Where to Look? Alcohol, Affect, and Gaze Behavior During a Virtual Social Interaction

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Abstract

COVID-19 forced social interactions to move online. Yet researchers have little understanding of the mental health consequences of this shift. Given pandemic-related surges in emotional disorders and problematic drinking, it becomes imperative to understand the cognitive and affective processes involved in virtual interactions and the impact of alcohol in virtual social spaces. Participants (*N*=246) engaged in an online video call while their gaze behavior was tracked. Prior to the interaction, participants were randomly assigned to receive an alcoholic or control beverage. Participants' affect was repeatedly assessed. Results indicated that a proportionally larger amount of time spent gazing at oneself (vs. one's interaction partner) predicted significantly higher negative affect after the exchange. Further, alcohol independently increased self-directed attention, failing to demonstrate its typically potent social-affective enhancement in this virtual context. Results carry potential implications for understanding factors that increase risk for hazardous drinking and negative affect in our increasingly virtual world.

Keywords: Addictive disorders, Drug/substance use, Social cognition, Eye movements, Affect.

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Self-focused attention is one of the most widely studied concepts in clinical psychology (Ingram, 1990; Mor & Winquist, 2002). Dysregulated self-focus has been linked to a variety of psychopathologies, with elevated levels of self-focus being theorized to contribute to the etiology of both internalizing (Bögels & Mansell, 2004; Clark & Wells, 1995; Mellings & Alden, 2000; Watkins & Teasdale, 2001) and externalizing disorders (Hull, 1981; Hull et al., 1986). Thus, researchers have long been interested in investigating both individual-difference and also contextual factors linked with the proportion of attention that is directed inwards toward the self vs. outwards toward the surroundings (Wood, Saltzberg, & Goldsamt, 1990).

Social contexts have provided particularly fertile ground for the study of self-focused attention (Flory et al., 2000; Hazem et al., 2017; Mellings & Alden, 2000; Vriends et al., 2017). As social beings, much of human life plays out in the company of others. Given the motivational salience of social relationships, the resulting concerns surrounding impression management can elicit especially high levels of self-focused attention during social interaction (Fenigstein, 1979). Levels of self vs. outward focus can vary widely at both the within- and between-person levels during social exchange, with such variability influencing both affective and social experience across both familiar and unfamiliar social spaces (Flory et al., 2000; Ingram et al., 1987; Leary & Kowalski, 1995; Mor et al., 2010; Nezlek, 2002; Wood, Saltzberg, Neale, et al., 1990; Zou et al., 2007). Individuals who experience chronically high levels of self-focus in social context are vulnerable to developing emotional disorders (Flory et al., 2000; Mor & Winquist, 2002). Further, clinical research reveals that individuals who direct attention toward the self during social interaction tend to experience heightened anxiety and depression as well as decreased social enjoyment (Clark & Wells, 1995; Ingram, 1990; Woody, 1996). As such, treatment

modalities aiming to promote outward-focused attention serve to enhance mood across a variety of contexts and so diminish negative mood (Mörtberg et al., 2015; Nix et al., 1995; Wells, 1990; Wells & Papageorgiou, 1998).

Given the widely-held belief that alcohol enhances mood in social context (Fairbairn & Sayette, 2014), it is perhaps unsurprising that research has tested the impact of alcohol on both self-focus and mood.[1] Hull and colleagues investigated the impact of drinking on self-focused attention during social exchange (Hull, 1981; Hull et al., 1983, 1986). His self-awareness model posits that alcohol's ability to diminish self-focused attention mediates alcohol's mood enhancing effects during in-person social exchange, thus potentially reinforcing consumption and undergirding the development of Alcohol Use Disorder (AUD).

Despite the theorized central role for self-focused attention in driving AUD and other forms of psychopathology, self-focused states have represented a challenge to capture in real-time (Hofmann, 2000; Vriends et al., 2017; Woody et al., 1997). Researchers have employed a variety of methods in an effort to assess self-focused states, including questionnaires (Boyraz & Kuhl, 2015; Mathews & Green, 2010), counts of self-focused pronouns within speech or writing (Brockmeyer et al., 2015; Hull et al., 1983; Wood, Saltzberg, & Goldsamt, 1990), facial expressions associated with self-presentational concerns (Fairbairn et al., 2013), and dot-probe paradigms assessing internal vs. external attentional focus (Mansell et al., 2003). While these techniques have contributed to our understanding of self-focused attention, each has limitations. Self-reports require awareness of a state that may often exist below consciousness (Rahal &

[1] The belief that alcohol enhances social interaction consistently emerges as the most strongly endorsed reason for consuming alcohol among drinkers (Cooper, 1994). However, alcohol can lead to a range of outcomes in social interaction, including aggression. Importantly, expressions of aggression don't necessarily imply a negative internal experience—e.g., see Fairbairn & Sayette (2014) for theory in which we link alcohol-related behavioral disinhibition, including aggression, to alcohol-related reductions in negative emotions during social exchange.

Fiedler, 2019), facial measures represent distal/indirect proxies of attention (e.g., Fairbairn et al, 2013), speech/prose-based techniques rely on active language production (Hull et al., 1983; Wood, Saltzberg, Neale, et al., 1990), and dot probe techniques have relatively low ecological validity (Mansell et al., 2003; Vriends et al., 2017). As such, researchers have sought alternative techniques for capturing the complex, sometimes automatic experience of attentional focus as it manifests during real-time social exchange.

Virtual Interaction: A Novel Social Paradigm

The spread of COVID-19 and the resultant proliferation of virtual modes of communication have offered a new paradigm for capturing self-focused attention. In an effort to halt the spread of COVID-19, the world plunged into a new mode of socializing (Marks, 2020; Sen-Crowe et al., 2020). For example, users of the online video call platform Zoom increased by a factor of 30 fold during the pandemic—burgeoning from 10 million in December 2019 to 300 million by April 2020 (Wiederhold, 2020). In short, COVID-19 has witnessed an explosion of online communications, a trend that seems likely to persist to at least some degree into the future (Almeida et al., 2020; Brown & Finn, 2021; Sawhill, 2020; Standaert et al., 2021). While many have embraced the potential of these novel social spaces, it is apparent that social experience in the virtual world can often differ substantially from experiences during in-person interaction (Morris, 2020). The pandemic has yielded a surge in levels of depression and anxiety and, given reports of heightened self-awareness and "fatigue" during virtual exchange, some have posited a role for virtual interaction in exacerbating such trends (Bailenson, 2021; Morris, 2020; Vriends et al., 2017). The online social world includes features that might alter cognitive/affective experiences and heighten self-consciousness, including random breaks or lags in conversation (e.g., due to connectivity or other technical issues) and a relative paucity of social information

(e.g., due to the limited view of interaction partners; Bailenson, 2021; Wiederhold, 2020). An additional notable feature of virtual interaction platforms is the integration of default views that depict a prominent video of the self (Wiederhold, 2020). Such self-views not only serve as a prominent cue to self-focused attention, but also, when combined with methods such as eye tracking for capturing attention in real-time, offer a distinctive, ecologically-valid paradigm for measuring the direction of attention during social exchange.

The shift to virtual modes of communication has marked not only professional interactions, but also casual exchanges occurring during leisure time, including interactions featuring alcohol consumption. Terms such as “zoomtail parties” and “quarantini hours” have entered the popular lexicon, as individuals presumably seek to ease the discomfort of online spaces through the integration of alcohol (Kelly, 2020; Smith, 2020). When consumed during in-person interactions, alcohol can exert robust positive mood-enhancing and negative mood-relieving effects (Sayette et al., 2012; see Fairbairn & Sayette, 2014 for a review). In contrast, alcohol’s effects during virtual exchange has received little attention. As noted, in many social spaces alcohol is thought to diminish self-focus and thus enhance mood (Hull, 1981; Hull et al., 1983). Interestingly, however, in the specific instance of a virtual meeting, there may be critical differences that affect the relation between alcohol and self-focus. Hull and Reilly (1983) specify, for example, that looking in a mirror enhances self-awareness and therefore potentially reverses alcohol’s effects. The sight of oneself on a video monitor during a virtual chat may well function like a mirror and therefore serve to suppress alcohol’s putative ability to reduce self-awareness and enhance mood. Further, and in line with alcohol myopia theory (Steele & Josephs, 1990), intoxication may lead one to focus on the most salient cues (presumably oneself), which would lead to the perhaps counterintuitive hypothesis that alcohol will serve to increase the time

that drinkers focus on themselves during a virtual interaction. However, to our knowledge, no research to date has examined alcohol's effects during online virtual interaction. In light of the increasing prevalence of alcohol use in virtual social spaces (Bochicchio et al., 2021; Pakdaman & Clapp, 2021; Palamar & Acosta, 2021) and the rise in AUD documented since the start of the pandemic (Kim et al., 2020; Sugarman & Greenfield, 2021; Yazdi et al., 2020), an exploration of alcohol's effects in the context of virtual social spaces is warranted.

The Current Study

The present research leverages eye-tracking technology to explore the relationship between affective states, alcohol consumption, and attentional focus during virtual social interaction.[2] In one of the larger experimental alcohol studies conducted to date (see Fairbairn et al., 2021; Fairbairn & Sayette, 2014 for reviews), we employed a virtual-call platform featuring video views of both self and the interaction partner, tracking gaze behavior in real-time as both familiar and also stranger dyads engage in unstructured social discourse. Although eye movements can offer critical information on social cognitive processes, to our knowledge only two studies have explored gaze behavior during in-vivo virtual interaction—both studies recruited relatively small participant samples and examined scripted interactions with a study confederate (Azriel et al., 2020; Vriends et al., 2017). The virtual interaction paradigm employed in the present research aimed to advance knowledge on both practical and conceptual levels. Although collected prior to the onset of COVID-19, data for this study might have important implications for social behavior during the pandemic. More specifically, in a world increasingly characterized by online social spaces, with some arguing that the switch to virtual social

[2] In this study we measure present-focused affective experience immediately preceding and following the virtual interaction. The primary interest in the current study is in the valence of the affective experience—i.e., whether participants' internal affective experience was broadly positive or negative following virtual social exchange.

encounters is here to stay, results might have direct implications for understanding patterns of affect and behavior in the wake of COVID-19 (Almeida et al., 2020; Brown & Finn, 2021; Sawhill, 2020; Standaert et al., 2021). At the same time, considered in light of research linking immediate affective responses to longer term mental health outcomes, such an investigation might ultimately yield conceptual insights surrounding links between self-focused attention and psychological disorder.

The aims of the current study were as follows: First, we aimed to explore the relationship between self-focused attention and affect in the context of virtual social exchange. In light of documented links between self-focused attention and negative affect, we hypothesized that individuals who spent a larger proportion of their time looking at themselves vs. their conversation partner would report higher levels of negative affect after the interaction, and further that these links would remain significant even after controlling for affect measured immediately prior to the virtual exchange. Second, we aimed to examine the effect of alcohol on self-focused attention and affect during virtual social exchange. Although research examining in-person interaction indicates alcohol might decrease self-focus and thereby enhance affect intensity (Hull, 1981; Hull et al., 1983), research examining the effects of alcohol in contexts featuring prominent self-referential cues similar to those observed in virtual social spaces suggests the opposite prediction might apply (Berman et al., 2009; Carey, 1995; Giancola, 2004; Hull & Reilly, 1983). Thus, we had no firm hypotheses surrounding the effect of alcohol on self-focus and affect in this novel virtual paradigm. Finally, an exploratory aim of the present research was to examine the extent to which the degree of self-focused attention was consistent across virtual social spaces featuring strangers vs. familiar conversation partners.

Methods

Participants

Participants were 246 social drinkers (average age = 22.04 years old, 56.1% female) between the ages of 21-30 years. Participants were recruited from the local Champaign-Urbana community from Fall 2018–Spring 2020. In line with national advisory council recommendations for the administration of alcohol in humans (1989), participants were excluded if they reported taking medication or having a diagnosis of a medical condition for which the consumption of alcohol is contraindicated (e.g., viral hepatitis, cirrhosis, cardiovascular disease, diabetes), a history of severe AUD or alcohol withdrawal, self-report of trying to cut down drinking out of fear of developing an AUD, reported prior diagnosis of severe mental illness (e.g., schizophrenia spectrum and other psychotic disorders or bipolar disorder), reporting having been admitted into residential treatment for substance use disorder, using depressant/sedative drugs in the past 30 days, and having an extreme BMI score (<18 or >35). Participants were required to report drinking alcohol regularly and to identify one same-sex friend who also met initial eligibility criteria. Data for this study were derived from a parent trial exploring the effect of social contextual factors on alcohol response, for which recruitment is ongoing (NCT03449095). Sensitivity analysis revealed the

Table 1
Characteristics of the study sample

	Total Sample *(N = 246)*
Beverage condition	
n(%) Alcohol	124 (50.4%)
n(%) Control	122 (49.6%)
Sex	
n(%) Male	108 (43.9 %)
n(%) Female	138 (56.1%)
Familiarity condition	
n(%) Strangers	124 (50.4%)
n(%) Friends	122 (49.6%)
Race	
n(%) White	164 (66.7%)
n(%) Black	18 (7.3%)
n(%) Asian	58 (23.6%)
n(%) Mixed Race	6 (2.4%)
Ethnicity	
n(%) Hispanic	41 (16.7%)
n(%) Not Hispanic	205 (83.3%)
Income	*Med*= $10k-15k *Ran*= <$5k - >$90k
Age (in years)	*M*=22.04 *SD*=1.609

Note. Med = Median; *Ran* = Range; *M* = Mean; *SD* = Standard deviation; k = thousand.

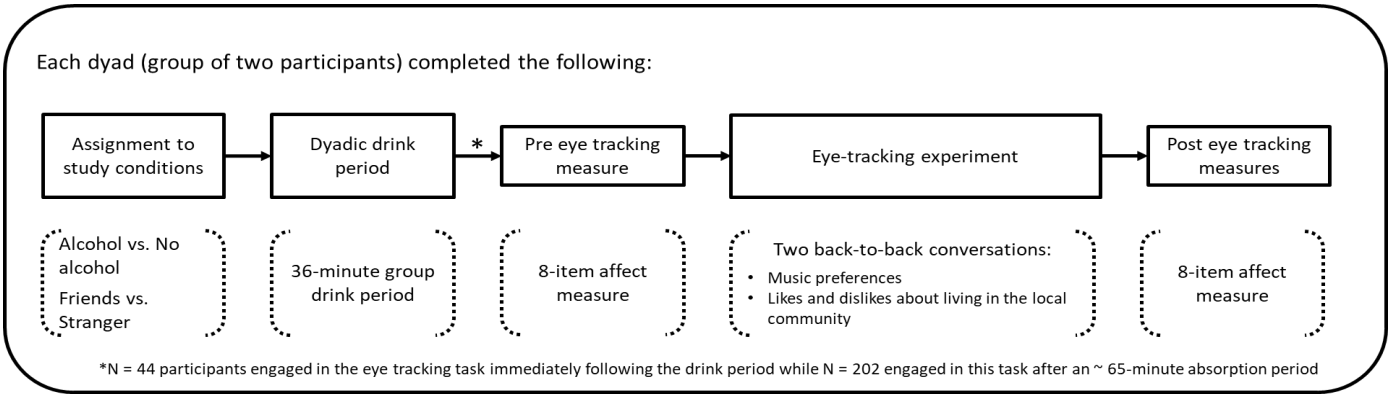
current study provided 80% power to detect small to medium-sized relationships between affect, alcohol consumption, and self-focused attention (Cohen's *f* range=.17-.18), assuming $\alpha = .05$. The sample size was determined prior to data analysis. Sample descriptives are provided in Table 1.

Study Procedure

Study procedures were approved by the University of Illinois at Urbana-Champaign Institutional Review Board. For an overview of study procedures, please refer to Figure 1. Further, for more information about the broader parent trial study procedures, please refer to the online supplement.

Figure 1

Procedural diagram of the study's experimental design.



Experimental procedures were completed in pairs. Two eligible friend dyads were invited to each experimental session (N = 4/session). On the day of their laboratory sessions participants were assigned to complete experimental procedures in the company of either their own friend (Friend Condition) or the friend of another participant (Stranger Condition; Ns provided in Table

1). To ensure no prior familiarity in the stranger condition, participants reactions were observed while they were individually and casually introduced at study initiation (see Sayette et al., 2012; Gurrieri et al., 2021; Kang et al., in press). During study sessions, each of the two dyads engaged in the below procedures in turn, with one of these dyads randomly assigned to complete experimental procedures ~1 hour after the other to ensure availability of experimental rooms and equipment.

Upon their arrival in the lab, participants' weight and height were measured, and a breathalyzer check was carried out to ensure a 0.00% BAC level prior to beverage administration. Participants then completed baseline questionnaires assessing their affect, attitudes, and personality in separate rooms. They were also administered a small meal roughly adjusted for their weight.

After completing baseline questionnaires, participants consumed study beverages in assigned pairs (see Fairbairn et al., 2018; Sayette et al., 2012 for similar procedures). Participants assigned to the alcohol condition received an alcoholic beverage intended to achieve a target peak BAC of .08%. The amount of alcohol administered was calculated using formulas accounting for the participant's age, sex, height, and weight (Watson et al., 1981). Participants assigned to the control condition received an isovolumic amount of a non-alcoholic soda beverage. Beverage doses were separated into three equal parts and participants were instructed to drink them over the course of 36 minutes, during which time they could interact freely. We did not include a placebo condition in this study (a condition where participants are told that they will drink an alcoholic beverage when in fact they are given a nonalcoholic drink) because previous research suggests that such a beverage manipulation can lead to unanticipated

compensatory behaviors in social contexts (Curtin & Fairchild, 2003; Fairbairn et al., 2015; Sayette et al., 2012; Testa et al., 2006; Vogel-Sprott & Fillmore, 1999).

After the beverage administration portion of the study, dyad members were escorted to separate rooms where they provided breathalyzer readings and completed several post-drinking questionnaires assessing affective and social experience. For those assigned to the alcohol condition, breathalyzer readings were taken at approximately 30-minute intervals to monitor BAC levels for the remainder of the visit.

Following the group drink procedure, participants engaged in the eye-tracking portion of the study. Dyads were assigned to engage in this task at the end of the drinking portion of the study either immediately following beverage administration or after an approximate 65-minute absorption period (see also Results section). [3] The eye-tracking task involved a video call completed in dyads, with dyad members seated in separate laboratory rooms to enable such a call. One of these rooms featured a desktop mount EyeLink 1000 Plus eye-tracker and a 20-inch monitor (1,600 × 1,200 resolution). This eye-tracker recorded data from one of the two participants at 1000hz. For standardization purposes both participants placed their head in a headrest which positioned their faces at an equivalent distance from the computer monitor and video camera. The participant's video call display was split, with exactly half of the screen displaying a video of the participant themselves ("self-view") and the other half displaying a video of their conversation partner ("other-view"). No other content was visible to participants on the screen. The headrests were positioned so that the display of both video feeds was the same

[3] At the outset of the study, we randomized equal numbers of participants into the immediate and delay conditions. However, in the latter half of the study, we prioritized integrating a delay that would allow participants to reach peak BAC and so fully absorb the dose of alcohol administered. Thus, more participants were randomized into the delay (N = 202) vs. immediate condition (N = 44). Note that BAC levels do not differ across these conditions.

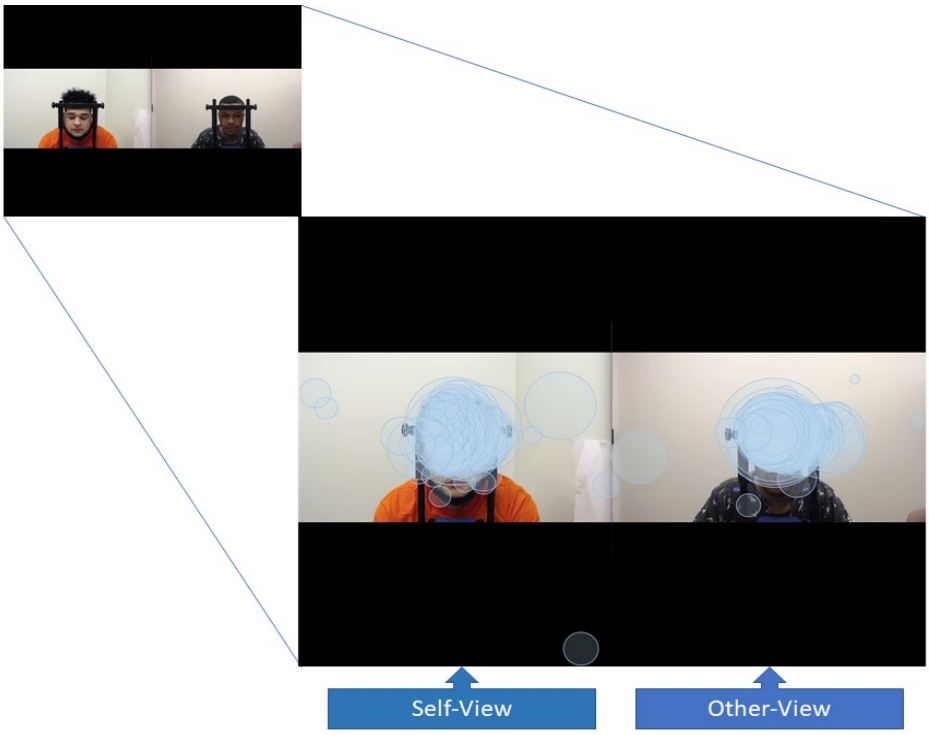
and standardized across participants (see Figure 2). The side of the screen (left vs. right) assigned to self-view vs. other-view was counterbalanced across participants.

Participants were instructed to position their heads such that the headrest hit at approximately mid-forehead and were asked to avoid moving their heads as much as possible during the call. Participants were informed that the purpose of the video call was to determine the effect of alcohol on visual response cues during everyday experiences. Each dyad engaged in two 4-minute-long conversations on relatively neutral topics, thus enabling the examination of gaze behavior in both members of the dyad successively. Conversation topics included music preferences (topic 1) and likes and dislikes of living in the local community (topic 2). The order of these conversations (topic 1 or 2) was counterbalanced across participants. In between conversations, the participants switched rooms such that eye-tracking data was captured from each dyad-member once (one track per participant).

Once the eye-tracking procedure was complete, participants engaged in additional tasks unrelated to the current experiment (see supplemental materials). Participants assigned to the control beverage condition were allowed to leave. Those who received alcohol were required to stay until their BAC dropped to a safe level (BAC 0.025%, typically 5-8 hours after the onset of beverage administration). Participants received $100 for completing the study.

Figure 2

Example screen view during virtual interaction with overlay of fixations on the screen.



Note. The above screenshot displays data from an example participant pair. The top left panel represents the display visible to participants during the exchange. The side of the screen corresponding to self-view vs. other-view was counterbalanced across pairs. Example eye-tracking data are displayed in the bottom right panel, with bubbles representing fixation durations. Participants displayed above consented to have their images shared.

Measures

Eye-tracking

Two main areas of interest were defined on the screen, the first being the self-view side, which corresponds to the section of the screen that displays a video feed of the self, and the second the other-view side, which corresponds to the section of the screen that captures a video feed of the other participant. Proportion fixation was defined as the amount of time in

milliseconds (ms) spent fixating on a specific screen area divided by total fixation time for the entire conversation. This measure was expressed in terms of a proportion to account for differences in track length and quality (note that proportion fixation for self-view vs. other-view side were non-independent but also non-redundant—see data analysis plan). Further, research findings generally indicate that eye tracking measures have good internal and test-retest reliability (Bargary et al., 2017; Ettinger et al., 2003; Klein & Fischer, 2005).

Affective Assessment

Participants' current affect was assessed at multiple times throughout the experimental session, including immediately prior to the eye-tracking experiment, and also after the eye-tracking experiment. Consistent with our prior research, we employed an 8-item questionnaire to assess positive and negative affective states in response to alcohol consumption (Fairbairn et al., 2015, 2018; Fairbairn & Sayette, 2013; Russell, 2003; Venerable & Fairbairn, 2020). This specific measure was selected as one that has demonstrated internal consistency within subscales and also validity in capturing alcohol's positive affect enhancing and negative affect relieving effects in prior research (see Fairbairn et al., 2018; Fairbairn & Sayette, 2013; Venerable & Fairbairn, 2020). A complete version of this questionnaire is provided in supplemental materials. In the context of this questionnaire, participants were asked to rate on a 6-point Likert scale from 0 (not at all) to 5 (extremely) the extent to which they are experiencing 8 different affective states in the present moment. The four negative and four positive items were averaged to create separate scales ($\alpha = 0.75$ for negative scale, $\alpha = 0.91$ for positive scale).

Data Analysis Plan

All data and analytic code required to replicate the results of this study can be found here: https://osf.io/tn7xd/?view_only=f66b89d2d9a04497bee046b2e98fc50d.[4] The aim of data analysis was to examine factors associated with: 1) time spent looking at the self vs. the interaction partner during a virtual social exchange; 2) participant affect measured immediately after the virtual exchange. Three-level multilevel models were employed to account for the clustering of observations within individuals and individuals within dyads. Importantly, for eye-tracking analyses, the proportion of fixations for self vs. other view were non-independent but also non-redundant, as participants also spent a small portion of time looking in directions outside these screen areas (e.g., blank portions of the screen; see Figure 2). Thus, screen area (self- vs. other-view) was incorporated as a within-subject factor in all analyses to avoid the confounding of total fixations with fixations for a specific area. Analyses examined post-conversation positive and negative affect, beverage condition (alcohol vs. control), and social familiarity (strangers vs. friends) as moderators of screen area (self- vs. other-view) in predicting proportion fixation time. The outcome of proportion fixation was non-normally distributed, and we thus employed hierarchical generalized linear modelling assuming a binomial distribution to account for the fixed trial length (Raudenbush & Bryk, 2002). Two-level multilevel models, accounting for the clustering of individuals within dyads, also examined the effect of beverage condition on positive and negative self-reported affect measured immediately after the virtual exchange.

We were not able to obtain eye-tracking data for four (1.6%) participants due to technical difficulties, and so data from these participants were excluded from fixation analyses.

[4] Data collection for this project spanned multiple years. Guidelines for open practice in clinical psychology have evolved considerably since this project was first launched. Although hypotheses for this study were formulated prior to analysis, they were not formally pre-registered.

Additionally, technical difficulties precluded us from collecting post-eye-tracking self-report affective data for one participant (0.4%), and this participant's data was excluded from affect analyses.

Results

Beverage Manipulation Check

Immediately following beverage administration, participants assigned to receive alcohol registered an average BAC of 0.071% (*SD* = 0.017). Participants who engaged in the virtual social exchange immediately after the group drink procedure registered an average BAC level of 0.075% (*SD* = 0.012; *N* = 44) at the midpoint of the virtual social exchange, whereas those who completed the virtual social exchange task after an absorption period registered a BAC level of 0.072% (*SD* = 0.015; *N* = 202). Of note, the mean BAC levels among those who completed the virtual social exchange task immediately after the drink period vs. after an absorption period did not differ significantly from one another, $t(122) = -1.03$, $p = 0.304$. Participants assigned to receive the control beverage registered 0.00% BAC following beverage administration.

Main Effect of Area of Interest on the Screen

Results indicated a significant main effect of screen area on proportion fixation time, $b = 2.49$, Odds Ratio (*OR*) = 12.06, 95%CI [2.31, 2.68], $t(364) = 26.51$, $p < .0001$, $N = 242$. Thus, results suggested that participants spent substantially longer looking at their conversation partner vs. themselves, with the odds of looking at the conversation partner being 12.06 times higher than the odds of looking at oneself during this social exchange.

Screen Area and Self-Reported Affect

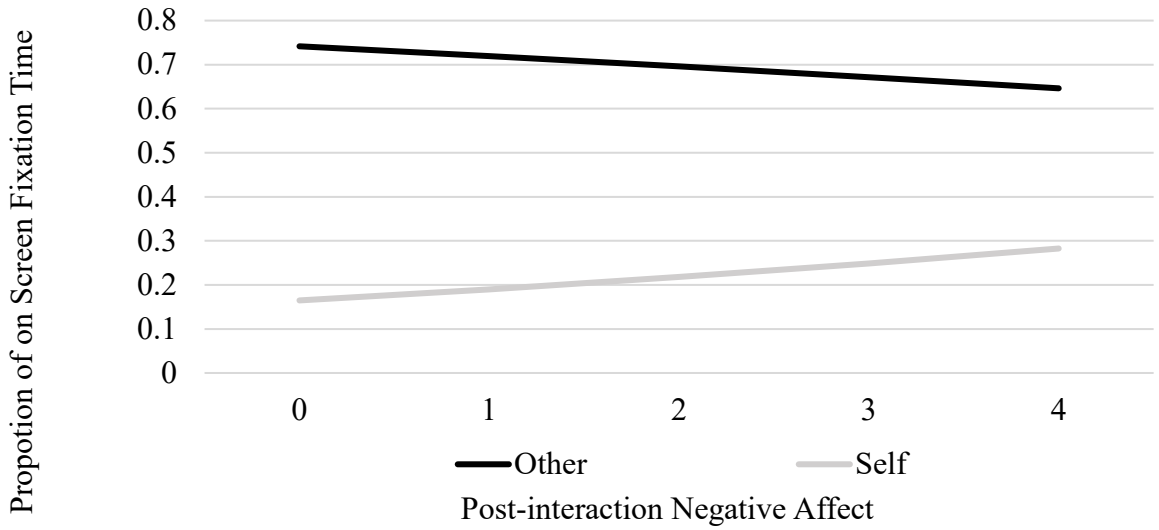
A significant interaction emerged between screen area and post-conversation self-reported negative affect in predicting proportion fixation time, $b = -0.29$, *OR* = 0.75, 95%CI [-

0.52, -0.06], $t(360) = -2.44$, $p = 0.015$, $N = 241$ (see Figure 3). Regardless of their affective experience post-conversation, all participants tended to spend a larger proportion of time looking at their conversation partner than at themselves during this virtual social exchange. However, the effect of screen area (other vs. self-view) was significantly smaller among participants who reported high levels of post-conversation negative affect, $b = 2.28$, $OR = 9.78$, 95%CI [2.03, 2.53], $t(360) = 17.89$, $p < .0001$, vs. those reporting low levels of negative affect post-conversation, $b = 2.68$, $OR = 14.59$, 95%CI [2.44, 2.92], $t(360) = 21.80$, $p < .0001$. Thus, among participants who reported low levels of negative affect post-interaction, the odds of looking at the conversation partner were 14.59 times higher than the odds of looking at oneself, whereas among participants who reported high levels of negative affect post-interaction, the odds of looking at the conversation partner were 9.78 times higher than the odds of looking at oneself. Importantly, this statistical interaction remained significant even after controlling for pre-conversation negative affect, $b = -0.29$, $OR = 0.75$, 95%CI [-0.52, -0.06], $t(359) = -2.44$, $p = 0.015$, $N = 241$, indicating temporal precedence in the relationship between self (vs. other)-fixation and negative affect. [Note that, in light of the gaze-based measure of self vs. other focus, direct manipulation of self-focus was not an option in the current study without skewing the interpretation of the outcome. See also discussion section.] There was no significant interaction between screen area and self-reported post-conversation positive affect in predicting proportion fixation time, $b = 0.03$, $OR = 1.03$, 95%CI [-0.12, 0.18], $t(360) = 0.38$, $p = 0.705$, $N = 241$.[5]

[5] Participants' responses to a brief version of the State Trait Anxiety Inventory were also assessed at the end of eye tracking (see supplementary materials).There was no significant effect of alcohol on this measure of anxiety, $b = 0.96$, 95%CI [-0.16, 2.07], $t(119) = 1.70$, $p = 0.091$ nor was there was a significant association between variability on this scale and proportion fixation time directed towards the self, $b = -0.02$, 95%CI[-0.07, 0.02], $t(360) = -1.13$, $p = 0.261$. Such a pattern of findings may suggest that results here apply to measures targeting negative affective experiences more broadly, rather than those aimed at targeting anxiety in particular (Sayette et al., 2001).

Figure 3

Proportion of on-screen fixation time as a function of post-conversation self-reported negative affect



Note. The above graph displays proportions. For results expressed in terms of odds, please see the text.

Screen Area and Social Familiarity

We next examined familiarity—whether participants completed study procedures in the company of a friend vs. a stranger—as a moderator of the proportion of time spent fixating on self vs. other screen view. There was no significant interaction between familiarity and screen area on proportion fixation time, b = -0.15, OR = 0.86, 95%CI [-0.52, 0.22], $t(363)$ = -0.80, p = 0.424, N = 242. These analyses indicated that participants spent a similar proportion of their time looking at themselves (relative to their conversation partner) regardless of whether they were interacting with a friend or a stranger.

Screen Area and Beverage Condition

There was a significant interaction between beverage condition and screen area in predicting proportion fixation time, b = -0.46, OR = 0.63, 95%CI [-0.83, -0.09], $t(363)$ = -2.44, p = 0.015, N = 242.[6] Although participants spent a larger proportion of time looking at their conversation partner (vs. themselves) in both beverage conditions, the difference between other- vs. self-fixation time was significantly smaller in the alcohol condition, b = 2.27, OR = 9.68 95%CI [2.02, 2.52], $t(363)$ = 17.63, $p < .0001$, vs. the non-alcohol condition, b = 2.73, OR = 15.33, 95%CI [2.46, 3.00], $t(363)$ = 20.05, $p < .0001$. In other words, individuals who consumed alcohol spent significantly more time looking at themselves (relative to their conversation partner) during the virtual social exchange compared to individuals who consumed a non-alcoholic beverage. More specifically, among participants drinking alcohol, the odds of looking at the conversation partner were 9.68 times higher than the odds of looking at oneself; while among sober participants, the odds of looking at the conversation partner were 15.33 times higher than the odds of looking at oneself. There was no three-way interaction between beverage condition, screen area, and absorption period on proportion fixation time, b = -0.49, OR = 0.61, 95%CI [-1.41, 0.43], $t(361)$ = -1.04, p = 0.297, N = 242, suggesting the size of the beverage condition by screen area interaction did not differ significantly according to the length of the absorption period following alcohol consumption. Of note, the interaction between screen area and both alcohol consumption, b = -0.49, OR = 0.61, 95%CI [-0.85, -0.12], $t(359)$ = -2.60, p = 0.010, N= 241, and also post-conversation self-reported negative affect b = -0.30, OR = 0.74,

[6] Of note, results of all primary analyses reported remained consistent when conversation topics (community vs. music) and the side of the screen on which the participant's own face appears (left vs. right) were included as covariates in the model. Specifically, there was still a significant interaction between beverage condition and screen area in predicting proportion fixation time when the two covariates were incorporated into the model, b = -0.46, 95%CI [-0.83, -0.09], $t(359)$ = -2.44, p = 0.015, N = 242; and there was still a significant interaction between screen area and post-conversation self-reported negative affect in predicting proportion fixation time when the two covariates were incorporated into the model, b = -0.29, 95%CI [-0.52, -0.05], $t(356)$ = -2.43, p = 0.015, N = 241.

95%CI [-0.53, -0.07], $t(359) = -2.57$, $p = 0.011$, $N = 241$, each remained significant in models in which both interactions were entered simultaneously, suggesting these two findings are non-redundant.[7]

Alcohol and Self-Reported Affect

We next investigated the effect of beverage condition on self-reported affect measured following the virtual social exchange. We found no significant effect of alcohol on self-reported positive affect, $b = 0.26$, 95%CI [-0.07, 0.59], $t(121) = 1.55$, $p = 0.123$, $N = 245$, or negative affect, $b = -0.04$, 95%CI [-0.25, 0.18], $t(121) = -0.33$, $p = 0.741$, $N = 245$, measured following the virtual social exchange. Results remained consistent in models controlling for pre-conversation affect, indicating no significant effect of alcohol on self-reported positive affect $b = -0.10$, 95%CI [-0.30, 0.09], $t(121) = -1.03$, $p = 0.304$, $N = 245$, or negative affect , $b = 0.13$, 95%CI [-0.01, 0.27], $t(121) = 1.87$, $p = 0.064$, $N = 245$. Additional models exploring the length of the absorption period as a moderator of these effects indicated a significant interaction between absorption period and beverage condition in predicting negative affect , $b = 0.68$, 95%CI [0.25, 1.10], $t(119) = 3.15$, $p = 0.002$, $N = 245$, with the effect of alcohol on negative affect reaching significance for those who engaged in the virtual exchange immediately after beverage administration, $b = -0.59$, 95%CI [-0.94, -0.24], $t(119) = -3.32$, $p = 0.001$, but not for those who engaged in virtual exchange after a delay, $b = 0.09$, 95%CI [-0.15, 0.32], $t(119) = 0.71$, $p = 0.480$. However, absorption period interaction effects did not reach significance in predicting post-conversation positive affect, or in positive or negative affect models controlling

[7] We ran an additional exploratory model to examine the three-way interaction between beverage condition, area of interest on the screen, and negative affect. Our results produced no evidence that beverage condition did not amplify the effects of self-focused attention on negative affect $b = -0.35$, $t(355) = -1.5$, 95%CI[-0.82, 0.11], $p = 0.135$.

for pre-conversation affective self-reports. Taken together, these findings revealed relatively weak affect-enhancing effects of alcohol within the context of this virtual social exchange.

Discussion

COVID-19 brought with it a radical shift toward the digital world, and the resulting trend towards virtual interaction seems likely to endure (Almeida et al., 2020; Brown & Finn, 2021; Sawhill, 2020; Standaert et al., 2021). In light of pandemic-related changes in drinking and also emotional wellbeing, there is now a critical need to better understand cognitive and affective processes during virtual exchange, and alcohol's effects in these novel social spaces. The current study was the first to examine the relationship between self-focused attention, affect, and alcohol in the context of an unstructured virtual social interaction. Results indicated that, on average, participants spent substantially longer looking at their conversation partner vs. themselves during an internet-based video call. Findings revealed a significant relationship between gaze direction and negative affect, such that those who spent especially large proportions of their time gazing at themselves vs. their conversation partner reported higher levels of negative affect following the virtual exchange. This relationship remained consistent even in models controlling for self-reported affect measured prior to the social exchange, pointing to temporal precedence in the relationship between self-focus and negative affect. Additionally, results revealed that, relative to sober participants, those consuming alcohol spent more time looking at themselves and less at their conversation partners in these virtual interactions, and further that the powerful mood-enhancing properties of alcohol that are typically observed in in-person interaction (see Fairbairn & Sayette, 2014) did not emerge in this online forum.

This study adds key evidence to the existing body of research indicating powerful links between self-focused attention and negative affect (Flory et al., 2000; Mor et al., 2010; Mor &

Winquist, 2002; Nezlek, 2002; Wood, Saltzberg, Neale, et al., 1990). In one of the first studies to examine the relationship between self-focused attention and affect in the context of virtual social interaction, we leveraged a continuous, automatic measure of attentional focus and a novel interaction paradigm with a productive real-world analog. Results revealed that individuals who spent a larger proportion of time gazing at their own image during the virtual interaction experienced an increase in negative affect during the call. When considered together with prior research linking self-focus to the etiology and maintenance of various internalizing disorders, results may have utility for understanding the role of self-focus in the development of more lasting negative affective states. In addition, by identifying prominent self-referential cues and the resulting internal focus as one potential factor driving negative affect during virtual interaction, results may also have implications for understanding factors exacerbating internalizing symptoms in the context of the current pandemic (Bailenson, 2021; Wiederhold, 2020). The consistent integration of self-view was required for the interpretation of our automatic eye-tracking measure of self-focus, and thus the present paradigm did not lend itself to direct manipulation of the prominence of self-referential cues. Nonetheless, using novel methods and measures, it identifies promising avenues for future research exploring a potential causal link between self-focus and affect.

Results of this study also carry conceptual implications for the understanding of alcohol's effects on self-awareness in virtual social interactions. Although past research has explored the effect of alcohol on attentional focus using gaze measures (Fernie et al., 2012; Monem & Fillmore, 2019; Silva et al., 2017; Weafer & Fillmore, 2013), no previous research has examined the effect of alcohol on attention processes in online social exchange. Results of the current study indicated that, in the presence of a strong draw to a self-referential external cue (the prominent

self-view video feed), alcohol enhanced self-focus, which is the opposite effect compared to what one would otherwise expect during an *in-person* social exchange when alcohol's putative ability to reduce self-awareness would lead to enhanced affective experience (Hull, 1981; Hull et al., 1983; Hull & Reilly, 1983). While prior work shows that alcohol increases positive affect and decreases negative affect during in person interactions (Sayette et al., 2012), the absence of the typical affect-enhancing properties of alcohol during this virtual exchange unearths a more complex social process that is potentially at play. Specifically, results point to the possibility that alcohol's reinforcing properties are less pronounced in online social contexts, with the presence of prominent self-referential cues representing one potential factor contributing to alcohol's diminished affect-enhancing effects in this virtual setting. It remains unclear how such a muted effect of alcohol might function in a post-COVID world that includes considerable opportunities for virtual interactions (e.g., might some people choose to drink greater quantities of alcohol in order to try to recapture the rewarding social effects they experienced during in-person settings?; Schuckit, 1994). Future research might explore the extent to which such muted alcohol responses correspond to trajectories of drinking behavior over time.

Limitations and future directions should be noted. An exploratory aim of the present study was to examine the effect of social familiarity on gaze behavior. One possible explanation for non-significant familiarity effects observed in the current study is the group beverage-administration period held prior to the virtual social exchange, during which strangers would have gained some (albeit minor) level of acquaintance. Future research may re-examine such dynamics by exploring interactions between strangers who meet for the first time in the context of the virtual interaction. Future research might also explore stranger and familiar interactions involving more than two people. Furthermore, we did not include a measure assessing the level

of perceived attractiveness of one's conversation partner, a factor likely to have influenced the direction of participants' gaze. Future research efforts may want to consider incorporating such a measure to explore interacting effects of affect, alcohol, and attractiveness perception on fixation times. In the same vein, even though both participants were fitted with an identical eye-tracking head mount, we cannot rule out the possibility that the added novelty of this head mount may have influenced the eye tracking results. Future research may consider using more novel eye tracking set-ups that do not require a head mount to determine replicability of our results. Additionally, although the gaze-based measure employed here does represent a measure likely to capture important variability in self-focus, self-focused attention might nonetheless manifest in a divergent manner across individuals and contexts (i.e., towards elements of the self aside from those that would be represented visually, or even towards elements of the visual self aside from the face). Future studies might explore this possibility further by employing a multidimensional approach to capturing self-focused attention. Also noteworthy is the fact that our sample consisted of primarily young adults (who tend to be generally well-versed in online interactions and technology) and was predominantly White (66.7% of the sample). Our study was not well powered to explore differences across individual racial sub-groups. Future research might productively explore the extent to which effects captured here generalize across races, cultures, and age groups. Furthermore, one interesting potential avenue of research would be to replicate this study's findings in a clinical sample of individuals reporting symptoms of social anxiety – especially in light of the solid evidence that people with social anxiety are more likely to consume alcohol in social settings. (Abrams et al., 2001; Kushner et al., 1994). Finally, this study assessed alcohol's social-cognitive effects at two time periods, with the majority of participants being examined following an alcohol absorption period. This design enabled examination of

alcohol's effects on social interaction across both the rising limb of the BAC curve and also following the acquisition of peak BAC. Nonetheless, future research might focus on alcohol's effects at alternative points on the BAC curve—e.g., examining a larger proportion of participants on the ascending BAC limb, during active alcohol consumption, or while BAC is descending.

In summary, this study's novel paradigm allowed for the examination of social-cognitive processes during an online exchange involving alcohol. Results inform knowledge of cognitive-affective links in online contexts and may further carry implications for understanding drinking patterns and negative affect in our increasingly virtual world. We hope this work motivates further research using state-of-the-science attentional measures to explore the implications of the shift to online modes of social engagement.

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Author Contributions

T. Ariss and Dr. C. E. Fairbairn both made substantial contributions to the conception, design, analysis and interpretation of data and contributed to the writing and intellectual content of the article. Dr. S. Brown-Schmidt contributed to the conceptualization and execution of the eye tracking procedures and supervised the processing and analysis of the eye tracking data. T. Ariss directly oversaw the research and carried out the data analysis, with supervision from Dr. C. E. Fairbairn. Dr. M. A. Sayette helped with the interpretation of data and contributed to the writing of the introduction and discussion. B. Velia aided in running participants and provided revisions on the manuscript. Dr. H. Berenbaum aided in the conceptualization and interpretation of affect-related findings in this project. All authors have approved the final manuscript.

Supplementary Materials

8-item affect measure (8AM)

This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent you feel this way at the present moment.

	Not at all					Extremely
	0	1	2	3	4	5
Cheerful	□	□	□	□	□	□
Annoyed	□	□	□	□	□	□
Upbeat	□	□	□	□	□	□
Sad	□	□	□	□	□	□
Irritated	□	□	□	□	□	□
Happy	□	□	□	□	□	□
Bored	□	□	□	□	□	□
Content	□	□	□	□	□	□

Measures and Procedures

This experimental design is part of a large-scale, multi-year data collection effort involving many components and measures. The current study represents among the first reports to emerge from this large-scale study, focusing on one core secondary task—the eye-tracking procedure and accompanying virtual interaction. Data collection for this larger parent study is still ongoing (NCT03449095), although data collection for specific secondary tasks, including the eye-tracking task as well as the previously integrated EEG task (Kang et al., in press), concluded in March 2020 with the onset of the COVID-19 pandemic. An analysis of all measures and tasks involved in this large-scale, multi-year data collection effort is outside the scope of the current study. However, for the sake of completeness, we list in this document all measures collected and tasks carried out as of December 2018-March 2020 (the period of time during which data for the current study was collected).

Study Visit Structure

Baseline Questionnaires

Upon arrival at the lab, participants were invited to complete a battery of baseline questionnaires assessing their personality, attitudes, quality of friendship, and drinking behaviors. Measures included the following: demographics, NIAAA 5-question set for assessing alcohol consumption (2018), DrInC (Miller et al., 1995), CAST-6 (Hodgins et al., 1993), DMQ-R (Cooper, 1994), a one-item closeness measure, PAM (Starzyk et al., 2006), URCS (Dibble et al., 2012), an 8-item relationship closeness and satisfaction measure, a one-item measure of self-confidence in the relationship, ECR-RS (Fraley, 2005) , NEO-FFI (Costa & McCrae, 1989), UPPS-P (Lynam et al., 2006), NPI-16 (Ames et al., 2006), SDO (Pratto et al., 1994), IUS (Freeston et al., 1994), SIAS (Mattick & Clarke, 1998), NTBS (Leary et al., 2013), SCS–R (Scheier & Carver, 1985), PANAS (Watson et al., 1988), STAI (Heimberg et al., 1992), and BAES (Martin et al., 1993). Participants also completed the IAT (Greenwald et al., 1998) and a feeling thermometer questionnaire during that time (Zavala-Rojas, 2014). See also Sayette et al (2012) for a similar baseline questionnaire battery. As affect and alcohol were the focus of our study aims, we do not include analyses of baseline measures in the current report.

Alcohol administration

Then, and depending on the beverage and familiarity conditions, participants were escorted with a stranger or a friend to the group drinking room where they were given an alcoholic or a non-alcoholic beverage. Over the course of 36 minutes, each pair drank their beverage dose (separated into three equal parts) and engaged in an unscripted social interaction (see main manuscript and also Gurrieri et al., 2021 for more information).

Post-Drinking questionnaires

After the group drink procedure, participants completed post-drinking questionnaires. Measures included the following: 8AM (Fairbairn et al., 2015; Fairbairn & Sayette, 2013), BAES, STAI, PGRS (Kirchner et al., 2006), a one-item closeness measure, IOS (Aron et al., 1992), and BAC levels. They then engaged in either the eye-tracking experiment or an electroencephalogram (EEG) experiment (and this depended on the length of the absorption period)—see also main manuscript for description of absorption period and delay condition assignment. In the delayed condition, participants completed the EEG experiment first then the eye-tracking experiment, whereas for those in the immediate condition, this sequence was flipped. Of note, the EEG experiment was the only major study task completed by participants prior to the eye-tracking experiment.

EEG experiment

During the EEG experiment, participants completed two oddball tasks involving viewing images of beverage cues as well as images of faces. In the idle time during EEG setup, participants engaged in a brief vigilance task (approx. 5 minutes) designed to test the speed with which participants respond to visual stimuli. Participants' BAC levels were measured during and after the EEG experiment was completed. At the end of the EEG experiment, participants completed a set of questionnaires which included 8AM, BAES, STAI. A full description of EEG procedures can be found in Kang et al. (in press).

Eye tracking Experiment

For more details on the eye tracking tasks, please refer to the main study manuscript. After the completion of the eye tracking task, participants watched a short (3-minute) video aimed at providing a distraction, reported their memory for the virtual conversation, provided a BAC measurement, and completed brief self-report questionnaires: 8AM, BAES, and STAI.

Eyewitness and Stroop Experiments

Next, participants took part in an eyewitness task and a Stroop task completed in a group format. Lastly, participants' BACs were assessed again and they completed one final set of questionnaires: 8AM, BAES, STAI, closeness measure, and IOS Scale.

Study Conclusion

At the end of the study visit, participants were debriefed and were given compensation as well as a list of local mental health resources. Their BAC levels were monitored until they were at levels deemed safe to leave the laboratory.

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