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## Case Report

A dynamic analysis of the effect of alcohol consumption on humor enjoyment in a social context<sup>☆, ☆ ☆</sup>Catharine E. Fairbairn<sup>a,\*,1</sup>, Brynne A. Velia<sup>a,1</sup>, Kasey G. Creswell<sup>b,1</sup>, Michael A. Sayette<sup>c,1</sup><sup>a</sup> University of Illinois at Urbana-Champaign, United States of America<sup>b</sup> Carnegie Mellon University, United States of America<sup>c</sup> University of Pittsburgh, United States of America

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## ABSTRACT

Many social interactions involve alcohol consumption, and drinking alcohol can lead to powerful increases in enjoyment in these social contexts. Yet we know almost nothing of the means by which alcohol enhances social experience. Importantly, since individuals in social contexts not only respond to environmental conditions, but can also actively generate these conditions, understanding alcohol's social enhancement within wholly unstructured social interaction presents challenges. To address this issue, the current study examines responses of individuals participating in a structured pleasurable experience in social context (humor presentation)—a drinking context with ecological-validity that permits us to test theories of alcohol-related social-enhancement through isolating responses to the controlled presentation of pleasurable stimuli (i.e., comedy punchlines). Participants ( $N = 513$ ) were randomly-assigned to consume an alcoholic, placebo, or control beverage in the laboratory. Participants were video-recorded during presentation of a comedy routine in 3-person groups, and participants' Duchenne smiles were recorded on a frame-by-frame basis using the Facial Action Coding System. Comedy punchlines were coded by five raters and validated via an independently collected sample of participants ( $N = 30$ ). Results of nested frailty survival models, controlling for the smiles of other group members, indicated a significant interaction between punchlines and alcohol in predicting smiles. Specifically, alcohol selectively increased smiling during times when no humorous stimuli were being presented, whereas there was no significant effect of alcohol on smiling in response to the humorous stimuli themselves. Findings highlight the importance of less intrinsically entertaining social moments for understanding alcohol-related social enhancement.

## 1. Introduction

Drinking alcohol forms an integral part of many everyday social interactions. Alcohol is consumed regularly by about half of the world's population (World Health Organization, 2018), and the majority of this drinking takes place in social settings (Fairbairn & Sayette, 2014; Heath, 2000). Thus, many individuals worldwide combine alcohol and social interaction on a daily or near daily basis (Fairbairn & Sayette,

2014). Importantly, converging evidence indicates that consuming alcohol can dramatically enhance an individual's experience of social interaction. Alcohol can lead to pronounced feelings of elation and social cohesion in group contexts (Fairbairn & Sayette, 2014), drinkers overwhelmingly report that alcohol leads to social pleasure (Goldman, Brown, & Christiansen, 1987), and social enhancement is the most strongly endorsed reason for consuming alcohol (Cooper, 1994). Surprisingly, however, there is almost no research exploring the means by

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which, or the circumstances under which, alcohol enhances social experiences. Social psychologists have largely ignored alcohol as a factor in social exchange,<sup>2</sup> and alcohol researchers examining social context have focused nearly exclusively on the question of “whether” rather than the question of “how” (see Fairbairn & Sayette, 2014 for review). As a result, we have not only limited our understanding of mechanisms driving an important health-relevant behavior but also, given alcohol's seemingly potent effects on social experiences, we have missed an opportunity to better understand the nature of social reward itself.

While there has been little research directly exploring how alcohol might lead to these robust increases in social enjoyment, several theorists have offered speculations. Of note, within the context of such theory, psychologists have overwhelmingly focused on responses to explicit environmental cues. For example, in the theory that arguably represents the most prominent of such models—alcohol myopia theory—authors Steele and Josephs posit that alcohol can lead to enjoyment by narrowing attentional capacity to stimuli in the immediate environment, and so alcohol would lead to emotional enhancement when immediate stimuli are positive (Steele & Josephs, 1990). According to alcohol myopia, alcohol's ability to enhance experience in many social interactions is due to the comparative commonality of positive cues in such casual drinking contexts and the increased responsiveness of drunk individuals to such cues (see Josephs & Steele, 1990). Thus, according to this theory, an individual attending a cocktail party after a stressful day at work would find the jokes of her conversation partner increasingly funny, and the aggravations of work increasingly distal, as intoxication settled in. Steele and Josephs (1990) conducted a series of studies involving alcohol-administration, stress manipulations, and positive slide-viewing tasks to provide support for their predictions. However, although some predictions of alcohol myopia regarding reward processes have received empirical support (e.g., affective dynamics; Fairbairn & Sayette, 2013), subsequent research exploring the predictions of alcohol myopia regarding alcohol's impact on responses to pleasurable stimuli has produced mixed results (Gilman, Ramchandani, Davis, Bjork, & Hommer, 2008; Stritzke, Patrick, & Lang, 1995) and no study has examined these predictions in social context.

More recently, some psychological scientists have embarked on research that effectively flips figure and ground in the understanding of human experience. Specifically, this work moves away from an exclusive focus on stimulus and response and instead considers experiences of individuals during moments of low external activity (Damoiseaux et al., 2006; Smallwood & Schooler, 2006). Social interactions can involve bursts of engaging verbal and nonverbal activity, as well as moments of comparative quiet where conversation may become less engaging and individuals can retreat into their own thoughts. Individuals may sometimes experience such moments as uncomfortable, with research in social psychology indicating that even the lack of explicit positive cues can be perceived as threatening belongingness (Leary, 2010; Wesselmann, Cardoso, Slater, & Williams, 2012), and alcohol consumption can relieve individuals from any underlying sense of strain or stress during such ambiguous moments (Fairbairn & Sayette, 2013, 2014; Sayette, 1993). Further, recent research examining alcohol's impact on internally generated cognitions indicates that intoxicated individuals may have particularly rich and active inner worlds. Alcohol consumption has been shown to increase episodes of mind wandering (Sayette, Reichle, & Schooler, 2009), enhance creativity (Jarosz, Colflesh, & Wiley, 2012), and further reduce subjective

sense of social boredom (Fairbairn & Sayette, 2013; Orcutt, 1984). Thus, one possibility is that, among intoxicated individuals, the party goes “internal”—drunk or sober, we could all enjoy a good joke, but only a drunk individual is likely to chuckle to himself during a quieter social moment.

One possible reason researchers have tended to neglect alcohol's impact on social interaction is that such examinations can present formidable methodological challenges. In unstructured social exchange, individuals not only alter their responding as environmental conditions shift, but, importantly, they themselves can contribute to bringing about these changes. Thus, in examining responding in such contexts, it is impossible to disentangle responses to the immediate conditions from factors associated with the creation of these conditions (e.g., alcohol consumption might not only increase individuals' tendency to smile but it might also lead them to change the manner in which they interact such that more smiling naturally follows). As such, testing specific predictions of a theory such as alcohol myopia concerning responses to extrinsic stimuli (Steele & Josephs, 1990)—as well as other theory (Fairbairn & Sayette, 2014; Sayette et al., 2009)—within the context of wholly unstructured social exchange presents a challenge. To add to this complexity, responses of individuals within a given social context tend to be highly correlated. In a prior publication, we aimed to take a step towards better characterizing this complexity by examining alcohol's impact on the “contagiousness” of smiles in social context—using survival analysis to map how smiles spread from one group member to the next (Fairbairn, Sayette, Aalen, & Frigessi, 2015; see also Fairbairn, 2016). Although valuable as a means by which to explore correlations between the behavior of participants in social exchange, these analyses remained unable to speak to the question of mechanism. As noted above, within the context of unstructured social exchange, individuals not only respond to but also actively create social conditions. Thus, effects of alcohol observed within such a context might capture alcohol's impact on responsiveness to others' smiles, or instead reflect an underlying change in the content of conversation that naturally results in more smile clustering (e.g., more frequent “jokes”). In the current study, we aim to answer questions left unaddressed in this prior work by examining a social setting structured by a common pleasurable experience. In particular, we chose a humor paradigm as one that allowed us to examine responding to *controlled* presentation of environmental stimuli (punchlines) as well as moments in-between these stimuli (non-punchline moments) within a context that mirrors many everyday social drinking settings.

### 1.1. Humor, social context, and alcohol

The study of humor is key to understanding both social interaction and also alcohol response. Regarding the former of these, humor represents one of the earliest social-communicative acts in which humans engage (Gervais & Wilson, 2005). Research suggests that most everyday humor takes place in social context (Gervais & Wilson, 2005; Mannell & McMahon, 1982; Vettin & Todt, 2004), and definitions of humor characterize it as an intrinsically social process (Bitterly, Brooks, & Schweitzer, 2017; Gervais & Wilson, 2005). Regarding the latter, alcohol is widely believed to enhance humorous experiences (Ruch, 1994). It is no mystery to comedy club owners that enforcing minimum drink requirements makes their comedians seem funnier. Indeed, one of the prime perceived benefits of alcohol consumption is the perception that something is funny (humor enjoyment) (Orford, Krishnan, Balaam, Everitt, & Van der Graaf, 2004).

In a recent study, we examined the impact of alcohol, a placebo, and a non-alcohol control beverage on response to comedy in a group context. Results revealed a main effect of alcohol on the overall duration of smiles and also aggregate ratings of funniness (Sayette et al., 2019). In this initial examination, however, we did not consider temporal characteristics that might offer subtle yet powerful clues to understanding not just whether alcohol affects humor enjoyment in social

<sup>2</sup>We conducted a database search of articles published in four top-ranked outlets for empirical social psychology research prior to December 2018—*Psychological Science*, *Journal of Personality and Social Psychology*, *Personality and Social Psychology Bulletin*, and *Journal of Experimental Social Psychology*. Of the over 10,000 articles published in these journals in the past 2 decades (since 1998), a total of 125 articles (~0.01%) mentioned the word alcohol anywhere in the database record.

context, but the timing and the mechanisms underlying this effect. Thus, this prior study joins numerous prior studies that have documented alcohol's ability to enhance mood across a variety of social contexts (e.g., Doty & de Wit, 1995; Kirchner, Sayette, Cohn, Moreland, & Levine, 2006; Pliner & Cappell, 1974; Sayette et al., 2012). Importantly, this previous research remains silent on the question of how such effects might emerge—under what circumstances, and in response to what specific contextual conditions, alcohol might yield its powerful social rewarding effects. Contexts involving humorous stimuli represent not only a common context for the social consumption of alcohol, but they also permit controlled presentation of pleasurable stimuli (e.g., punchlines) in a manner that permits the parsing of these stimuli from nonverbal social cues. The current study employs nested frailty survival models featuring multiple time-varying covariates (comedy punchlines and other group members' smiles) in order to capitalize on this feature. More specifically, we leverage a large sample, powerful experimental manipulations, a social context, fine-grained behavioral measures, and sophisticated event-based analyses to examine not only the impact of alcohol on responses to punchlines but also the moments in-between.

### 1.2. The current study

In sum, by employing real-time unobtrusive assessment in a social context, we aimed to offer a comprehensive, temporally sensitive analysis of the impact of drinking during a comedy routine. The project from which we currently draw data represents the results of an over 12-year effort involving the coding of millions of frames of video data—an experiment that is both the largest study to employ the Facial Action Coding System (FACS; Ekman, Friesen, & Hager, 2002) and also one of the largest alcohol-administration trials ever conducted.<sup>3</sup> Importantly, the social paradigm employed in this research allowed us to parse effects of distinct pleasurable stimuli (e.g., jokes) from responses to nonverbal behavior of other group members, while also reflecting a structured social experience similar to those observed in many everyday drinking contexts (e.g., viewing television or movies, attending concerts, watching sporting events, etc.; Single & Wortley, 1993). Of particular importance, the current paradigm enabled us to test competing theories of alcohol's effects on social experience including: 1) If assumptions underlying traditional theories of alcohol and social enjoyment were correct (Steele & Josephs, 1990), we might expect that alcohol's socially enhancing effects would emerge in response to pleasurable external cues—alcohol-related increases in smiles of enjoyment would emerge as most pronounced in response to punchlines; 2) If instead predictions of recent work on alcohol's effects on social anxiety and mind wandering were borne out (Fairbairn & Sayette, 2014; Sayette et al., 2009), we would expect that alcohol's socially enhancing effects would emerge during less entertaining social moments—alcohol-related increases in smiles would emerge as most pronounced in response to moments between punchlines.

## 2. Method

### 2.1. Participants

Participants were 513 young social drinkers recruited through advertisements in the Greater Pittsburgh Area. Participants were 52% female with an average age of 22.5 ( $SD = 1.9$ ). Participants were 83.2% White, 10.3% African American, 1.4% Hispanic, 2.1% Asian, and 2.9%

<sup>3</sup> Some findings from this large, multi-year study have been published (e.g., Fairbairn et al., 2015; Sayette, Creswell, et al., 2012). With the exception of the article mentioned previously (Sayette et al., 2019), which focused only on the main effect of alcohol on humor enjoyment, these articles have all focused on the 36-min drinking period at the beginning of the experiment prior to the comedy clip.

other racial category. Individuals were excluded if they had a medical condition for which alcohol consumption was contraindicated, endorsed past or current alcohol use disorder, or if they indicated discomfort with the alcohol dose administered in the study. Women who were pregnant or trying to become pregnant were also excluded. Participants reported drinking on average 3–4 times a week ( $M = 3.7$ ,  $SD = 0.91$ ). Participants in this study represent the subgroup of participants from our larger trial (see Sayette, Creswell, et al., 2012) who engaged in the group comedy routine task (Sayette et al., in press). The sample size provided 80% power to detect a small effect size for alcohol ( $d = 0.261$ ) assuming a 2-tailed test of significance and  $\alpha = 0.05$ —note that prior studies have found effect sizes for alcohol on enjoyment in group settings to be in the moderate range ( $d = 0.5$ ; see Fairbairn & Sayette, 2014 for a meta-analysis).

### 2.2. Procedure

Participants were invited into the laboratory in groups of three strangers. Participants were individually introduced to ensure no acquaintance prior to study participation. Unacquainted groups were examined because they allowed us to hold constant factors such as relationship quality, type, and duration that can affect interactions between familiar individuals (Leary, 2010) while also reflecting a reasonably-common real-world drinking configuration (e.g., in settings such as bars, clubs, and large parties; Fairbairn & Sayette, 2014). Participants were then randomly assigned to one of three beverage conditions: alcohol condition (told alcohol, received alcohol;  $N = 177$ ), placebo condition<sup>4</sup> (told alcohol, received no alcohol;  $N = 171$ ), or control condition (told no alcohol, received no alcohol;  $N = 165$ ). All members of the same group were assigned to the same beverage condition. All four possible gender compositions were represented within 3-person groups in relatively comparable proportions: 27% all-female, 29% all-male, 20% 1-male 2-females, and 24% 2-females 1-male.

#### 2.2.1. Beverage administration

After completing some baseline questionnaires, participants were administered their study beverages. Participants consumed their beverages in 3 equal parts over the course of 36 min. In the alcohol condition, participants consumed a mixed drink comprising 1 part 100 proof (50%) vodka and 3.5 parts cranberry juice cocktail. Doses were adjusted based on gender and body weight (0.82 g/kg for males and 0.74 g/kg for females). A 170-lb man in our study would receive the equivalent of about 7 oz. of standard-issue 80 proof liquor, and a 130-lb female would receive 4.9 oz. All beverages were mixed in front of the participants. In the placebo condition, participants' cups were smeared with vodka prior to the experimental session, and flat tonic water was stored in and poured from a vodka bottle—a method effective in making participants believe they are consuming alcohol (Sayette, Creswell, et al., 2012). Participants in the control condition consumed cranberry juice cocktail and were told they would not be consuming alcohol. The beverages were isovolumic across conditions. The three participants consumed their beverages together as a group, and their behavior was video recorded during this phase. The social interaction during the group drink period was entirely unstructured—participants were given no instructions on whether to talk or what to talk about, and no stimuli were presented to them during this period. Periodically after

<sup>4</sup> A placebo condition was included to account for the possible impact of expectations surrounding alcohol's effects on affective display. However, since theories informing our hypotheses deal with the pharmacological (i.e., ethanol consumed vs. no ethanol consumed) effects of alcohol (Fairbairn & Sayette, 2014; Sayette et al., 2009) and prior analysis of the present dataset found no significant effects of placebo (Sayette, Creswell, et al., 2012), we did not anticipate significant differences between placebo and control participants in the present study.

beverage administration, participants provided breathalyzer readings to assess their blood alcohol concentration (BAC) and also provided reports of their subjective intoxication ratings (Subjective Index of Intoxication; SIS).

### 2.2.2. Comedy routine

After a post-drink absorption period lasting approximately 20 min, during which participants completed questionnaires and engaged in a brief decision making task (Sayette, Dimoff, Levine, Moreland, & Votruba-Drzal, 2012), groups were seated at equidistant intervals around a round table. They then listened to approximately 5 min of comedian Jerry Seinfeld's stand-up act (see supplementary materials for a transcript). The clip was chosen as one that: 1) Contained no excessively provocative material—i.e., aggressive or sexual content; 2) Included jokes that ranged in their complexity (see transcript), varying from very basic “silly” humor (one punchline is literally sung) to jokes that may demand more cognitive resources to understand (e.g., “if I'd had a pimple, I would have won!”); and 3) Included not only material likely to be perceived as entertaining but also brief pauses in material presentation and material that was not explicitly humorous (see below for descriptives). The clip was played using a compact disc player, which was placed at the center of the table, equidistant from the three participants such that all group members listened to the audio clip simultaneously. As with the group drink period, participants' behavior during the comedy clip was video recorded. Participants were unaware at the time that their behavior was being video recorded, and their consent was gained at the time of study debriefing for the analysis of this video data. Participants' BACs and SIS ratings were recorded after the comedy routine. They also rated their enjoyment of the comedy routine at this time (Sayette et al., 2019).

At the end of the experiment, participants were debriefed about the video recordings and were paid \$60 for their time. Participants in the placebo and control conditions were debriefed immediately after the experimental procedures terminated and were permitted to leave. Participants in the alcohol condition remained in the lab for a period of time after the experiment and were debriefed once a breathalyzer test indicated their BACs were below 0.025%.

One group was excluded from the study due to procedural abnormalities—a decision that was made during the experimental session—and then later replaced. Video recordings from 2 additional groups were cut short by 2 min or less due to equipment malfunction. Aside from these events (which constituted about 1% of sessions), the study involved no other incomplete or excluded video recordings.

## 2.3. Measures

### 2.3.1. Duchenne smiles

Participants' facial expressions throughout the group drink period and comedy clip were coded on a frame-by-frame basis (every 1/30th second). Videos were coded by FACS-certified coders blind to beverage condition using Observer Video-Pro software (Version 5, Noldus Information Technology, Wageningen, The Netherlands).<sup>5</sup> More than 5 million frames of video were coded for this project. In line with humor theory which emphasizes “Duchenne” (emotionally valenced) over “non-Duchenne” (emotionless) humor displays (Gervais & Wilson, 2005), we focused on Duchenne smiles, which are characterized by the

<sup>5</sup> In recent years, criticisms of the FACS system have emerged, with some expressing the view that claims that FACS offers a window into true emotion, independent of context, have been exaggerated. Of note, the potential usefulness of this study does not rest on the notion of FACS as the final truth teller. Rather, we suggest that, when context is known and held constant, and real-time emotion is of interest, specific facial expressions will often be related to emotion and FACS may be useful as a reliable system for coding behavioral-affective display.

combination of AU 6 (contraction of outer part of orbicularis oculi “cheek raiser”) and AU 12 (contraction of zygomatic major “lip corner puller”), as a proxy for felt enjoyment (Ekman et al., 2002; Ekman & Rosenberg, 2005). The precise onset and offset points of each Duchenne smile were coded continuously as they occurred in time. Although specific negative AUs were also collected in the conduct of this research (Sayette, Creswell, et al., 2012), the Duchenne smile was the only AU directly relevant to the current hypotheses and therefore the only variable analyzed for the purposes of the present study. Reliability was assessed by comparing a subset of 50 randomly selected videos which were coded by another FACS-certified coder. Agreement between coders was high ( $\kappa$ 's = 0.81).

### 2.3.2. Punchlines

Punchlines within the comedy routine were coded according to a two-stage process. In the first (“identification”) phase of this process, punchlines were coded by the first author and then were coded for reliability by 4 independent research assistants. Average interrater reliability was  $\kappa = 0.74$ . Punchlines were then selected for inclusion if at least 75% of coders agreed on the punchline. In order to account for cognitive and also behavioral latencies required for processing and responding to jokes, we added 1 s on to the end of each coded punchline to allow participants time to respond (see also Results section for an examination of generalizability across different punchline latencies). Using this method, we identified a total of 28 independent punchlines within the comedy routine.

In the second (“validation”) phase of this process, a total of 30 participants were recruited from the local community at the University of Illinois at Urbana-Champaign. Participants were recruited to approximately match participant characteristics in the original Pittsburgh study—50% male social drinkers, average age 22.73 years. These participants, who were assembled into groups of three, listened to the same Jerry Seinfeld comedy routine as that used in the prior study. Their Duchenne smiling behavior during the comedy routine was then coded by a FACS-certified coder. Analyses confirmed that participants were significantly more likely to Duchenne smile during portions of the comedy routine coded as punchlines,  $B = 0.47$ ,  $Exp(B) = 1.59$ ,  $SE(B) = 0.13$ ,  $p < .001$ —specifically, participants in this validation sample were 59% more likely to initiate a smile during a punchline vs. a non-punchline moment. See online supplement for complete transcript along with identified punchlines.

## 2.4. Data analysis

The aim of data analysis was to predict the likelihood that a participant would “crack a smile” during the comedy routine, using punchlines as predictors while also accounting for the behavior of group-mates. We present our analyses in three stages. First, in preliminary models, we examine effects employing analytic methods commonly used within psychology (mixed models). Next, we move to more complex analyses that allow us to examine the dynamic interplay of various predictors of transition to smiling (nested frailty survival models; Stoolmiller & Snyder, 2006). Finally, we test several “alternative” models intended to help us towards a conceptual understanding of our findings. We present overlapping analyses in the first and second stage of the results for several reasons including: 1) Increases in statistical complexity can come at the cost of decreases in transparency. In the results that follow, we aim to present the most parsimonious model that allows us to address our research question, fully justifying each increase in analytic complexity; 2) We view examining and demonstrating the robustness of results to different analytic frameworks as an important exercise.

In our preliminary analyses, we employed 3-level mixed effects models to examine rates of smiling per unit time during both punchline and non-punchline intervals of the comedy routine (Raudenbush & Bryk, 2002). Models incorporated random effects accounting for

clustering at the level of the individual as well as the 3-person group. Since rates of smiling were highly skewed, we employed generalized linear models that incorporated a log-link function.

In our final models, we employed 3-level “nested” frailty survival analysis to predict the hazard of transition from a non-smiling state to a smiling state (Fairbairn et al., 2015; Griffin & Gardner, 1989; Stoolmiller & Snyder, 2006). The hazard—the quantity examined within a survival framework—can be defined as the probability of a given outcome occurring per unit time. In the results reported below, the hazard is represented by the abbreviation  $Exp(B)$  and can be interpreted as a form of “relative risk” across levels of the predictors. In survival models, punchlines (a dichotomous variable) and also the smiles of other group-members (a quantity varying from 0 to 2) were entered simultaneously as time-varying covariates. Data were analyzed in counting process format. Survival models examining punchlines include both smiles of other group members, as well as the interaction of group members' smiles and alcohol, as covariates. Time intervals that ended without eliciting a transition from non-smile to smile were considered censored.

### 3. Results

#### 3.1. Beverage manipulation check

Participants in the alcohol condition were on the ascending limb of the BAC curve during comedy routine presentation and reached a peak average BAC of 0.062% ( $SD = 0.012$ ) immediately after this task.

#### 3.2. Descriptive statistics

The comedy routine lasted 329 s, 112 s of which corresponded to a punchline while 217 s were coded as a non-punchline. On average, each participant initiated 15.06 ( $SD = 7.66$ ) smiles during the comedy routine, with smiles lasting an average of 6.38 ( $SD = 7.88$ ) seconds. The association between smiling and self-reported enjoyment of the comedy clip (see Sayette et al., 2019) did not differ across punchline and non-punchline moments,  $B = 0.01$ ,  $Exp(B) = 1.01$ ,  $SE(B) = 0.01$ ,  $p = .210$ .

#### 3.3. Preliminary analysis of smiling rates

In order to get a broad sense for the effect of punchlines on participants' enjoyment, we examined overall rates of smiling across various epochs of the comedy clip. For the purposes of these models, we divided the total number of smiles by the duration of punchline moments vs. non-punchline moments (see Table 1). Results of mixed models indicated that rates of smiling were significantly higher during punchlines than non-punchline moments,  $B = 0.89$ ,  $t = 27.79$ , 95%  $CI = 0.82$  to  $0.95$ ,  $p < .001$  (see also Table 1). These analyses further indicated a significant interaction between alcohol condition and punchlines,

**Table 1**

Average frequency and rate (/minute) of Duchenne smiling initiation according to beverage condition and punchline epoch.

	Alcohol ( $N = 177$ )		Placebo ( $N = 171$ )		Control ( $N = 165$ )	
	Freq	Rate	Freq	Rate	Freq	Rate
Punchline (1.87 min)	8.79 (5.10)	4.71 (2.73)	8.42 (5.18)	4.54 (2.79)	8.72 (5.51)	4.67 (2.95)
No-punchline (3.62 min)	7.58 (4.43)	2.09 (1.23)	5.61 (3.34)	1.56 (0.93)	6.02 (3.59)	1.66 (0.99)

*Note.* The above represent the average number of smiles (*freq*) and average smiling rate per minute (*Rate*) across individuals in our study. Data are presented in the format mean (standard deviation). Intervals coded as punchlines lasted a total of 1.87 min, whereas non-punchline moments lasted 3.62 min.

$B = -0.22$ ,  $t = -3.34$ , 95%  $CI = -0.35$  to  $-0.09$ ,  $p < .001$ , such that the effect of alcohol on smiling was significantly larger during non-punchline moments,  $B = 0.26$ ,  $t = 3.32$ , 95%  $CI = 0.11$  to  $0.41$ ,  $p = .001$ , vs. during punchlines,  $B = 0.04$ ,  $t = 0.49$ , 95%  $CI = -0.12$  to  $0.20$ ,  $p = .624$ .

The above models represent an analytic approach commonly applied to behavioral-observation data within psychology (Fairbairn et al., 2015; Griffin & Gardner, 1989), and, as such, represent a useful starting place in our examination of smiling. Nonetheless, they have significant limitations including: 1) These models do not account for when things happen. An individual who began smiling at the very beginning of a 5-minute interval and continued to smile throughout this interval would be treated identically to an individual who only managed to crack a smile in the final few seconds; and 2) In social context, behaviors are interdependent. Punchline intervals would also necessarily be associated with increased smiling, and non-punchline moments with decreased smiling, of an individual's fellow-group members. Thus, based on the models examined so far, it is unclear whether effects represent the effects of punchlines, group mates' smiling, or some combination of these two factors.

#### 3.4. Survival analysis

We next examined smiling behaviors using survival models, which not only allow for the consideration of the timing of events but also permit the simultaneous examination of multiple time-varying covariates within a single model. We first employed these models to examine the main effect of punchlines and alcohol on the hazard of smiling. Results of nested frailty survival models indicated that participants were significantly more likely to smile during punchlines than during times when punchlines were not taking place,  $B = 0.87$ ,  $Exp(B) = 2.39$ ,  $SE(B) = 0.02$ ,  $p < .001$ . The hazard of smiling was 139% higher when a punchline was taking place than when it was not, even after controlling for the smiles of other group members. Participants in the alcohol condition tended to be more likely to initiate a smile than participants in either of the two no-alcohol conditions,  $B = 0.18$ ,  $Exp(B) = 1.19$ ,  $SE(B) = 0.10$ ,  $p = .077$ , although this effect did not reach significance.<sup>6</sup> There was no significant difference or trend towards a difference between placebo and control conditions in the hazard of smiling,  $B = -0.08$ ,  $Exp(B) = 0.93$ ,  $SE(B) = 0.12$ ,  $p = .510$ .

We next used survival models to address our main study aim of examining the interplay of alcohol consumption and punchline moments in predicting smiling. Results revealed a significant interaction between punchlines and beverage condition in predicting smiling,  $B = -0.22$ ,  $Exp(B) = 0.80$ ,  $SE(B) = 0.05$ ,  $p < .001$ . Individuals consuming alcohol tended to smile more during both punchline and non-punchline moments, but the effect of alcohol was significantly stronger when a punchline was not taking place,  $B = 0.29$ ,  $Exp(B) = 1.34$ ,  $SE(B) = 0.09$ ,  $p < .001$ , whereas the effect of alcohol did not reach significance during punchlines,  $B = 0.08$ ,  $Exp(B) = 1.08$ ,  $SE(B) = 0.09$ ,  $p = .390$ . There was no significant interaction between punchlines and the distinction between placebo vs. control conditions in predicting smiling,  $B = 0.04$ ,  $Exp(B) = 1.04$ ,  $SE(B) = 0.06$ ,  $p = .470$ . Participants were significantly more likely to smile when other group members were smiling,  $B = 0.84$ ,  $Exp(B) = 2.31$ ,  $SE(B) = 0.02$ ,  $p < .001$ , even after controlling for punchlines. However, consistent with results from our prior research examining the main effect of alcohol on emotion contagion (see Fairbairn et al., 2015), here we found no significant interaction between alcohol condition and the smiles of other group

<sup>6</sup> Note that the alcohol effect reported here is similar, although not identical to, the main effect of alcohol reported in our prior publication (Sayette et al., 2019)—here we take an event-based approach to smile analysis, whereas our previous publication, which did not examine epochs of the comedy clip as defined by punchlines, simply examined total summed smile duration.

members in predicting smiling,  $B = -0.03$ ,  $Exp(B) = 0.97$ ,  $SE(B) = 0.03$ ,  $p = .320$ .

### 3.5. Exploring conceptual interpretations

#### 3.5.1. Response latency

One possible explanation for the differential relationship between punchlines and smiles across alcohol conditions in the current study is that intoxicated participants are laughing *later* than sober participants. In other words, perhaps participants consuming alcohol are smiling in response to the punchlines, but, perhaps due to cognitive and/or behavioral disruptions associated with alcohol consumption, it is simply taking them longer to respond to the joke. In order to examine this possibility, we added first 3 s and then 5 s onto the end of each punchline, combining punchlines when necessary. If the diminished relationship between punchlines and smiling in the alcohol condition were associated with latency effects, we might expect the interaction between alcohol and punchlines to diminish and possibly disappear as we extended the end of punchlines. But, with this alteration, the interaction between alcohol and punchlines became, if anything, somewhat stronger (Punchline +3 s:  $B = -0.29$ ,  $Exp(B) = 0.75$ ,  $SE(B) = 0.05$ ,  $p < .001$ ; Punchline +5 s:  $B = -0.35$ ,  $Exp(B) = 0.71$ ,  $SE(B) = 0.06$ ,  $p < .001$ ).

#### 3.5.2. Hidden punchlines

A second possible explanation for the differential relationship between punchlines and smiles across alcohol conditions is that intoxicated individuals may simply have a lower threshold for finding a joke funny. So perhaps, when sober, participants might have to consider a joke truly hilarious in order to crack a smile whereas, when intoxicated, a mildly funny joke might suffice. It is conceivable that our original coding of punchlines—requiring at least 75% of our (sober) coders to agree on the joke—did not capture moments that an intoxicated individual might consider sufficiently funny to smile. In order to examine this possibility, we returned to our original comedy routine coding with a more inclusive view to coding punchlines. In this 2nd coding, we categorized an event as a punchline if any one of our 5 original coders (1st author and 4 RA's) had coded it as a punchline. This method produced an additional 14 “subthreshold” punchlines (48 s) beyond the original 28 “full” punchlines identified within our first coding (see online supplement). If the tendency of alcohol participants to smile more during moments previously categorized as non-punchlines was accounted for by a lower threshold for finding a joke funny, we might expect an effect of alcohol to emerge during these “subthreshold punchline” moments. Instead, results indicated that the effect of alcohol was strongest during the moments that zero of our 5 coders had categorized as a punchline,  $B = 0.358$ ,  $Exp(B) = 1.43$ ,  $SE(B) = 0.09$ ,  $p < .001$ , weaker during “subthreshold” punchlines,  $B = 0.213$ ,  $Exp(B) = 1.24$ ,  $SE(B) = 0.09$ ,  $p = .012$ , and weakest of all during “full” punchlines,  $B = 0.07$ ,  $Exp(B) = 1.07$ ,  $SE(B) = 0.09$ ,  $p = .430$  (see Fig. 1).

#### 3.5.3. Comedy context

A final possibility is that effects of alcohol observed in the current study are, in fact, wholly unconnected to humor. Since alcohol effects emerge as most pronounced during times when no humorous stimuli are actively being presented, and are non-significant during punchlines, it seemed possible that these effects would have emerged regardless of the context and that the humorous stimuli are in fact irrelevant. An alternative possibility is that, although alcohol's effects do not align precisely with the presentation of comedic stimuli, they nonetheless are influenced by the broader setting (e.g., a general cognitive framework is generated by the humorous context that permeates beyond the punchlines). To investigate this possibility, we combined data from the (entirely unstructured) social interaction during the original group drink period with data from the non-punchline moments of the comedy

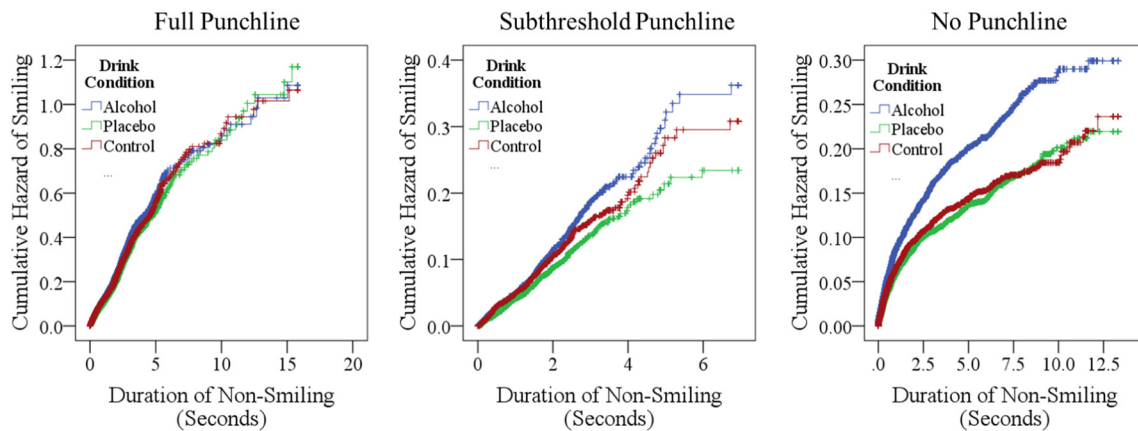
clip<sup>7</sup>—a combined dataset that, including the smiles of other group members as covariates, comprised over one hundred thousand observations. This dataset allowed us to examine the broader influence of the humor context by comparing the effects of alcohol during the non-punchline moments of the comedy clip with alcohol effects observed during a nearly identical social context during which no humorous stimuli were presented. Importantly, alcohol's stimulative effects are largest in the very earliest stages of intoxication, and, by the time of comedy clip exposure, alcohol participants were feeling significantly less intoxicated ( $SIS_{Post-Drink} = 38.25$ ;  $SIS_{Post-Comedy} = 35.14$ ,  $p < .001$ ) vs. immediately following the group drink period. Thus, based solely on these limb effects, we would anticipate a larger effect of alcohol during the group drink period than during non-punchline intervals of the comedy clip. In fact, precisely the opposite pattern of effects emerged. As estimated within the context of this combined dataset, controlling for the smiles of other group members, alcohol's tendency to increase the hazard of smiling was in fact lower during the group drink period,  $B = 0.25$ ,  $Exp(B) = 1.28$ ,  $SE(B) = 0.05$ ,  $p < .001$ , vs. during non-punchline intervals of the comedy clip,  $B = 0.37$ ,  $Exp(B) = 1.45$ ,  $SE(B) = 0.06$ ,  $p < .001$ .<sup>8</sup> The interaction between alcohol and comedy presentation (group drink vs. non-punchline comedy moments) emerged as statistically significant,  $B = 0.13$ ,  $Exp(B) = 1.13$ ,  $SE(B) = 0.04$ ,  $p = .001$ . Of note, when subthreshold punchlines were accounted for and parsed from non-punchline intervals of the comedy clip (see above section on “Hidden punchlines”), this interaction emerged as even larger in magnitude,  $B = 0.19$ ,  $Exp(B) = 1.20$ ,  $SE(B) = 0.05$ ,  $p < .001$ . Taken together, results suggest that, although in the current study alcohol's effects do not emerge specifically in response to punchlines, nonetheless the broader humorous setting may have an important influence on the alcohol effects observed herein.

## 4. Discussion

Harnessing analyses that allow for a nuanced consideration of the precise timing of events, the current study aimed to move towards a better understanding of alcohol's impact on response to both humor enjoyment in social context as well as social enjoyment more broadly. Specifically, using data drawn from one of the largest alcohol-administration studies, we examined the temporal patterning of participants' smiles as elicited in response to punchlines from a comedy routine—a paradigm that allowed us to isolate responses to controlled positive stimuli while also reflecting a structured social experience similar to those observed in many everyday drinking contexts. Results indicated a significant interaction between alcohol condition and epoch of the comedy clip in predicting the probability of smiling. Alcohol did not increase the likelihood of smiles of enjoyment elicited in response to the discreet positive stimuli of comedy punchlines. Instead, alcohol significantly increased the likelihood a participant would smile during times when no humorous content was being presented (non-punchline moments). Analyses further indicated that alcohol's effects at non-punchline moments of the comedy clip were likely not attributable to intoxicated individuals simply taking longer to understand the joke, or to these individuals responding to more mildly humorous content presented during non-punchline moments. Taken together, results suggest that alcohol might enhance social experiences not necessarily

<sup>7</sup>We wish to acknowledge the contribution of an anonymous reviewer, who suggested that we include the analyses contained in this section.

<sup>8</sup>When we examined the hazard of smiling within the context of this combined dataset, effects estimated for non-punchline moments differed slightly from effects estimated within the comedy clip dataset alone—differences that are likely attributable to the interplay of covariates (e.g., group members' smiles) in the new larger dataset. Note that, regardless of the covariates included in the model, the magnitude of the alcohol effect during non-punchline intervals of the comedy clip exceeded the magnitude of the alcohol effect during the group drink period.



**Fig. 1.** Effect of drink condition on the cumulative hazard of Duchenne smiling during punchlines, subthreshold punchlines, and non-punchline intervals. Time intervals that ended before a smile was initiated are represented by + symbol. All participants ( $N = 513$ ) listened to a Jerry Seinfeld comedy routine, a routine that included intervals coded as full punchlines, subthreshold punchlines, and non-punchlines. Immediately prior, these participants had been assigned to receive alcohol ( $N = 177$ ), placebo ( $N = 171$ ), or control beverage ( $N = 165$ ).

by making the good times even more enjoyable, but instead by altering experience during the moments “in-between.”

Given alcohol's powerful socially-enhancing effects (Fairbairn & Sayette, 2014), the current results suggest implications for how individuals extract meaning from social experience and inform their impressions of social pleasure. People identify alcohol as one of the factors that can most increase enjoyment of social context, with studies indicating that alcohol can cut by half perceived negative emotion and lead to feelings of social closeness even among strangers (Fairbairn & Sayette, 2014). Social interactions can involve a great deal of activity, requiring individuals to process an often quickly-moving conversation and extract meaning from jokes in real-time, and such active moments can constrain attention towards specific affective cues and also offer limited opportunity for reflection (Fiske & Taylor, 2017). Social settings may also involve less active moments when no jokes are being exchanged and conversation is less engaging. Such inactive moments can offer time for reflection and impose fewer constraints on attention, such that they might give rise to a variety of experiences ranging from boredom/anxiety to pleasure (Smallwood & Schooler, 2006). Research indicates that individuals often experience a sense of hypervigilance surrounding belongingness status in social settings, and these “quieter” moments might engender discomfort or anxiety (Leary & Kowalski, 1995). In contrast, in a mind less primed for anxiety and more open to pleasant meanderings, these moments might yield an enjoyable daydream or perhaps a chuckle over an internal joke. That is, while drinking alcohol, the party might “go internal,” flowing seamlessly from punchlines to interludes thanks to the lubricating effects of alcohol.

Results of this study also have implications for theories of alcohol's social rewards. While traditional alcohol theory has overwhelmingly focused on the study of alcohol's effects in response to discrete external cues (e.g., Greeley & Oei, 1999; Sayette, 1993), results of the current study emphasize that a complete understanding of alcohol's rewarding effects will require research that extends beyond the study of stimulus and response. In particular, by demonstrating that alcohol enhances experience specifically during moments characterized by low external stimulation, results of this study appear to offer support for theories emphasizing alcohol's ability to enhance mood in response to ambiguous social stimuli (Fairbairn & Sayette, 2014) as well as research pointing to alcohol's ability to enhance internally generated cognition (Sayette et al., 2009). Implications of this work specifically for alcohol myopia theory are also interesting, if somewhat more complex. As a framework for understanding alcohol reward, alcohol myopia theory emphasizes immediate responses to external cues and, to the extent to which such responses would be expected to manifest in a temporally

sensitive manner (Josephs & Steele, 1990), results of the current study did not provide support for alcohol myopia. It is worth noting that supplementary analyses comparing alcohol's effects during the group drink period revealed that alcohol increased smiling to a greater extent during the non-punchline period of the comedy clip than during a period of group interaction that involved no comedic stimulus presentation. One possible interpretation of this finding is that alcohol and humorous context may act together to generate a broader cognitive framework that lingers beyond the punchlines—thus, although the punchlines themselves do not yield an immediate alcohol effect, the broader humorous context is nonetheless important in contributing to the alcohol-reward observed therein. An alternative possibility is that confounding factors (e.g., order effects, the fact that we were not able to account for conversational content during the group drink period, etc.) account for differential effects of alcohol during non-punchline moments of the comedy clip vs. during the group drink period. Future research should further investigate these possibilities as a means of gaining a more nuanced theoretical understanding of alcohol's rewards in social context.

To our knowledge, this is the first study to track dynamic response patterns over time during punchline and non-punchline moments when evaluating humor enjoyment. Future research on this topic might vary the duration of refractory periods as well as the extent of stimulus presentation during these periods. Further, in the current research, consistent with social encounters observed in many everyday drinking settings (e.g., clubs, bars, large parties; Fairbairn & Sayette, 2014), we examined social contexts featuring unacquainted individuals. Future research should also examine effects within groups of familiar individuals. Finally, consistent with prior research (Gervais & Wilson, 2005; Ruch, 1994), we operationalize humor enjoyment as the Duchenne smile. Future research might also consider examining laughter, continuous behavioral measures, and self-reports.

In sum, the current study represents an initial foray into the examination of the means by which alcohol enhances social interaction. We present evidence that alcohol might enhance social experience by specifically increasing enjoyment during the less intrinsically entertaining moments in social context. Future research should employ a variety of paradigms and social configurations to further explore this question.

#### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jesp.2019.103903>.

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