mood enhancement from alcohol than those low in extraversion. Surprisingly, however, alcohol administration studies have not found individuals high in extraversion to experience enhanced mood following alcohol consumption. Of note, prior studies have examined extraverted participants—individuals who self-identify as being highly social—consuming alcohol in isolation. In the present research, we used a group drinking paradigm to examine whether individuals high in extraversion gained greater reward from alcohol than did those low in extraversion and, further, whether a particular social mechanism (partners' Duchenne smiling) might underlie alcohol reward sensitivity among extraverted individuals. Social drinkers (n = 720) consumed a moderate dose of alcohol, placebo, or control beverage in groups of three over the course of 36-min. This social interaction was video-recorded, and Duchenne smiling was coded using the Facial Action Coding System. Results indicated that participants high in extraversion reported significantly more mood enhancement from alcohol than did those low in extraversion. Further, mediated moderation analyses focusing on Duchenne smiling of group members indicated that social processes fully and uniquely accounted for alcohol reward-sensitivity among individuals high in extraversion. Results provide initial experimental evidence

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that individuals high in extraversion experience increased mood-enhancement from alcohol and further highlight the importance of considering social processes in the etiology of Alcohol Use Disorder.

Keywords

alcohol; personality; social processes; extraversion; emotion; social interaction

Researchers have long been interested in identifying individuals who might be at risk for developing an alcohol use disorder (AUD). One approach to distinguishing susceptible individuals has been to examine individual variation in alcohol's impact on mood (Sher & Levenson, 1982; Sher & Walitzer, 1986). Researchers have observed that some individuals experience greater emotional reward in response to alcohol consumption than others and, noting that alcohol reward tends to covary with AUD risk profile, have suggested that an examination of alcohol's emotional rewards in a laboratory setting could help elucidate factors that reinforce problematic drinking (Levenson, Oyama, & Meek, 1987). Indeed, laboratory studies have examined alcohol's mood-enhancing effects among individuals displaying a range of AUD risk factors, including family history of alcoholism, male gender, and personality characteristics (see Sher & Wood, 2005).

Individual differences in the personality trait of extraversion have long been of interest to these researchers. Dating back for nearly a century, psychologists have hypothesized that individuals will respond differentially to alcohol consumption according to their level of extraversion and have called for research testing this premise (Eysenck, 1957; McDougall, 1929; see Sher & Wood, 2005 for a review). In the current research, we re-visit the question of differential alcohol reward sensitivity among individuals high in extraversion, applying new methods and measures in an effort to understand the mechanisms that might underlie this effect.

Extraversion, Alcohol use, and Social Reward Processes

Extraversion—defined by Jung (1921) as the tendency to focus attention on external stimuli and later by Hans Eysenck (1967, p. 37) as the disposition to behave in a sociable manner—has received attention as a potential risk factor for AUD. Together with a number of other personality traits including impulsivity and neuroticism, extraversion has been linked to problematic drinking patterns (Sher, Trull, Bartholow, & Vieth, 1999). Studies have indicated that individuals high in extraversion initiate alcohol use at an earlier age (Hill, Shen, Lowers, & Locke, 2000; Hill & Yuan, 1999) and, in non-clinical samples, extraverts show higher rates of heavy drinking than do introverted individuals (Cook, Young, Taylor, & Bedford, 1998; Grau & Ortet, 1999; Martsh & Miller, 1997). The role of extraversion in AUD etiology still remains unclear, as some prospective studies have found that higher levels of extraversion predict later onset of disordered drinking (Grekin, Sher, & Wood, 2006; Kilbey, Downey, & Breslau, 1998; Wennberg, 2002) while others find no evidence of a significant relationship (Littlefield, Sher, & Wood, 2010; LoCastro, Spiro, Monnelly, & Ciraulo, 2000; Stacy & Newcomb, 1998). Thus, although other personality traits such as

impulsivity are believed to represent more powerful predictors of AUD, extraversion has nonetheless received a great deal of attention as a risk factor for heavy drinking and AUD.

One explanation for why extraverted individuals may be at risk for developing an AUD focuses on their sensitivity to the rewarding effects of alcohol. Psychologist William McDougall was among the first to hypothesize differential sensitivity to alcohol-reward for individuals high in extraversion, observing that "the markedly extraverted personality is very susceptible to the influence of alcohol" (McDougall, 1929, p. 301). Results of questionnaire studies asking extraverted and introverted individuals about the reward they typically derive from alcohol support McDougall's hypothesis. These surveys consistently find that individuals high in extraversion expect to receive greater mood-enhancing effects from alcohol than do those low in extraversion (Anderson, Schweinsburg, Paulus, Brown, & Tapert, 2005; Brown & Munson, 1987; Fischer, Smith, Anderson, & Flory, 2003; Read & O'Connor, 2006) and that alcohol-related mood enhancement represents a particularly potent force in motivating extraverts' drinking (Stewart & Devine, 2000; Theakston, Stewart, Dawson, Knowlden-Loewen, & Lehman, 2004; see Kuntsche, Knibbe, Gmel, & Engels, 2006).Thus, in surveys, individuals high in extraversion consistently report deriving more reward from alcohol in their everyday drinking settings than do those low in extraversion. However, when extraverted individuals consume alcohol in a laboratory setting, they do not report more alcohol-related mood enhancement than introverted individuals. Indeed, despite years of research examining individual difference criteria as moderators of alcohol reward, it is striking that researchers have produced no known published reports of extraversion, as it has traditionally been defined, being linked to enhanced alcohol-related reward. While some studies have found links between general scales indexing both disinhibited and sociable personality traits and enhanced alcohol-reward (Sher & Levenson, 1982), studies using measures of extraversion defined within a standard three-factor or five-factor approach have not found a relationship between extraversion and alcohol-induced mood enhancement (e.g., Finn & Pihl, 1987; Rammsayer, 1995; Ruch, 1994; Sayette, Martin, Perrott, Wertz, & Hufford, 2001). Indeed, one such study found that individuals high in extraversion derived less reward from a moderate dose of alcohol (Ruch, 1994).

While failure to detect a significant moderating influence of extraversion on alcohol reward might be attributable to a number of factors—including small sample sizes, paradigms producing no overall effect of alcohol on mood, and a general lack of reliance on empirically verified measures of personality (Sher et al., 1999)—another potentially important factor might be the failure to test the relationship between alcohol consumption and extraversion in social contexts. Of note, a recent daily diary study found evidence of greater stress dampening effects from alcohol among extraverted individuals, but these effects were limited to drinking that occurred in a social setting and were not observed when extraverted participants drank alone (Armeli et al., 2003). Indeed, although prior laboratory studies have focused on alcohol reward among participants drinking in isolation, the vast majority of alcohol consumption outside the laboratory takes place in social settings (Cahalan, Cisin, & Crossley, 1969; Demers et al., 2002; Single & Wortley, 1993). In some cases, this consumption occurs among people who are just getting acquainted; in other cases, it occurs among people who know one another well (Beck, Summons, & Thombs, 1991).

The ability of "asocial" laboratory studies to capture alcohol reward as it might occur in more naturalistic settings is likely to be particularly limited with respect to examining alcohol reward among individuals with strong social motivations. Individuals high in extraversion not only spend more time in social settings than individuals low in extraversion (Argyle & Lu, 1990; Watson, Clark, McIntyre, & Hamaker, 1992), but they are more strongly motivated by social goals (King, 1995; King & Broyles, 1997; Roberts & Robins, 2000), pay closer attention to affiliative social cues in these settings (Graziano, Feldesman, & Rahe, 1985; Lieberman & Rosenthal, 2001) and derive more reward from social settings than do individuals low in extraversion (Ashton, Lee, & Paunonen, 2002; Oerlemans & Bakker, 2014).

Sensitivity to pleasurable (vs. punishing) stimuli in the environment has frequently been emphasized in models of extraversion (e.g., Lucas, Diener, Grob, Suh, & Shao, 2000). More specifically, extraversion is often conceptualized as a sensitivity to pleasurable stimuli in the external environment ("Extroversion [Def. 1]," n.d.), with social settings frequently representing a potent source of these pleasures (Lucas et al., 2000). Consistent with this premise, a recent fMRI study (Canli, Sivers, Whitfield, Gotlib, & Gabrieli, 2002) found that amygdala activation in response to smiling faces differed significantly according to participants' level of extraversion, with individuals high in extraversion showing greater activation than did individuals low in extraversion. In contrast, amygdala responses to negative facial expressions did not vary according to extraversion. Thus, research on alcohol response among extraverted individuals would benefit from laboratory paradigms involving social drinking, allowing participants access to the pleasurable social stimuli that underlie reward in these individuals (Sayette, Creswell, et al., 2012).

Alcohol Consumption and Social Reward

While social processes might have particular relevance to the alcohol-related reward experienced by extraverted individuals, social factors likely play a role in the mood enhancement experienced by all drinkers. Research suggests that alcohol enhances mood to a greater extent among individuals drinking in a social setting vs. those drinking alone (del Porto & Masur, 1984; Doty & de Wit, 1995; Kirkpatrick & de Wit, 2013; Pliner & Cappell, 1974; although see Sher, 1985), and several theories of alcohol's effects consider social processes as a potential mechanism underlying alcohol-related reward (Hull, 1981). For example, in their attention-allocation model, Steele and colleagues (1988, 1990) propose that alcohol will enhance mood selectively in drinking settings featuring pleasantly distracting stimuli. Steele and Josephs note that alcohol is frequently consumed in social settings and theorize that alcohol's widely-acknowledged rewarding properties are therefore often mediated by social processes (Josephs & Steele, 1990), proposing that alcohol enhances mood by increasing the salience of pleasurable social stimuli in the drinker's immediate environment (e.g., a smile on the face of an interaction partner) (Josephs & Steele, 1990; Steele & Josephs, 1988).

In a recent meta-analysis examining alcohol's effects on mood in social contexts, it was found that the behavior of a drinker's interaction partner had important implications for alcohol-related mood enhancement (Fairbairn & Sayette, 2014). Mood-enhancing effects of

alcohol were found selectively in studies in which participants interacted with other naïve participants who were free to respond spontaneously within the context of the exchange. When, instead, participants interacted with scripted confederates—who were non-responsive, rarely spoke and never smiled— no evidence of a significant mood-enhancing effect of alcohol was obtained. Thus, the dynamic behavioral expressions of interaction partners appears to play an important role in mediating alcohol reward, and unstructured social interactions among naïve-participants seem to offer an optimal context in which to examine alcohol-related mood enhancement.

Examining Personality and Alcohol Reward during Group Formation

The present study examined the influence of extraversion on alcohol's mood-enhancing properties and the mechanisms underlying this effect within the context of unstructured social exchange. The study included several key methodological improvements over prior laboratory-based examinations of alcohol and personality including: 1) a large enough number of participants to afford sufficient power to test mediators and moderators of alcohol's effects; 2) empirically verified measures of personality; 3) fine-grained observational measures that allow examination of moment-to-moment affective processes underlying alcohol-related mood enhancement; 4) a group formation paradigm with increased ecological validity compared with many previous studies, simulating a non-laboratory setting in which drinking often occurs; and 5) a paradigm that yields powerful mood-enhancing effects of alcohol.

More specifically, we examined alcohol's impact on mood among 720 social drinkers using a laboratory-based group-formation drinking paradigm. Emotional responses were coded using the Facial Action Coding System (FACS: Ekman, Friesen, & Hager, 2002) for every frame ($1/30^{th}$ of a second) of a 36-minute social interaction yielding 66,000 points of observation for each subject (totaling 34.9 million frames of coded video). Initial analyses revealed a powerful overall effect of alcohol consumption on increased duration of Duchenne smiling, a marker for felt positive emotion (Ekman, Davidson, & Friesen, 1990), increased speech duration, decreased negative facial expressions, and enhanced self-reports of mood and social bonding (see Sayette, Creswell, et al., 2012). We also examined the mechanisms underlying alcohol-based reinforcement, exploring alcohol's effect on moment-to-moment affective fluctuations as a mediator of alcohol's tendency to enhance self-reports of mood and social bonding (Fairbairn & Sayette, 2013).To date, however, our work has not considered between-person (social) processes as mediators of alcohol-related mood enhancement, and these social processes represent a focus of the present research. Specifically, we examine the influence of behaviors displayed by participants' interaction partners—the emotional displays that individuals see in their immediate social drinking environment—as a mediator of alcohol reward among extraverted individuals.

We hypothesized a significant overall moderating influence of extraversion on alcohol-related reward. Specifically, we predicted that alcohol's capacity to enhance reports of mood and social bonding would be greater among participants high vs. low in extraversion. Further, we hypothesized that the mediational pathway explaining alcohol reward would vary depending on an individual's personality (a mediated moderation effect). Specifically,

we predicted that individuals high in extraversion, who are theorized to be sensitive to pleasurable social stimuli, would derive more reward from the genuine smiles of enjoyment displayed by their interaction partners than would individuals low in extraversion. Thus, we predicted that these social processes would mediate alcohol-related reward to a greater extent among extraverted individuals than among introverted individuals. In sum, we predicted that a) reported alcohol reward would be higher among individuals high vs. low in extraversion (moderation) and b) that alcohol reward sensitivity among extraverted individuals would be explained by social processes (mediated moderation).

Method

Participants

Participants were 720 healthy social drinkers (360 female) aged 21–28, recruited via ads in local newspapers as reported in Sayette, Creswell et al. (2012). Participants were required to have no medical conditions that contraindicated alcohol consumption (including pregnancy for females) and have no past alcohol abuse or dependence, as indexed by DSM-IV. Participants were further required to be within 15% of ideal weight for height and to report that they could comfortably drink at least 3 drinks in 30-min. Participants were 83% European-American, 11% African-American, 1% Hispanic, 2.5% Asian, and 2.5% other. Participants reported drinking 2–3 times/week and consuming 4.29 (*SD* = 1.89) drinks/occasion.

Procedure

Questionnaire Session—Participants who answered advertisements were informed that the purpose of the study was to measure alcohol's impact on cognitive performance and were invited into the Alcohol and Smoking Research Laboratory for an initial Questionnaire session. Following informed consent, exclusion criteria were assessed. Participants then completed personality questionnaires including the NEO Five Factor Inventory (NEO-FFI; see study measures). Participants who met inclusion criteria were invited back to the Alcohol and Smoking Research Laboratory for the experimental Drink session held on a separate day.

Drink Session—Participants were randomly assigned to groups of three. Equal numbers of these 3-person groups were randomly assigned to consume an alcoholic beverage, a placebo beverage, or a nonalcoholic control beverage (isovolemic across conditions). Within each beverage condition there were equivalent numbers of groups representing the 4 possible gender composites: 20 all-male, all-female, 2 females and 1 male. 2 males and 1 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). Participants then provided a breath sample to assess blood alcohol content (BAC) and completed a variety of self-report assessments (e.g., the Positive and Negative Affect Schedule; Watson, Clark, & Tellegen, 1988).

The three participants were then seated at equidistant intervals around a round table. Cameras were positioned in all four corners of the room, and a microphone recorded

conversation. Participants were originally told that the cameras were used to monitor their drink consumption and were later informed (see below) that the cameras recorded facial expressions.

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. In the placebo group, the glass was smeared with vodka, and a few drops of vodka were "floated" on the top of the beverage to increase credibility. Males in the alcohol condition were administered a .82g/kg dose of alcohol, while females were administered a .74g/kg dose (Sayette et al., 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 entered the room only 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 on whether to speak during the interaction period or what to talk about—they were ostensibly seated in the same room to facilitate drink administration and communication with the experimenter.

Immediately following drinking, participants' BACs were recorded and they completed measures of mood and social bonding, including an 8-item mood measure and the Perceived Group Reinforcement Scale (see section on study measures). They then performed some additional cognitive tasks. [Because these cognitive tasks followed all relevant measures for the present study they are discussed elsewhere (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%, and they were not permitted to drive themselves home. Before leaving, participants were informed that their behavior had been videotaped, and their consent to analyze the data was solicited (all participants agreed).

Participants' facial expressions and speech during the drinking period were later coded. Facial data were coded by FACS-certified personnel using Observer Video-Pro software (Noldus Information Technology, 2010). The Observer system allows coders to time-stamp the start (onset) and stop (offset) of each FACS Action Unit (AU) to preserve the flow and synchrony of the interaction. Each frame ($1/30^{th}$ of a second) of the interaction was manually evaluated by coders for the presence or absence of relevant facial AUs. Video from each participant was independently coded so that the facial expressions of only one group member were visible to the coder at one time. Coders were blind to experimental condition.

Measures

Personality—Participants completed a battery of questionnaires including the NEO-FFI. The NEO assesses five domains of adult personality (neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness) (Costa & McCrae, 1992). We used the abbreviated 60-item version of the revised NEO Personality Inventory, a reliable index of

the broad domains of the "Big Five" (Agreeableness α = .78; Conscientiousness α = .86; Extraversion α = .80; Neuroticism α = .83; Openness α = .77).

Behavioral-Affective Display—We indexed behavioral affective display during the social interaction by measuring duration of "Duchenne" smiling. The Duchenne smile, also known as the "felt" smile or the smile of enjoyment, is the most widely researched facial expression within FACS (Ekman et al., 1990; Hess, Banse, & Kappas, 1995; Kirchner et al., 2006). Unlike the "social smile," which includes movement of only the zygomaticus major (AU 12) muscle, Duchenne smiles include combined movement of not only AU 12 but also obicularis oculi muscles (AU 6) (Ambadar, Cohn, & Reed, 2009; Ekman et al., 1990). In addition to Duchenne smiles, we examined the overall duration of speech during the interaction, and, in line with our past research (Sayette, Creswell, et al., 2012), examined a composite index of negative affective display comprising AUs 9, 14, 15, and 20 (AU's linked to disgust, contempt, sadness, and fear, respectively). Reliability of facial coding, evaluated based on three minutes of video tape drawn from the beginning of the drink period, was assessed on a random subset of 72 participants. There were good levels of agreement for smiling (AU12, κ = .84; AU6, κ = .88), negative facial expressions (κ = .73) and speech (κ = .80).

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) (see Creswell et al., 2012 for more details). We assessed mood using an 8-item mood measure (see Fairbairn & Sayette, 2013 for more details). 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—this negative mood measure was included to promote consistency with our own past alcohol research and also with other past studies of alcohol's impact on mood (Fairbairn & Sayette, 2013; Steele & Josephs, 1988). 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 Plan

Data analyses tested the following two hypotheses: 1) Extraverted individuals are more sensitive to alcohol-related reward than are introverted individuals; and 2) Social processes (namely Duchenne smiling) mediate alcohol-related reward to a greater extent among extraverted than introverted individuals.

Data Processing—Data were coded continuously throughout the 36-minute interaction with the exception of minutes 3–11 and two additional minutes during which the experimenter entered the room to refill drinks. As in prior studies using this dataset, we examined data from minutes 12–36 of the interaction—the period in which the effects of alcohol were hypothesized to be the strongest (Sayette, Creswell, et al., 2012).[1]

Beverage Condition—Beverage Condition was represented in all initial models as a complete orthogonal set of contrast codes, the first ("Alcohol") contrast comparing alcohol to both placebo and control conditions and the second ("Placebo vs. Control") contrast comparing placebo and control conditions (Cohen, Cohen, West, & Aiken, 2003). Theories informing our hypotheses deal with the pharmacological (i.e., ethanol consumed vs. no ethanol consumed) effects of alcohol (Steele & Josephs, 1990), and prior analysis of the present dataset found no significant differences between placebo and control conditions in affective display (Sayette, Creswell, et al., 2012). Thus, after confirming that there is empirical justification for collapsing across placebo and control conditions in these analyses (non-significant Placebo vs. Control contrast), we represent alcohol condition as a single code comparing alcohol to no alcohol.

Social Processes—We indexed social-emotional mediators according to Kenny and colleagues' Actor-Partner Interdependence Model (APIM; Kenny, Mannetti, Pierro, Livi, & Kashy, 2002). Within this model, participants' own responses ("actor" effects) are distinguished from the responses of their interaction partner(s) ("partner" effects). Here, analyses focus on the overall duration of Duchenne smiling among an individual's *group-mates* ("partner" smiling, referred to here as "group-mates' smiling")—a factor that we distinguish from the overall duration of the individual's *own* Duchenne smiling ("actor" smiling)—as a social mechanism underlying alcohol-related reward. In other words, we examined social processes by exploring the extent to which the affective displays of fellow group members ("partners") mediated alcohol-related reward among study participants. In addition to APIM analyses, we also examine a second social mediator of alcohol reward. Specifically, we explore Duchenne smiles that occur simultaneously among group members (simultaneous smiles) as a mechanism underlying alcohol reward. We also examine the generalizability vs. specificity of Duchenne smiling mediation effects by also examining negative facial expressions and overall speech duration. Mediators are represented in terms of average seconds per 10 second interval.

Mediated Moderation—Mediated moderation analyses were conducted according to procedures outlined by Muller, Judd, and Yzerbyt (2005). In line with our past research, models control for participants' facial behavior during the "baseline" period—the first three minutes of the social interaction, a period when no significant effects of alcohol have emerged—as well as participant gender (Creswell et al., 2012; Sayette, Creswell, et al., 2012). Consistent with recommendations of Krull and MacKinnon (1999; 2001) for multilevel mediation analyses, all analyses described in this section were conducted within

[1]One participant failed to comply with instructions and was excluded from analysis (see Sayette, Creswell, et al., 2012). Data from four additional participants were excluded from extraversion analyses due to failure among these participants to complete the NEO-FFI.

the framework of a two-level hierarchical model that accounts for the clustering of the individual-level self-report outcome variable within groups of three. Since the present research examines multiple outcome variables, all analyses begin with multivariate hierarchical linear models in which the overall significance of moderation and mediated moderation effects are examined across all three self-report outcome variables (Raudenbush, Brennan, & Barnett, 1995), specifying a unstructured or "unrestricted" covariance structure among outcomes. Where multivariate effects reached significance, we followed up with univariate models examining each outcome independently to explore where effects emerged as strongest.[2] All self-reported outcomes were converted to standardized units (z-scores) for ease of interpretation, while independent variables are left in their original metric.

Mediated moderation analyses requires that three distinct conditions be met (Muller et al., 2005). First, the effect of the predictor (Alcohol) on outcome (Reward) must be significantly moderated by a third variable (Extraversion). Second, upon the inclusion of a mediator (Smiling), either (a) the path between the predictor and mediator is moderated by the third variable and the path between the mediator and outcome is significant, or (b) the opposite is true, such that the path between the mediator and outcome is moderated and the path between predictor and mediator is significant, or (c) both are true. Third, the significant direct moderation must either be non-significant or reduced in magnitude upon the inclusion of the mediator and its moderated effect.

To test these conditions we examined three separate models. In the first model, procedures began with a test of overall moderation (Condition 1), examining whether extraversion moderates the impact of alcohol on self-reported mood and social bonding. Next, in one model we examined the pathway from the independent variable (Alcohol) to the mediator (Group-mates' smiling), and, in a separate model, we tested whether the partial effect of the mediator on the outcome was moderated. That is, in line with our hypotheses, we tested whether there was a significant relationship between the independent variable and the mediator and whether personality moderated the effect of the mediator on the outcome after controlling for all direct effects of the independent variable on the outcome (Condition 2b). Finally, we evaluated whether the overall moderation effect became non-significant or was reduced in magnitude (Condition 3). While extraversion was of primary interest, we repeated analyses using all Big Five personality traits to examine the specificity of effects. Personality was entered into models as a continuous variable and, where analyses indicated a significant moderation effect, we examined simple contrasts by centering personality at one standard deviation above and below the mean. The strength of mediational pathways at different levels of the moderator variable was calculated (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002; Muller et al., 2005) and their significance was tested using the Sobel standard error (MacKinnon, Warsi, & Dwyer, 1995; Preacher & Hayes, 2008).

[2]Univariate hierarchical linear models examined here included two levels of analysis whereas multivariate models included three levels. Alcohol was entered at the level of the group (level 2 in univariate models and level 3 in multivariate models), personality and also mediators were entered at the level of the individual (level 1 in univariate models and level 2 in multivariate models), and interactions with alcohol were examined across these respective levels.

Results

Beverage Manipulation Check

BACs and measures of subjective intoxication appear in Table 1. Participants administered alcohol were on the ascending limb of the BAC curve with a BAC rising to about .06% immediately following the interaction period. All placebo and alcohol participants estimated that they had consumed at least 1 oz. of vodka. Consistent with prior studies (e.g., Sayette et al., 2001), placebo participants reported experiencing some level of intoxication, significantly more than control participants and less than alcohol participants.

Baseline Individual Differences and Descriptive Statistics

Age, extraversion, marital status, income, smoking status, ethnicity, and baseline positive and negative mood were equivalent across Beverage conditions, as were responses to questions about drinking history and current drinking patterns. Descriptive statistics for extraversion, mood, and Duchenne smiling variables both at baseline and following drink administration are presented in Table 2. Correlations between the post-interaction measures of mood and social bonding were significant and moderate in magnitude (see Fairbairn & Sayette, 2013) and there was significant clustering on self-reports among members of the same social group (ICC's: social bonding = 0.141; positive mood = 0.113; negative mood = 0.119). Participants reported a mean extraversion score of 32.11 (SD = 6.52), which corresponds to average scores reported by participants in standardization samples (M = 30.58, SD = 6.67; McCrae & Costa, 2004).

Moderation Analyses

Findings revealed a significant multivariate main effect of extraversion on self-reported mood and social bonding, $B = 0.03$, $t = 7.65$, $p < 0.001$. Univariate tests indicated that individuals high in extraversion reported significantly higher positive mood, $B = 0.04$, $t = 8.28$, $p < 0.001$, more social bonding, $B = 0.04$, $t = 7.51$, $p < 0.001$, and marginally lower negative mood, $B = -0.01$, $t = -1.74$, $p = 0.082$, compared with individuals low in extraversion. As noted elsewhere (Fairbairn & Sayette, 2013), analyses also revealed a significant main effect of alcohol in enhancing self-reported mood and social bonding, $B = 0.38$, $t = 6.52$, $p < 0.001$ (positive mood, $B = 0.34$, $t = 4.33$, $p < 0.001$; negative mood, $B = -0.54$, $t = -7.61$ $p < 0.001$; social bonding, $B = 0.25$, $t = 3.18$, $p = 0.002$). With the exception of social bonding, there were no significant differences between placebo and control groups in self-reported outcomes (see Sayette, Creswell, et al., 2012).

Of particular relevance, analyses also indicated a significant multivariate interaction between extraversion and alcohol in predicting self-reported mood and social bonding, $B = .02$, $t = 2.30$, $p = 0.022$.[3] The effect of alcohol on mood and social bonding was almost twice as high among individuals high in extraversion (alcohol $B = .48$, $t = 6.94$, $p < 0.001$) compared with individuals low in extraversion (alcohol $B = 0.26$, $t = 3.30$, $p = 0.001$). Tests examining the interaction for each self-report variable independently suggested that this

[3]The extraversion by alcohol interaction remains significant even in models controlling for both baseline mood and typical drinking patterns, $B = 0.015$, $t = 2.21$, $p = 0.027$

multivariate effect was primarily driven by positive mood, $B = 0.02$, $t = 2.18$, $p = 0.030$, with a trend towards significance emerging with respect to perceived social bonding, $B = .02$, $t = 1.84$, $p = 0.066$, and a non-significant effect in the expected direction for negative mood, $B = -0.01$, $t = -0.99$, $p = 0.323$ (see Figure 1). Importantly, none of the other four traits in the Big Five—neuroticism, conscientiousness, agreeableness, or openness to experience—demonstrated a significant interaction with alcohol in the current study, p's > .140. Again, there was no difference in the effects of extraversion on mood and social bonding within the placebo vs. the control conditions, $p = 0.345$. Although there was a significant main effect of gender on self-reported mood, with women reporting more reward than men, $B = .26$, $t = 4.59$, $p < 0.001$, there was no interaction between gender and alcohol on self-reported outcomes, $p = 0.352$.

In sum, in the current study, individuals high in extraversion derived greater reward from alcohol than did individuals low in extraversion. This moderation effect appeared to be specific to extraversion, as differences in alcohol reward sensitivity were not observed for other Big Five traits.

Mediated Moderation and Group-Mates' Smiling

Having established that extraverted individuals were sensitive to alcohol's effects on mood and social bonding, we next examined the mechanisms underlying this effect. We conducted mediated moderation analyses aimed at understanding *why* individuals high in extraversion might be sensitive to alcohol reward.

As predicted, results suggested that differential sensitivity to group-mates' (partner) smiling was a significant mediator underlying alcohol reward sensitivity among individuals high in extraversion (Figure 2). Analyses revealed a significant main effect of alcohol on group-mates' smiling that was un-moderated by extraversion, $B = 1.31$, $t = 8.01$, $p < 0.001$. Alcohol increased the total amount of time individuals' group-mates spent smiling by about 1.3 sec during each 10 sec interval of the social interaction.

After confirming that a significant pathway existed from the independent variable to the mediator, we next examined pathways from the mediator to the outcomes (see Table 3). In line with criteria for mediated moderation, analyses revealed that the partial effects of group-mates' (partner) smiling were significantly moderated by extraversion in multivariate models examining effects across all three self-report outcomes, $B = 0.01$, $t = 2.90$, $p = .004$ (Condition 2b). Among individuals high in extraversion, a 1 second increase in group-mates' smiling was associated with a .11 (standardized) unit increase in self-reported mood and social bonding, after accounting for all moderated and un-moderated direct effects of alcohol, $B = 0.11$, $t = 3.80$, $p < .001$. In contrast, among individuals low in extraversion, higher levels of group-mates' smiling were not significantly associated with enhanced self-reported mood and social bonding, $B = 0.02$, $t = 0.52$, $p = 0.370$. An examination of calculated indirect effects provided further support for the premise that group-mates' smiles explained alcohol-related reward to a greater extent among individuals high in extraversion, $B = 0.21$, $z = 3.43$, $p < 0.001$, compared with individuals low in extraversion, $B = 0.03$, $z = 0.89$, $p = 0.373$. Importantly, once the (moderated) indirect effects of group-mates' smiling were accounted for, the significant overall moderating influence of extraversion on mood

and social bonding no longer reached significance, $p = 0.343$ (Condition 3). Tests examining the interaction across each of the three self-report variables independently suggested that this multivariate effect was primarily driven by both positive mood, $B = 0.01$, $t = 2.68$, $p = 0.008$, and social bonding, $B = 0.01$, $t = 3.11$, $p = 0.002$, with a non-significant effect in the expected direction for negative mood, $B = -.002$, $t = -0.76$, $p = .449$.[4]

Specificity of Effects—Next we explored whether the specific pairing of extraversion and group-mates' (partner) Duchenne smiling was necessary to produce the significant findings reported above. First, we found that the mediated moderation effects reported above were specific to what Kenny and colleagues refer to as "partner" effects and did not generalize to "actor" smiling models. In other words, an individual's *own* average duration of Duchenne smiling did not explain alcohol-reward sensitivity among extraverted individuals according to mediated moderation analyses, $p = .137$. Next we examined whether effects generalized across 1) behavioral expression and 2) personality trait. First, we examined whether other behavioral displays by group-mates explained alcohol reward sensitivity among individuals high in extraversion. As detailed previously (Sayette, Creswell, et al., 2012), alcohol not only altered levels of Duchenne smiling, but also increased the overall duration of speech and decreased the duration of facial expressions associated with negative affect. Nonetheless, alcohol-reward sensitivity among extraverted individuals was not explained by increases in group-mates' overall speech duration or decreases in negative facial expression, p's >.182, suggesting that individuals high in extraversion were selectively sensitive to pleasurable social stimuli (partner Duchenne smile) and not to negative or neutral social signals. Second, we examined the specificity of the effects described above across personality traits. We examined whether other traits within the Big Five moderated the group-mates' smiling pathway to alcohol-related mood and social enhancement. Although a trend emerged with respect to agreeableness, $B = 0.00003$, $t = 1.71$, p = 0.087, none of the other traits within the Big Five moderated the group-mates' smiles mediational pathway (all other p's > .461). Thus, unlike extraversion, individuals high in neuroticism, conscientiousness, openness to experience, and (to some extent) agreeableness did not derive particular reward from the smiles of their group-mates.

In sum, individuals high in extraversion experienced more alcohol-related reward during the social interaction than did those low in extraversion, and this moderating effect of extraversion was explained (mediated) by their tendency to associate greater reward with the genuine smiles displayed by their fellow group-mates.

Mediated Moderation and Simultaneous Smiling

In social interaction, the overall duration of individual behaviors may not paint a complete picture of the social and reward processes at play. Indeed, the timing and coordination of behavior among group members may have implications for reward that are independent of

[4]One potential explanation for increased associations between group-mates' smiling and self-reported mood among individuals high in extraversion is that group-mates' smiles are viewed as carrying more self-relevant information to these individuals. Individuals high in extraversion tend to be especially social and talkative. It is possible that group-mates' smiles were more frequently displayed in response to remarks made by extraverted individuals and, therefore, were more likely to be a source of reward to these individuals. Of note, there was no overall interaction between extraversion and alcohol in predicting amount of speech, p = .982. Further, the mediated moderation findings reported above remained significant even after controlling for overall speech duration, p = .009.

individual-level behavioral duration. In this next section, we explore the extent to which coordinated smiling might help explain alcohol-reward sensitivity among individuals high in extraversion. More specifically, we focus on the amount of time an individual smiled simultaneously (i.e., during the same 1/30th sec interval) with at least one fellow group member.

Results indicated a significant mediated moderation effect with respect to simultaneous smiling and further suggested that this effect was independent of the group-mates' smiling effects reported above. There was a significant main effect of alcohol on simultaneous smiling that was un-moderated by extraversion, $B = .47$, $t = 6.90$, $p < 0.001$. Alcohol increased the total amount of time individuals spent smiling simultaneously with another group member by about .5 seconds during each 10 second interval of the social interaction.

The partial effects of simultaneous smiling on self-reported mood and social bonding were significantly moderated by extraversion in multivariate models examining effects across all three self-report outcomes, $B = 0.01$, $t = 2.09$, $p = 0.037$ (see Table 4 for all results of mediated moderation models as subdivided by number of group members engaged in simultaneous smiling). Among individuals high in extraversion, a 1 second increase in simultaneous smiling was associated with a .28 (standardized) unit increase in self-reported mood and social bonding, after accounting for all moderated and un-moderated direct effects of alcohol, $B = 0.28$, $t = 4.07$, $p < 0.001$ (calculated overall indirect effect: $B = 0.13$, $z = 3.39$, $p < .001$). In contrast, among individuals low in extraversion, higher levels of simultaneous smiling did not appear to be associated with self-reported mood and social bonding, $B = 0.11$, $t = 1.49$, $p = 0.137$ (overall indirect effect: $B = 0.05$, $z = 1.46$, $p = 0.145$). Once the (moderated) indirect effects of simultaneous smiling were accounted for, the significant overall moderating influence of extraversion on alcohol mood and social bonding no longer reached significance, $p = 0.190$. Tests examining the interaction across each self-report variable independently suggested that this multivariate effect was primarily driven by social bonding, $B = 0.02$, $t = 2.25$, $p = 0.025$, with a trend towards significance emerging with respect to positive mood, $B = 0.02$, $t = 1.75$, $p = 0.082$, and a non-significant effect in the expected direction with respect to negative mood, $B = -.01$, $t = -.49$, $p = .623$. (When only "golden moments"—smiles involving all three group members (see Sayette, Creswell, et al., 2012)—were considered in simultaneous smiling analyses, models predicting positive mood also reached significance, p = .042). While the duration of "group-mates' smiling" and "simultaneous smiling" are not entirely independent constructs, the moderated-mediational effects of each was independent of the other. Thus, extraversion still moderated the "simultaneous smiling" mediational pathway even after controlling for all effects of "group-mates' smiling," and, in turn, extraversion moderated the "group-mates' smiling" mediational pathway after controlling for "simultaneous smiling."

Specificity of Effects—The duration of non-simultaneous smiles (the duration of time an individual spent smiling alone) did not interact with extraversion in mediating alcohol reward—individuals high in extraversion did not associate greater reward with these non-simultaneous smiles than individuals low in extraversion, p = 0.945 (see also Table 4). Aside from Duchenne smiles, many facial displays did not occur "simultaneously" with sufficient frequency such that we were able to examine them as mediators. Thus, we could not

examine “negative” facial displays, as we did in specificity analyses examining group-mates’ smiling. However, “social smiles” (see p. 13) were displayed simultaneously with nearly equal frequency to Duchenne smiles. Importantly, however, individuals high in extraversion did not seem to associate particular reward from simultaneous social smiles, and social smiles did not emerge as a viable explanation for alcohol-reward sensitivity among extraverted individuals in mediated moderation analyses, $p = .380$. Finally, as before, we examined the generalizability of mediated moderation findings to the other four traits within the Big Five, and none of these other traits moderated the “simultaneous smiling” mediational pathway explaining alcohol-related reward, p’s $> .320$.

In sum, analyses identified a second, distinctly social mechanism explaining alcohol reward sensitivity among extraverted individuals. Individuals high in extraversion associated greater reward with alcohol-related increases in simultaneous Duchenne smiles compared to individuals low in extraversion, and simultaneous smiling accounted for the increased reward extraverted individuals derived from alcohol.

Discussion

While individuals high in extraversion consistently report greater mood-enhancing effects from alcohol in surveys, they have not reported significant alcohol reward sensitivity in prior laboratory-based drinking studies. Importantly, none of these alcohol-administration studies have examined extraverted individuals—who self-identify as being highly social—consuming alcohol in a social context. The present research is, to our knowledge, the first laboratory-based study to produce evidence that individuals high in extraversion derive more alcohol-related reward than individuals low in extraversion. Using a large sample of participants and empirically verified measures of personality, we found that individuals high in extraversion reported gaining significantly greater reward from alcohol than those who were low in extraversion. Since alcohol-related rewards can serve to reinforce drinking behaviors, this finding has clinical implications for the understanding of individual differences in AUD vulnerability, pointing to an important mechanism that might explain susceptibility to alcohol problems among extraverted individuals.

Findings of this study further indicate an important role for social processes in mediating alcohol reward among individuals high in extraversion. Alcohol consumption increased the overall duration of Duchenne smiling. Individuals high in extraversion appeared to associate greater reward with the Duchenne smiles that were displayed by their group-mates, while, in contrast, the relationship between group-mates’ smiling and reported mood and social outcomes was not significant among individuals low in extraversion. In addition, we found evidence for social coordination as an important and independent contributor to alcohol-reward sensitivity among extraverted individuals, with individuals high in extraversion associating greater reward with the smiles they shared with other group members (simultaneous smiles) than individuals low in extraversion. We found that these social processes explained alcohol-reward sensitivity among extraverted individuals in our study, with group-mates’ smiling and simultaneous smiling fully accounting for the increased alcohol reward experienced by individuals high in extraversion. Further, results suggested that social processes might have a unique and specific place in accounting for extraverted

individuals' alcohol-reward sensitivity. Individuals high in extraversion did not associate greater self-reported reward with their *own* Duchenne smiling or with smiles that were *not* simultaneous with another group member, and, unlike the previously examined "social" mediators, these factors did not account for extraverted individuals' alcohol reward sensitivity in mediated moderation analyses.

In addition to carrying conceptual implications for the understanding of alcohol-reward sensitivity and AUD susceptibility, the present study applies new methods well suited to integrate an examination of moderators with the study of mediators of alcohol's effects. Research examining social-cognitive mediators of alcohol's effects and research examining individual differences in AUD susceptibility each represent dominant subfields within alcohol studies. Notably, these two major research areas have proceeded fairly independently to this point, with little evidence of conversation or mutual influence. Research examining individual difference criteria has generally not considered indirect effects of alcohol on mood, while cognitive theories such as Alcohol Myopia have tended to ignore individual differences in alcohol reward, leading scholars to observe that the study of moderators has been largely "divorced" from studies of mechanism underlying alcohol reward (Sher, Bartholow, Peuser, Erickson, & Wood, 2007, p. 362). A handful of studies have attempted to bridge this divide by demonstrating a conceptual connection between moderators and mediators of alcohol's effects—e.g., a cognitive mediator and a cognitive moderator (Sher et al., 2007; see also Hull, Levenson, Young, & Sher, 1983). However, the present project represents the first to establish that a proposed conceptual connection also withstands statistical tests designed to examine moderation and mediation simultaneously, demonstrating that a proposed mediational pathway explains individual differences in alcohol reward.

The present study also has implications for the particular types of social drinking paradigms used in alcohol research. As noted earlier, social drinking paradigms are rarely implemented within alcohol administration studies. When social paradigms have been employed, participants often have not interacted with other participants but instead engage with confederates. More specifically—in an effort to standardize experimental conditions across participants and, in some cases, create an aversive social environment—alcohol-administration researchers have often employed confederate interactions in which confederates follow strict behavioral scripts and are largely facially and verbally unresponsive to participants (Fairbairn & Sayette, 2014). Results produced by the present study suggest that the natural behavioral coordination and responsiveness that occur within the context of most everyday social discourse is key to understanding alcohol's mood enhancing properties as well as individual differences in alcohol reward. At a minimum, alcohol researchers should consider carefully the differences between confederate and naïve-participant group studies.

Future Directions and Limitations

Results of this study point to interesting avenues for future research. In particular, the current study identified powerful effects of gender on self-reported outcomes, but did not examine gender effects in detail. Future research would do well to explore the impact of

gender on alcohol reward in a social setting (e.g., Fairbairn, Sayette, Aalen, & Frigessi, in press). Further, while the results of this study cannot directly speak to alcohol use disorder interventions, they do point to social factors as an important component of the reward that extraverted individuals derive from alcohol. It is possible that interventions that include a social component (e.g., group treatment settings) could be particularly effective for some heavy drinkers.

Limitations of the present research should be noted. First, responses of participants in this study were assessed on the ascending limb of the BAC curve, and future studies should also test the generalizability of these results to individuals whose BACs are descending. Second, our analyses suggested that the overall speech duration of extraverted individuals did not account for the increased reward they derived from group-mates' smiles. Nonetheless, it is possible that our content-free measure of speech was not able to fully capture relevant aspects of behavior (e.g., joke telling). Future research might examine, for example, whether individuals high in extraversion derive more reward from the smiles of fellow group members because these smiles are more likely to be viewed as self-relevant. Future research might also explore whether an individual's level of extraversion is impacted by alcohol consumption in social context. Third, an overall test of model significance is not currently advocated in mediated moderation procedures, and we therefore confirm mediated moderation through the combined results of three different models rather than through a single statistical test (Muller et al., 2005). Thus, in line with these procedures, we established mediated moderation using a stepwise approach. Fourth, the current research did not employ repeated self-report assessments of mood throughout the social drink period, since we felt that to do so would disrupt the social experience (Fairbairn & Sayette, 2013). A challenge for future research will be to establish the temporal precedence of behavioral mediator and self-report outcome. Fifth, although the present paradigm mirrors a common real-world situation in which people consume alcohol together – namely relative strangers getting to know one another – it does not shed light on how people in long-standing relationships (e.g., friends, family members) behave during alcohol consumption. Finally, the current study does not directly compare responses among participants drinking in solitary vs. social situations (e.g., Sayette, Dimoff, et al., 2012), and such a comparison is important to firmly establish a role for social processes in mediating alcohol reward sensitivity among individuals high in extraversion.

Summary

Outside the laboratory, the vast majority of alcohol is consumed in the company of others. Within laboratory studies, in contrast, participants have almost always consumed alcoholic beverages in isolation. Perhaps unsurprisingly, past alcohol-administration studies testing subjects alone have not produced evidence that individuals high in extraversion are more susceptible to alcohol reward than other individuals. Using continuous behavioral-affective measurement and dynamic, individual-level process variables, we found that highly social individuals gained greater reward from alcohol consumption, and that social processes explained their enhanced alcohol reward sensitivity. Results of the current study provide evidence that social paradigms can offer novel information relevant to identification of those

at risk for AUD and suggest that such paradigms deserve a place within laboratory-based alcohol research.

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References

Ambadar Z, Cohn JF, Reed LI. All smiles are not created equal: Morphology and timing of smiles perceived as amused, polite, and embarrassed/nervous. Journal of Nonverbal Behavior. 2009; 33:17–34. [PubMed: 19554208]

Anderson KG, Schweinsburg A, Paulus MP, Brown SA, Tapert S. Examining personality and alcohol expectancies using functional magnetic resonance imaging (fMRI) with adolescents. Journal of Studies on Alcohol. 2005; 66:323–331. [PubMed: 16047521]

Argyle M, Lu L. The happiness of extraverts. Personality and Individual Differences. 1990; 11:1011–1017.

Armeli S, Tennen H, Todd M, Carney MA, Mohr C, Affleck G, Hromi A. A daily process examination of the stress-response dampening effects of alcohol consumption. Psychology of Addictive Behaviors. 2003; 17:266–276. [PubMed: 14640822]

Ashton MC, Lee K, Paunonen SV. What is the central feature of extraversion?: Social attention versus reward sensitivity. Journal of Personality and Social Psychology. 2002; 83:245–252. [PubMed: 12088129]

Beck KH, Summons TG, Thombs DL. A factor analytic study of social context of drinking in a high school population. Psychology of Addictive Behaviors. 1991; 5:66–77.

Brown SA, Munson E. Extroversion, anxiety and the perceived effects of alcohol. Journal of Studies on Alcohol and Drugs. 1987; 48:272–276.

Cahalan, D.; Cisin, IH.; Crossley, HM. American drinking practices: A national study of drinking behavior and attitudes. New Brunswick, NJ: Rutgers Center of Alcohol Studies; 1969.

Canli T, Sivers H, Whitfield SL, Gotlib IH, Gabrieli JD. Amygdala response to happy faces as a function of extraversion. Science. 2002; 296:2191–2191. [PubMed: 12077407]

Cohen, J.; Cohen, P.; West, SG.; Aiken, LS. Applied multiple regression/correlation analysis for the behavioral sciences. (3rd ed.). Hillsdale, NJ: Routledge Academic; 2003.

Cook M, Young A, Taylor D, Bedford AP. Personality correlates of alcohol consumption. Personality and Individual Differences. 1998; 24:641–647.

Costa PT, McCrae RR. Four ways five factors are basic. Personality and Individual Differences. 1992; 13:653–665.

Creswell KG, Sayette MA, Manuck SB, Ferrell RE, Hill SY, Dimoff JD. DRD4 polymorphism moderates the effect of alcohol consumption on social bonding. PloS One. 2012; 7:e28914. [PubMed: 22347363]

Del Porto JA, Masur J. The effects of alcohol, THC and diazepam in two different social settings: A study with human volunteers. Research Communications in Psychology, Psychiatry & Behavior. 1984; 9:201–212.

Demers A, Kairouz S, Adlaf E, Gliksman L, Newton-Taylor B, Marchand A. Multilevel analysis of situational drinking among Canadian undergraduates. Social Science & Medicine. 2002; 55:415–424. [PubMed: 12144149]

Doty P, de Wit H. Effect of setting on the reinforcing and subjective effects of ethanol in social drinkers. Psychopharmacology. 1995; 118:19–27. [PubMed: 7597118]

Ekman P, Davidson RJ, Friesen WV. The Duchenne smile: Emotional expression and brain physiology: II. Journal of Personality and Social Psychology. 1990; 58:342–353. [PubMed: 2319446]

Ekman, P.; Friesen, WV.; Hager, JC. Facial Action Coding System. Salt Lake City, UT: Network Information Research; 2002.

Extroversion [Def. 1]. (n.d.). Merriam-Webster Online. Retrieved from http://www.merriam-webster.com/dictionary/extroversion

Eysenck HJ. Drugs and personality I. Theory and methodology. The British Journal of Psychiatry. 1957; 103:119–131.

Eysenck, HJ. The biological basis of personality. Springfield, IL: Charles C. Thomas; 1967.

Fairbairn CE, Sayette MA. The effect of alcohol on emotional inertia: A test of alcohol myopia. Journal of Abnormal Psychology. 2013; 122:770–781. [PubMed: 24016015]

Fairbairn CE, Sayette MA. A social-attributional analysis of alcohol response. Psychological Bulletin. 2014; 140:1361–1382. [PubMed: 25180806]

Fairbairn CE, Sayette MA, Aalen OO, Frigessi A. Alcohol and emotional contagion: An examination of the spreading of smiles in male and female drinking groups. Clinical Psychological Science. in press

Finn PR, Pihl RO. Men at high risk for alcoholism: The effect of alcohol on cardiovascular response to unavoidable shock. Journal of Abnormal Psychology. 1987; 96:230–236. [PubMed: 3680762]

Fischer S, Smith GT, Anderson KG, Flory K. Expectancy influences the operation of personality on behavior. Psychology of Addictive Behaviors. 2003; 17:108–114. [PubMed: 12814274]

Grau E, Ortet G. Personality traits and alcohol consumption in a sample of non-alcoholic women. Personality and Individual Differences. 1999; 27:1057–1066.

Graziano WG, Feldesman AB, Rahe DF. Extraversion, social cognition, and the salience of aversiveness in social encounters. Journal of Personality and Social Psychology. 1985; 49:971–980.

Grekin ER, Sher KJ, Wood PK. Personality and substance dependence symptoms: Modeling substance-specific traits. Psychology of Addictive Behaviors. 2006; 20:415–424. [PubMed: 17176176]

Hess U, Banse R, Kappas A. The intensity of facial expression is determined by underlying affective state and social situation. Journal of Personality and Social Psychology. 1995; 69:280–288.

Hill SY, Shen S, Lowers L, Locke J. Factors predicting the onset of adolescent drinking in families at high risk for developing alcoholism. Biological Psychiatry. 2000; 48:265–275. [PubMed: 10960157]

Hill SY, Yuan H. Familial density of alcoholism and onset of adolescent drinking. Journal of Studies on Alcohol and Drugs. 1999; 60:7–17.

Hull JG. A self-awareness model of the causes and effects of alcohol consumption. Journal of Abnormal Psychology. 1981; 90:586–600. [PubMed: 7320328]

Hull JG, Levenson RW, Young RD, Sher KJ. Self-awareness-reducing effects of alcohol consumption. Journal of Personality and Social Psychology. 1983; 44:461–473.

Josephs RA, Steele CM. The two faces of alcohol myopia: Attentional mediation of psychological stress. Journal of Abnormal Psychology. 1990; 99:115–126. [PubMed: 2348005]

Jung, CG. Psychological Types: Collected Works. Princeton, NJ: Princeton University Press; 1921.

Kenny DA, Mannetti L, Pierro A, Livi S, Kashy DA. The statistical analysis of data from small groups. Journal of Personality and Social Psychology. 2002; 83:126–137. [PubMed: 12088122]

Kilbey MM, Downey K, Breslau N. Predicting the emergence and persistence of alcohol dependence in young adults: The role of expectancy and other risk factors. Experimental and Clinical Psychopharmacology. 1998; 6:149–156. [PubMed: 9608346]

King LA. Wishes, motives, goals, and personal memories: Relations of measures of human motivation. Journal of Personality. 1995; 63:985–1007. [PubMed: 8531046]

King LA, Broyles SJ. Wishes, gender, personality, and well-being. Journal of Personality. 1997; 65:49–76. [PubMed: 9143145]

Kirchner TR, Sayette MA, Cohn JF, Moreland RL, Levine JM. Effects of alcohol on group formation among male social drinkers. Journal of Studies on Alcohol. 2006; 67:785–793. [PubMed: 16847549]

Kirkpatrick MG, de Wit H. In the company of others: Social factors alter acute alcohol effects. Psychopharmacology. 2013; 230:215–226. [PubMed: 23712603]

Krull JL, MacKinnon DP. Multilevel mediation modeling in group-based intervention studies. Evaluation Review. 1999; 23:418–444. [PubMed: 10558394]

Krull JL, MacKinnon DP. Multilevel modeling of individual and group level mediated effects. Multivariate Behavioral Research. 2001; 36:249–277.

Kuntsche E, Knibbe R, Gmel G, Engels R. Who drinks and why? A review of socio-demographic, personality, and contextual issues behind the drinking motives in young people. Addictive Behaviors. 2006; 31:1844–1857. [PubMed: 16460883]

Levenson RW, Oyama ON, Meek PS. Greater reinforcement from alcohol for those at risk: Parental risk, personality risk, and sex. Journal of Abnormal Psychology. 1987; 96:242–253. [PubMed: 3680764]

Lieberman MD, Rosenthal R. Why introverts can't always tell who likes them: Multitasking and nonverbal decoding. Journal of Personality and Social Psychology. 2001; 80:294–310. [PubMed: 11220447]

Littlefield AK, Sher KJ, Wood PK. Do changes in drinking motives mediate the relation between personality change and "maturing out" of problem drinking? Journal of Abnormal Psychology. 2010; 119:93–105. [PubMed: 20141246]

LoCastro J, Spiro A, Monnelly E, Ciraulo D. Personality, family history, and alcohol use among older men: the VA Normative Aging Study. Alcoholism: Clinical and Experimental Research. 2000; 24:501–511.

Lucas RE, Diener E, Grob A, Suh EM, Shao L. Cross-cultural evidence for the fundamental features of extraversion. Journal of Personality and Social Psychology. 2000; 79:452–468. [PubMed: 10981846]

MacKinnon DP, Lockwood CM, Hoffman JM, West SG, Sheets V. A comparison of methods to test mediation and other intervening variable effects. Psychological Methods. 2002; 7:83–104. [PubMed: 11928892]

MacKinnon DP, Warsi G, Dwyer JH. A simulation study of mediated effect measures. Multivariate Behavioral Research. 1995; 30:41–62. [PubMed: 20157641]

Martsh CT, Miller WR. Extraversion predicts heavy drinking in college students. Personality and Individual Differences. 1997; 23:153–155.

McCrae RR, Costa PT. A contemplated revision of the NEO Five-Factor Inventory. Personality and Individual Differences. 2004; 36:587–596.

McDougall W. The chemical theory of temperament applied to introversion and extroversion. The Journal of Abnormal and Social Psychology. 1929; 24:293–309.

Muller D, Judd CM, Yzerbyt VY. When moderation is mediated and mediation is moderated. Journal of Personality and Social Psychology. 2005; 89:852–863. [PubMed: 16393020]

Noldus Information Technology. The Observer: Professional System for Collection, Analysis, and Presentation of Observational Data (Version XT). Wageningen: The Netherlands; 2010.

Oerlemans WGM, Bakker AB. Why extraverts are happier: A day reconstruction study. Journal of Research in Personality. 2014; 50:11–22.

Pliner P, Cappell H. Modification of affective consequences of alcohol: A comparison of social and solitary drinking. Journal of Abnormal Psychology. 1974; 83:418–425. [PubMed: 4414699]

Preacher KJ, Hayes AF. Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. Behavior Research Methods. 2008; 40:879–891. [PubMed: 18697684]

Rammsayer T. Extraversion and alcohol: Eysenck's drug postulate revisited. Neuropsychobiology. 1995; 32:197–207. [PubMed: 8587702]

Raudenbush SW, Brennan RT, Barnett RC. A multivariate hierarchical model for studying psychological change within married couples. Journal of Family Psychology. 1995; 9:161–161.

Read JP, O'Connor RM. High-and low-dose expectancies as mediators of personality dimensions and alcohol involvement. Journal of Studies on Alcohol and Drugs. 2006; 67:204–214.

Roberts BW, Robins RW. Broad dispositions, broad aspirations: The intersection of personality traits and major life goals. Personality and Social Psychology Bulletin. 2000; 26:1284–1296.

Rohsenow DJ, Marlatt GA. The balanced placebo design: Methodological considerations. Addictive Behaviors. 1981; 6:107–122. [PubMed: 7023202]

Ruch W. Extraversion, alcohol, and enjoyment. Personality and Individual Differences. 1994; 16:89–102.

Russell JA. Core affect and the psychological construction of emotion. Psychological Review. 2003; 110:145–172. [PubMed: 12529060]

Sayette MA, Creswell KG, Dimoff JD, Fairbairn CE, Cohn JF, Heckman BW, Moreland RL. Alcohol and group formation: A multimodal investigation of the effects of alcohol on emotion and social bonding. Psychological Science. 2012; 23:869–878. [PubMed: 22760882]

Sayette MA, Dimoff JD, Levine JM, Moreland RL, Votruba-Drzal E. The effects of alcohol and dosage-set on risk-seeking behavior in groups and individuals. Psychology of Addictive Behaviors. 2012; 26:194–200. [PubMed: 21639596]

Sayette MA, Martin CS, Perrott MA, Wertz JM, Hufford MR. A test of the appraisal-disruption model of alcohol and stress. Journal of Studies on Alcohol. 2001; 62:247–256. [PubMed: 11327191]

Sher KJ. Subjective effects of alcohol: The influence of setting and individual differences in alcohol expectancies. Journal of Studies on Alcohol. 1985; 46:137–146. [PubMed: 3990300]

Sher KJ, Bartholow BD, Peuser K, Erickson DJ, Wood MD. Stress-response-dampening effects of alcohol: Attention as a mediator and moderator. Journal of Abnormal Psychology. 2007; 116:362–377. [PubMed: 17516768]

Sher KJ, Levenson RW. Risk for alcoholism and individual differences in the stress-response-dampening effect of alcohol. Journal of Abnormal Psychology. 1982; 91:350–367. [PubMed: 7142573]

Sher, KJ.; Trull, T.; Bartholow, BD.; Vieth, A. Personality and alcoholism: Issues. methods, and etiological processes. In: Leonard, KE.; Blane, HT., editors. Psychological theories of drinking and alcoholism. New York: Plenum; 1999. p. 54-105.

Sher KJ, Walitzer KS. Individual differences in the stress-response-dampening effect of alcohol: A dose-response study. Journal of Abnormal Psychology. 1986; 95:159–167. [PubMed: 3711440]

Sher, KJ.; Wood, MD. Subjective effects of alcohol II: Individual differences. In: Earleywine, M., editor. Mind Altering Drugs: Scientific Evidence for Subjective Experience. New York: Oxford; 2005. p. 86-134.

Single E, Wortley S. 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 and Drugs. 1993; 54:590–599.

Stacy AW, Newcomb MD. Memory association and personality as predictors of alcohol use: Mediation and moderator effects. Experimental and Clinical Psychopharmacology. 1998; 6:280. [PubMed: 9725112]

Steele CM, Josephs RA. Drinking your troubles away II: An attention-allocation model of alcohol's effect on psychological stress. Journal of Abnormal Psychology. 1988; 97:196–205. [PubMed: 3385073]

Steele CM, Josephs RA. Alcohol myopia: Its prized and dangerous effects. American Psychologist. 1990; 45:921–933. [PubMed: 2221564]

Stewart SH, Devine H. Relations between personality and drinking motives in young adults. Personality and Individual Differences. 2000; 29:495–511.

Theakston JA, Stewart SH, Dawson MY, Knowlden-Loewen S, Lehman DR. Big-Five personality domains predict drinking motives. Personality and Individual Differences. 2004; 37:971–984.

Watson D, Clark LA, McIntyre CW, Hamaker S. Affect, personality, and social activity. Journal of Personality and Social Psychology. 1992; 63:1011–1025. [PubMed: 1460554]

Watson D, Clark LA, Tellegen A. Development and validation of brief measures of positive and negative affect: the PANAS scales. Journal of Personality and Social Psychology. 1988; 54:1063–1070. [PubMed: 3397865]

Wennberg, P. The development of alcohol habits in a Swedish male birth cohort. In: Shohov, SP., editor. Advances in Psychology Research. Hauppauge, NY: Nova Sci.; 2002.

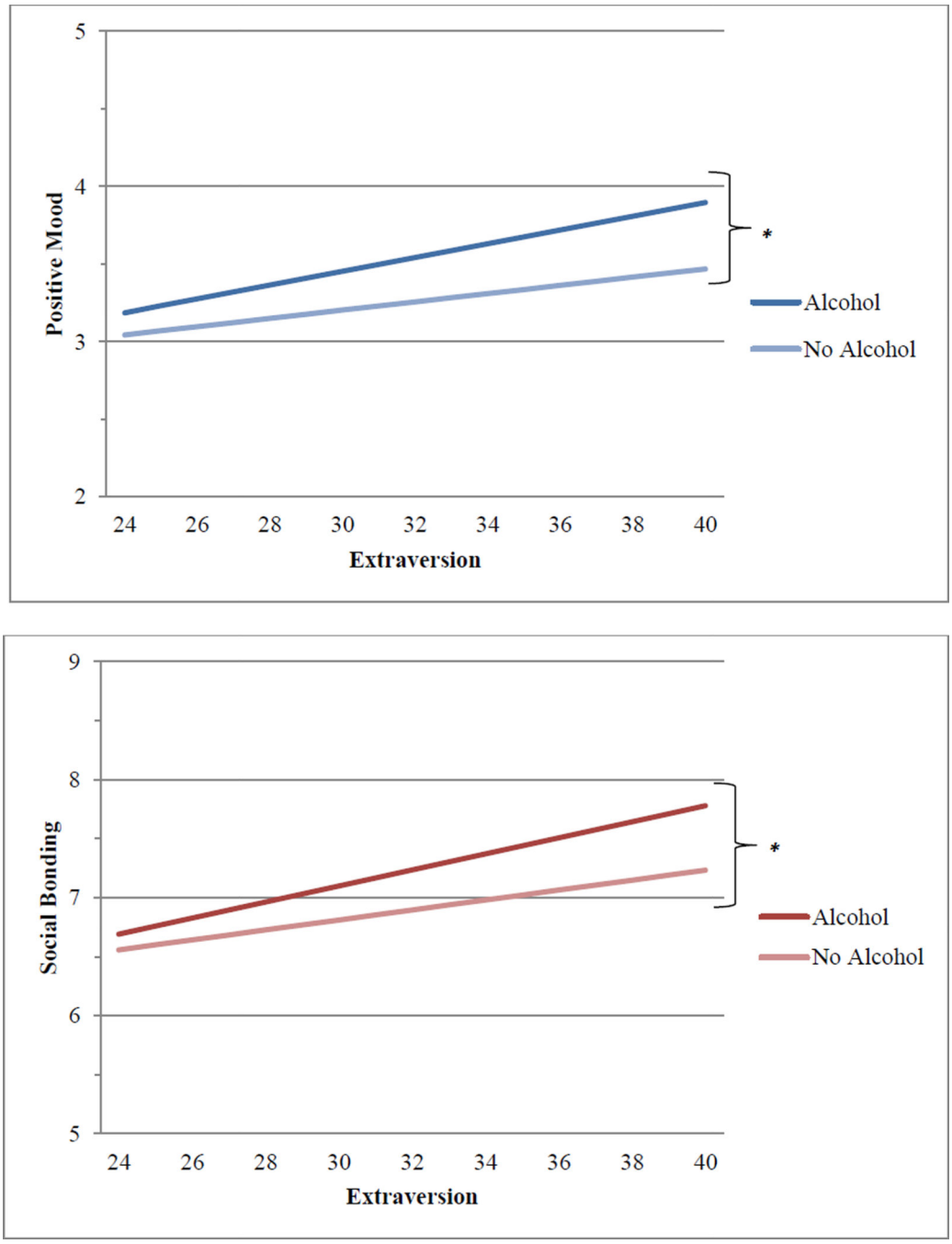

Figure 1.
Extraversion as a moderator of alcohol's impact on self-reported positive mood

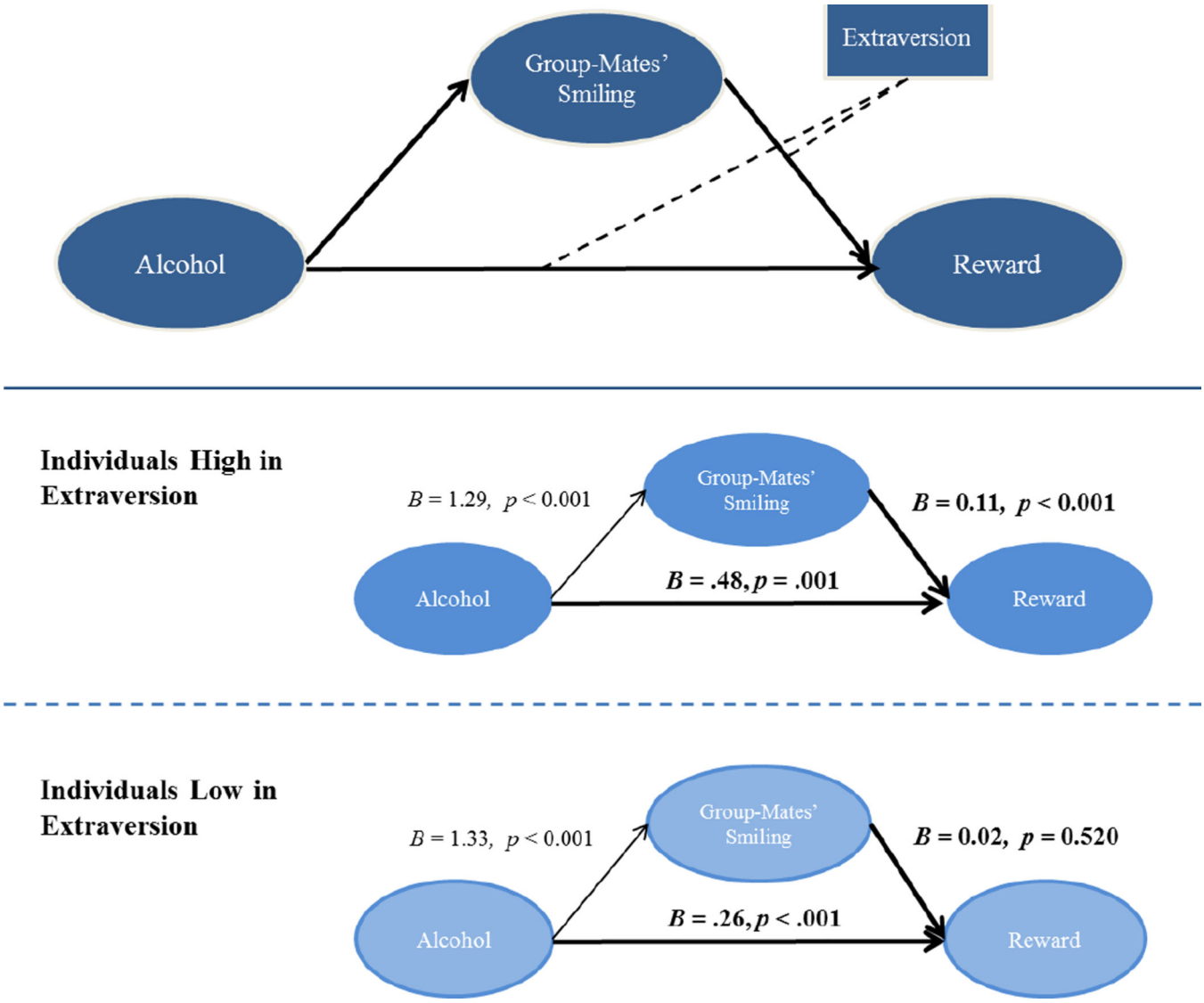

Figure 2.

Mediated moderation effect explaining alcohol reward among extraverts

*$p < .0001$

The effect of alcohol on self-reported positive mood and social bonding is not significant among individuals low in extraversion, whereas this effect is highly significant among individuals high in extraversion.

In graphs above, range of x-axes are set to approximately 1 standard deviation above and below the mean and y-axis are set to approximately 2 standard deviations above and below the mean.

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Table 1

Beverage Manipulation Check

	Alcohol		Placebo		Control		
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Test Statistic**
BAC after drinking	0.06^{a}	0.01	0.00^{b}	0.00	0.00^{b}	0.00	$t = 70.89^{**}$
BAC 40-min after drinking†	0.06^{a}	0.01	0.00^{b}	0.00	—	—	$t = 85.45^{**}$
SIS after drinking	38.50^{a}	17.31	14.90^{b}	10.44	0.20^{c}	1.49	$F = 647.70^{**}$
SIS 40-min after drinking†	35.12^{a}	16.90	8.90^{b}	10.80	—	—	$F = 410.12^{**}$
Highest Intoxication	43.53^{a}	18.71	16.15^{b}	11.11	0.61^{c}	3.19	$F = 698.07^{**}$
Vodka Estimate	7.11^{a}	9.85	4.64^{b}	5.44	0.05^{c}	0.43	$F = 70.80^{**}$

$^{*}p = < .05$

$^{**}p = < .001$

BAC's were examined using a one sample *t*-test comparing those in the alcohol condition against a mean of 0. All other variables were examined using ANOVA.

†control participants not asked to provide these data

Notes. BAC = blood alcohol concentration. SIS = subjective intoxication scale. SIS and Highest Intoxication were scored on scales ranging from 0 to 100. Groups with non-overlapping superscripts differed significantly (p < .05).

Table 2

Descriptive Statistics by Beverage Condition

	Alcohol		Placebo		Control	
	Mean	***SD***	***Mean***	***SD***	***Mean***	***SD***
Extraversion and Baseline Duchenne Smiling and Mood Measures						
Extraversion	31.84[a]	6.76	32.31[a]	6.83	32.17[a]	5.95
Baseline Duchenne Smile (secs)	23.63[a]	19.24	26.03[a]	20.48	24.91[a]	18.43
Positive Mood	26.10[a]	7.08	25.79[a]	6.88	25.10[a]	6.87
Negative Mood	11.81[a]	2.53	12.01[a]	2.53	11.52[a]	2.37
Duchenne Smiling During Drink and Post-Drink Mood and Social Bonding Measures						
Duchenne Smile (secs/10 sec interval)	1.48[a]	0.87	0.94[b]	0.70	1.02[b]	0.71
Positive Mood	3.53[a]	0.83	3.22[b]	0.81	3.31[b]	0.82
Negative Mood	0.33[a]	0.42	0.68[b]	0.62	0.60[b]	0.59
Social Bonding	7.22[a]	1.25	6.74[b]	1.52	7.07[a]	1.30

Baseline mood was measured using the PANAS, while mood following the interaction was indexed using an eight item mood measure in order to avoid anchoring effects (see study measures).

Groups with non-overlapping superscripts differed significantly ($p < .05$).

Table 3

Mediated Moderation models examining both group-mates' smiling (partner effects) and own smiling (actor effects) as explanatory mechanisms underlying alcohol reward sensitivity among extraverted individuals.

	Mediators					
	Group-mates' Duchenne Smiling (Partner effect)			**Own Duchenne Smiling (Actor effect)**		
	B	***t ratio***	***p value***	***B***	***t ratio***	***p value***
Extraversion	0.03	7.90	<.001	0.03	8.15	<.001
Mediator	0.07	2.94	0.003	0.12	2.81	0.005
*ExtraversionXMediator	0.01	2.90	0.004	0.01	1.49	0.137
Alcohol	0.30	4.61	<.001	0.31	4.94	<.001
Extraversion X Alcohol	0.01	0.95	0.343+	0.01	1.65	0.098
Baseline Smiling	0.001	0.52	0.605	0.0001	0.07	0.947
Gender	0.25	4.47	<.001	0.23	4.02	<.001

All variables are centered. Gender is coded such that Male = −.5 and Female = .5 and Alcohol is coded such that No Alcohol= −.5 and Alcohol = .5.

*Coefficient represents the mediated moderation effect of interest in the present research

+The overall moderating effect of extraversion on alcohol response (Extraversion X Alcohol) is significant, p = 0.0215, when the mediated moderational pathway is not included in the model.

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Table 4

Mediated moderation models examining mediational pathways that differ according to number of group members smiling explaining alcohol reward-sensitivity among extraverted individuals

	Mediators											
	Simultaneous Smiling			Unilateral Smiling			Dyadic Smiling			Golden Moments		
	B	*t ratio*	*p value*	*B*	*t ratio*	*p value*	*B*	*t ratio*	*p value*	*B*	*t ratio*	*p value*
Extraversion	0.030	7.81	<.001	0.03	8.38	<.001	0.03	7.90	<.001	0.03	7.96	<.001
Mediator	0.20	3.41	<0.001	0.14	1.62	0.107	0.31	3.06	0.002	0.34	3.49	<.001
*Extraversion X Mediator	0.01	2.09	0.037	0.001	0.07	0.945	0.02	1.67	0.095	0.03	2.42	0.016
Alcohol	0.30	4.71	<.001	0.35	6.14	<.001	0.31	5.05	<.001	0.32	5.11	<.001
Extraversion X Alcohol	0.01	1.31	0.190	0.02	2.30	0.021	0.01	1.54	0.125	0.01	1.32	0.186
Baseline Smiling	0.003	1.19	0.236	−0.002	−0.48	0.634	0.004	1.01	0.315	0.004	0.94	0.347
Gender	0.22	3.86	<0.001	0.25	4.34	<.001	0.22	3.88	<0.001	0.24	4.21	<.001

All variables are centered. Gender is coded such that Male = −.5 and Female = .5 and Alcohol is coded such that No Alcohol= −.5 and Alcohol = .5.

Simultaneous smiling = target group member smiles simultaneously with either one or two other group members; Unilateral smiling = only target group member smiling; Dyadic smiling = target group member smiles simultaneously with one other group member; Golden moments = target group member smiles along with both other group members.

*Coefficient represents the mediated moderation effect of interest in the present research

+The overall moderating effect of extraversion on alcohol response (Extraversion X Alcohol) is significant, p = 0.0215, when the mediated moderational pathway is not included in the model.