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Attentional and Approach Biases to Alcohol Cues among Young Adult Drinkers: An Ecological Momentary Assessment Study

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Alcohol-specific attentional biases (AttB) and approach biases (AppB) are postulated to play a role in alcohol use disorders but their association with drinking in young adults remains unknown. A subsample of young adults with risky alcohol use (N=296) enrolled in a randomized trial testing different text message interventions completed weekly tasks via a mobile app for up to 14 weeks: Alcohol Stroop was used to measure AttB and Approach-Avoidance Task was used to measure AppB. Participants also provided reports of their alcohol consumption up to twice per week. We analyzed feasibility of measuring alcohol biases on mobile phones, whether repeated testing and conditions of testing affected mean reaction times, and whether mean AttB and AppB scores were associated with baseline alcohol use severity and same-day binge drinking (4+/5+ drinks per occasion for women/men). Task completion decreased from 93% on week 1 to 39% by week 14 with a mean of 8.2 weeks completed. Mean reaction times for Alcohol Stroop decreased over weeks assessed. Reaction times to Stroop and Approach-Avoid tasks were longer when participants reported distractions or after alcohol and/or drug use. Mean AttB and AppB scores were not associated with baseline drinking, and within-day fluctuations of AttB and AppB scores did not predict same day binge drinking. Barriers to measuring alcohol biases in the natural environment include learning effects, contextual influences of distractions and prior alcohol/drug use, and absence of robust associations of reaction times to alcohol cues with either baseline or same-day alcohol consumption.

KEYWORDS: alcohol; young adult; implicit bias

FIGURES: 2

TABLES: 4

Public Health Significance: We found that there are numerous challenges to measuring attentional and approach biases to alcohol cues from young adults in the natural environment. We also found that attentional and approach biases measured in the natural environment are not associated with alcohol use severity or event-level drinking amount.

Risky alcohol consumption in young adults, primarily in the form of binge drinking (consuming 4+/5+ drinks for women/men on a single occasion), is a preventable public health problem (Kanny et al., 2018). Theoretical models, such as the incentive sensitization model (Robinson & Berridge 1993) and dual-process model (Wiers et al., 2007; Koob & Volkow, 2010) suggest that repeated exposure to drugs such as alcohol and concomitant positive experiences strengthen automatic approach tendencies toward alcohol-related cues, which in turn increases alcohol consumption. The associations of automatic processes with alcohol consumption have been mixed (Field et al., 2016) and their role among young adults uncertain (Lannoy et al., 2014). Therefore, greater understanding of the role of automatic processes in event-level alcohol consumption by young adults is needed.

One paradigm for understanding automatic processes related to alcohol consumption is the addiction Stroop task (Cox et al., 2006). When the addiction Stroop is designed to measure alcohol-related attentional biases (AttB), individuals are randomly presented with an alcohol-related word or matched neutral word and instructed to rapidly select the color in which the word is printed. Slower color-naming for alcohol words is interpreted to indicate that the alcohol words capture the attention of an individual with AttB. In one study, young adult college students showed increased attentional bias to alcohol cues compared to neutral cues using the Stroop task, which was associated with drinking intensity (Hallgren & McCrady, 2013). Subsequent systematic review has called into question the predictive validity of AttB for alcohol consumption outcomes (Christiansen et al., 2015).

Another paradigm for understanding automatic processes related to alcohol is the Approach-Avoidance Task (AAT) (Rinck & Becker, 1998; Wiers et al., 2009). For the AAT, individuals are presented with alcohol-related pictures or matched neutral pictures and are instructed to either make a symbolic movement toward (i.e. approach) or away (i.e. avoid), such that the image either gets larger (when approaching) or smaller (when avoiding). Faster approach movements to alcohol pictures are interpreted to indicate that the individual has automatic tendencies to be attracted to or approach alcohol cues (i.e. AppB). There is some evidence that AppB may be predictive of alcohol consumption in adolescent drinkers (Peeters et al., 2012) and in older treatment-seeking individuals with alcohol dependence (Martin Braunstein et al., 2018), but evidence is mixed (Field et al., 2016) and little is known regarding how AppB varies among non-treatment seeking young adults.

To objectively measure automatic processes, investigators have typically measured reaction times (RTs) on computerized tasks administered in laboratories to make inferences about underlying cognitive processes. Limitations of lab paradigms include the inability to represent ecological validity or understand temporal variability in task performance based on the current state of the individual. These temporal variations are postulated to be key in understanding how automatic processes to alcohol cues are influenced by situational factors and how the automatic processes in-turn predict proximal alcohol consumption (Field et al, 2016).

Capturing ecologically valid measures of alcohol biases can be accomplished with ecological momentary assessment (EMA) methods (Stone & Shiffman, 1994). In young adult populations, EMA has been used to examine relationships between situational cognitive factors like positive mood (Dvorak et al., 2018) and expectancies (Lee et al., 2018) with event-level alcohol consumption. Although no prior study to our knowledge has examined the temporal relationship between AttB or AppB and event-level alcohol consumption in young adults, several studies have examined these relationships among individuals with drug dependence. For example, in one study, individuals who relapsed with heroin exhibited a larger AttB and AppB to drugs than did non-relapsers and AttB increased before relapse (Marhe et al., 2013).

We designed a smartphone application (i.e. MATCH app) that deploys Alcohol Stroop and AAT, records RTs, and sends data weekly to a central server. We used smartphones given smartphone ubiquity among young adults (Pew Research Center, 2018) and availability of embedded sensors allowing precise RT measurement to touchscreen tasks (Kay et al., 2013). We leveraged the infrastructure and protocol of a randomized trial testing different text message interventions (clinicaltrials.org NCT02918565).

We invited young adults (ages 18-25) who screened positive for at-risk drinking to enroll in a sub-study where, each Thursday for 14 weeks, they were prompted to complete the Alcohol Stroop and AAT through MATCH app on their personal smartphone. To assess feasibility, we examined the completion of the two tasks over 14 weeks and self-reported naturalistic testing conditions (e.g., number of distractions). To assess learning effects, we examined change in RTs over weeks of task completion. To assess construct validity, we assessed the between-person associations of mean AttB and AppB with baseline alcohol use (i.e. AUDIT-C score, drinks per drinking day (Bradley et al. 2007). To assess predictive validity, we assessed the within-person associations of AttB and AppB with event-level binge drinking. We hypothesized that there would be higher odds of binge drinking when there were elevated AttB and AppB to alcohol cues. Real time assessment of attentional and approach biases in the natural environment could have important implications for identifying heightened risk for binge drinking and intervening with optimized "just-in-time" interventions to reduce the probability of alcohol-related negative consequences.

Materials and Methods

Study Overview

Young adult emergency department (ED) patients who were not seeking help for their drinking but screened positive for at-risk alcohol consumption and enrolled in a randomized trial testing five unique text message interventions (N=359) opted in to a sub-study where they were asked to complete the Alcohol Stroop and AAT through a smartphone app (i.e. MATCH app) once per week for 14 weeks. All participants provided written informed consent. This study was approved by the university's institutional review board. The study obtained a Certificate of Confidentiality from the National Institute on Alcohol Abuse and Alcoholism.

Participants

Recruitment. From November 2017 to November 2018, a convenience sample of patients aged 18 to 25 years who presented to an urban ED were identified using an electronic patient tracking system. Following introduction by a member of the care team, young adults who were medically stable, not impaired by drugs or alcohol based on clinical judgement of the care team and not seeking treatment for alcohol use were approached by research staff and provided consent to complete a questionnaire including assessments of alcohol use severity.

Study Eligibility. Young adults with an Alcohol Use Disorder Identification Test for Consumption (AUDIT-C) score of ≥3 for women or ≥4 for men (Bradley et al. 2007), and who reported at least one binge drinking episode in the prior month were eligible. Young adults were excluded if they reported past treatment for drug or alcohol use or current medical treatment for psychiatric disorders.

Procedures

Overview. Procedures and intervention conditions closely followed pilot study procedures (Suffoletto et al., 2019). In the ED, eligible participants completed a baseline assessment and were oriented to the MATCH app tasks. During the brief orientation, participants were shown how to download the MATCH app, provided with a unique ID, and directed through a sample of the Alcohol Stroop and AAT. Following ED enrollment, on the two days per week they typically drank alcohol, participants were prompted via text messaging to report drinking plans and desire to get drunk. The two days were selected based on the days with the highest average drinking reported in the timeline follow-back calendar (i.e. TLFB; Sobell et al., 1996). The following day, participants were prompted to report the number of standard drinks they consumed the prior day. During a 2-week run-in period, no feedback was provided. Only those participants who completed at least half of these assessments and opted in to the master trial after 2-weeks continued the text message assessments and MATCH app tasks for 12 more weeks.

Each Thursday at 3pm, participants would receive a text message telling them to open the MATCH app to complete their weekly tasks. We chose to send the prompt at 3pm as we expected this to be before onset of typical weekday drinking episodes. The 3pm message also said that after completing the tasks, $6 would be added to their debit card. After the MATCH app was opened, the participant was presented with a landing page stating whether the two tasks were available, and if so, participants were instructed to press start to begin. The two tasks take roughly 3 minutes total to complete. The app also allowed participants to track their progress and see their cumulative earnings (see Supplemental material online for screenshots). Participants were given until Sunday at midnight to complete the tasks, after which time the app, if opened, would not present tasks (until the next assessment period). This cutoff time was set to minimize the interval between task completion and subsequent drinking episodes and to reduce potential for temporal variability.

Measures

Demographic characteristics. At baseline, participant reported their age, sex (coded 0=female; 1=male), race (coded as 0=Caucasian/white, 1=African American/black, 2=Asian; 3=mixed), and education (coded as 0=no college; 1=college enrolled).

Baseline Alcohol Use Patterns. As part of screening, all participants completed the AUDIT-C. In baseline assessments, participants were presented with a web-based calendar and a visual reference displaying standard drink amounts and were asked to report their alcohol consumption by day using the Time Line Follow Back (TLFB; Sobell, et al. 1996). A standard drink was defined as 12 oz. of beer; 5 oz. of 12% table wine; 12 oz. of wine cooler; or 1.25 oz. of 80-proof liquor. Using the 30-day TLFB, we coded the number of days when a binge drinking episode (≥4/5 standard drinks for a woman/man) was reported and computed the mean drinks per drinking day as total drinks consumed divided by the number of days with any alcohol consumption.

Stage of Change. At baseline, we used the Alcohol Ladder (Clair et al., 2011) to measure an individual's motivation to change their drinking. The Alcohol Ladder is a visual analog scale that consists of 10 rungs, each with a corresponding statement (e.g. "I never think about changing the way I drink, and I have no plans to change"). We coded responses to fit the stage of change (SOC) continuum (pre-contemplation, contemplation, preparation, action, and maintenance) (see Prochaska et al., 1983).

Alcohol-Stroop Task. The Addiction Stroop was used to assess AttB to alcohol words (Cox et al., 2006). Our Stroop task consisted of 2 blocks of 10 alcohol-related (e.g. vodka) and 10 neutral clothing (e.g. jeans) words (c.f., Hallgren & McCrady, 2013) presented in 4 different colors (blue, green, red, or yellow), for a total of 20 trials during which the participant was instructed to rapidly indicate the color of the word presented on the screen by tapping the appropriate colored box (see Appendix for screenshot). At the start of each trial, the participant was required to place a thumb on each side of the screen. This design feature was incorporated in attempt to ensure phone landscape orientation and equal distance to all four corners where color response options were displayed. Once thumbs were sensed, for 500 ms, the screen displayed a plus sign in the center of the screen followed by the randomly selected word and color. The position of the color response buttons on the screen varied for each stimuli. Stimuli remained on the screen until a response was given or after a timeout period of 3000 ms. If the response was incorrect or slower than 3000 ms, a red "X" appeared on the screen for 500 ms. Following a choice or time-out, there was a 200 ms post-trial pause with a blank screen followed by the next stimuli. Stimulus-response RTs were calculated as the time between stimulus presentation and first contact of finger within the borders of a color selection block. In a recent study by Spanakis et al. (2018), the Alcohol Stroop had acceptable reliability when administered on the smartphone in naturalistic environments.

Alcohol Attentional Bias (AttB) score. For the Alcohol Stroop task, there were 119,720 stimuli-response pairs recorded across all weeks. Following the cleaning procedures outlined in Field et al. (2009), trials with incorrect responses were discarded (n=2040), stimulus-response RTs<250 ms were discarded (n=18), and trials with stimulus-response RTs >3 standard deviations above the mean were discarded (n=4384). The internal consistency reliability coefficient for alcohol stimuli was 0.88 and for neutral stimuli was 0.88. AttB score was computed by subtracting each session's mean neutral RT from mean alcohol RT, so that a positive value indicated that participants took longer to identify the color in which alcohol-related words were presented during the task (Waters et al., 2009).

Approach Avoidance Task. We created an approach-avoidance task (AAT) similar to Martin Braunstein et al. (2018) and Kersbergen et al., (2015) by combining the Relevant Stimulus-Response Compatibility (R-SRC) task in which alcohol content is the relevant feature for categorizing the pictures (Barkby et al., 2012), and similar to the AAT (Wiers et al., 2009), in which a joystick is used to categorize pictures and pictures zoom in/out to reflect approach/avoidance. Our AAT task included two blocks; each block consisted of 28 test trials. A different instruction of how to respond to each stimulus (alcohol, office supplies) was given at the beginning of each block. In one block, individuals were instructed to swipe alcohol-related images toward themselves (i.e. approach) while swiping neutral/office supply images away from themselves (i.e. avoid). In another block, individuals were instructed to swipe alcohol-related images away from themselves (i.e. avoid) while swiping neutral/office supply images toward themselves (i.e. approach). After a 3 second countdown, the screen displayed a plus sign in the center of the screen for 500 ms followed by the randomly selected picture. Stimuli remained on the screen until a response was given or after a timeout period of 3000 ms. If the response was incorrect or slower than 3000 ms, a red "X" appeared on the screen for 500 ms. Following a choice or time-out, there was a 200 ms post-trial pause with a blank screen followed by the next stimuli. Stimuli that were relevant to United States drinkers were taken from Martin Braunstein et al. (2018) and Pronk et al. (2015). Stimuli were presented one by one and appeared in a quasi-random order (maximum three consecutive pictures of the same category or format). Pushing a picture away went along with a decrease in picture size, whereas pulling a picture closer resulted in an increased size (zoom-effect). Stimulus-response RTs were calculated as the time between stimulus presentation and first contact of finger to swipe.

Alcohol Approach Bias (AppB) score. There were 83,804 stimuli-response pairs recorded for the avoid block and 85,640 stimuli-response pairs recorded for the approach block. Again following the cleaning procedures outlined in Field et al. (2009), AAT trials with incorrect responses were discarded (n=28,275), stimulus-response RTs<250 ms were discarded (n=140), and AAT trials with stimulus-response RTs >3 standard deviations above the mean were discarded (n=7964). The internal consistency reliability coefficient for both approaching and avoiding alcohol stimuli was 0.77. AppB score was computed by using the following formula:

(RT avoid alcohol – RT approach alcohol) - (RT avoid neutral –RT approach neutral) (MacLeod et al. 2002; Wiers et al., 2009). A resulting positive value indicates participants that are faster to approach than avoid alcohol cues, relative to the speed at which they can approach and avoid control cues. We chose not to use the "D-score" algorithm (Greenwald et al., 2013) given published concern about biased results due to distribution of error (Blanton, Jaccard, Burrows, 2015) and our own examination of how it amplified outliers in our dataset.

EMA Survey. At the completion of the Alcohol Stroop and AAT, participants were directed to a brief survey with response options pre-defined to identify sessions with sub-optimal testing conditions. We first asked about the number of distractions or interruptions while completing the tasks [0,1, 2, 3, >3]. We then asked about location where the tasks were completed [quiet room; noisy room; outside; in a motor vehicle; other]. Finally, we asked if any alcohol was consumed in the 4 hours prior to task completion [yes; no], and if any drugs were used in the past 24 hours [yes; no].

Event-Level Drinking Quantity. Using EMA data, we coded the number of standard drinks consumed the previous day as a count value from 0 to 40.

<u>Data Analyses.</u>

All data analyses were performed using Stata 14.0 (StatCorp LP, College Station ,TX). We included only the 296 participants who downloaded the MATCH app and completed Alcohol Stroop and AAT tasks on at least one occasion over the 14 week sampling period in analyses. To assess feasibility, we first examined the mean number of tasks completed over 14 weeks. We explored baseline participant factors (i.e. age, sex, race, education, AUDIT-C scores, stage of change) associated with mean number of completed tasks in univariate linear models. We used general linear models with generalized estimating equations (Hardin & Hilbe, 2001) to examine whether there were learning effects over time in mean RTs. We explored potential within-person correlation structures and determined that an exchangeable correlation structure fit the data. We analyzed the impact of distraction (0=none; 1=any) and any drug/alcohol (0=none; 1=any) on mean RTs using Student t-tests. To assess construct validity, we calculated the within-person means of AttB and AppB scores and used a correlation matrix and univariate linear models where baseline AUDIT-C score and drinks per drinking day were the dependent variables and mean AttB and AppB were the independent variables.

To assess predictive validity and test our hypothesis that within-person AttB and AppB scores are predictive of same day binge drinking, we first matched occasions when drinking quantity was reported less than 24 hours after task completion and participants reported no alcohol consumption prior to completing tasks. Mixed effects logistic regression models were fit to the data to disaggregate between- and within-person variance (Curran & Bauer, 2011). We entered two versions of AttB and AppB into random-effects models: a mean value of AttB and AppB for each person (i.e., person-mean) and a deviation of AttB and AppB from the person-mean (delta AttB/AppB), which represents whether a change in AttB/AppB on a given day from what was typical for the participant was predictive of binge drinking (0=no; 1=yes). We explored potential within-person correlation structures and determined that an exchangeable correlation structure fit the data. Within-subject variables included AttB (Model 1) or AppB (Model 2). Between-subject variable included alcohol use severity (i.e. AUDIT-C score).

RESULTS

Sample Characteristics

Participants (n=296) were a diverse sample of young adults (mean age=22.0 years, SD=2.0; 26% underage drinkers (<21 years), mainly female (69.6%), 49% black or mixed race and around a third (38%) currently enrolled in college (Table 1). The mean number of binge drinking days in the past month was 3.2 (SD=4.6) and the mean number of drinks per drinking day was 3.6 (SD=1.8).

Task Completion

As shown in Figure 1, the percentage of completed tasks decreased over the 14 weeks from 93% to 39%. No baseline participant characteristics were associated with task completion. 30.5% of tasks were completed the same day as the reminder prompt (i.e. Thursday), 31.0% on Friday, 15.2% on Saturday and 23.3% Sunday. As shown in Figure 2, tasks were completed mostly between 3pm and 10pm.

Reaction Times to Task Stimuli and Practice Effects

The distributional properties of RTs to alcohol and neutral stimuli in Alcohol Stroop and AAT tasks are shown in Table 2. Mean RTs for Alcohol Stroop are faster than RTs for AAT tasks and faster for alcohol AAT stimuli than neutral AAT stimuli. GEE models, which were used to examine learning effects, indicated that mean RTs decreased over occasions for Alcohol Stroop stimuli, but not for AAT stimuli, shown in unadjusted beta values (Table 2). In separate GEE models examining AttB and AppB, there were no changes in mean scores over time.

Testing Conditions

Participants reported any distractions or interruptions on 60% of the tasks, with frequent disruptions (i.e. >3 interruptions) occurring rarely (<1% of time). RTs were higher when any distraction was reported for AAT tasks, as shown in Table 3. In terms of location where tasks were completed, 44% were completed in a quiet room, 36.5% in a noisy room, 6.5% outside, 8.6% in a motor vehicle, and 4.8% somewhere else. As may be expected, there were lower rates of distractions when in a quiet room (38.6%) compared with all other conditions (67.7%-79.7%). Participants also reported completing tasks after drinking alcohol 16% of the time and other drug use 20.8% of the time. Alcohol and drug use were associated with longer RTs for both Alcohol Stroop and AAT tasks, also shown in Table 3.

Construct Validity

To understand whether the within-person mean scores for AttB and AppB relate to baseline drinking variables, we examined a correlation matrix and found no significant correlation between AttB or AppB and AUDIT-C score or drinks per drinking day.

Predictive Validity

There were 702 SMS drinking quantity reports completed within 24 hours following task completion from 219 participants when drinking did not occur before task completion. The 702 reports included 425 (60.5%) days with no drinks, 151 (21.5%) days with a low-risk drinking episode (1-3/4 drinks for women/men), and 126 (18.0%) days with a binge drinking episode (4+/5+ drinks for women/men). As reported in Tables 4 and 5, at the daily-level, deviations of

AttB and AppB from an individuals' average scores were not significant predictors of a binge drinking event. At Level-2, higher AUDIT-C scores were associated with higher odds of binge drinking. When we examined only those tasks where the participant did not report any prior drug use, alcohol use or distractions (n=227 tasks), we did not find deviations of AttB and AppB from an individuals' average scores to be significant predictors of a binge drinking event.

DISCUSSION

In this study, we examined the measurement of attentional and approach biases to alcohol cues in the natural environment among a diverse group of non-treatment seeking young adults with risky drinking. Partially supporting our hypothesis that it would be feasible to measure attentional and approach biases using smartphones in the natural environment over a sampling period of 14 weeks, a mean of 8 weeks of Alcohol Stroop and Alcohol Approach-Avoidance reaction time data were captured. Although no prior studies have asked individuals to complete Alcohol Stroop or AAT for this intensity or duration, completion rates were similar to prior studies of young adult populations asked to complete weekly web-based surveys (Barber et al., 2016).

Feasibility challenges include increasing missing data over time, distractions while completing tasks in the natural environment, and psychomotor impairment due to drug and/or alcohol use prior to task completion. Despite these feasibility issues, internal reliability and stimuli-response reaction times were within the range of prior lab-based studies (Lusher et al., 2004; Hallgren & McCrady, 2013). Also, although we found some evidence of practice effects in reaction times to the Alcohol Stroop task, these faster reaction times did not result in significant changes to alcohol bias scores over time. Although we did not specifically measure why users completed or missed completing the app tasks, methods for reducing missing data could include increased incentive strategies such as points or monetary rewards. Methods for reducing the deleterious effect of distractions on task performance (Fernandez & Moscovich, 2000) could include use of phone sensors that only allow task completion when phone is stationary and without ambient noise.

We found that mean attentional or approach biases were not robustly related to baseline alcohol consumption variables in this sample of young adult risky drinkers. We also did not find support for our hypothesis that within-person alcohol attentional and approach biases predicted subsequent same-day drinking quantity. One interpretation of these findings is that attentional and approach biases to alcohol cues might not be significantly related to alcohol use among young adult at-risk drinkers due, in part, to relatively moderate level of alcohol use severity. In other words, being motivated to consume alcohol might not strongly alter the way in which alcohol cues influence attentional orienting among young adult risky drinkers. This interpretation fits with prior work in this population (Sharma et al., 2001), and with the idea that automatic neurobiological pathways are not as influential at this stage of development (Koob & Volkow, 2010). Another interpretation is that the chosen tasks and/or modality for testing biases on a mobile phone were not sensitive enough to detect alcohol biases. Future work should test the validity of these app tasks in a controlled setting. Employing methods for either reducing the high within-person variability in reaction times to stimuli or improving the sensitivity of detecting cue-related reactions using innovative techniques such as eye tracking (Krafka et al., 2016), and/or using alcohol targets presented within a larger array of multiple distractors (Pennington et al., 2019) could possibly be useful. A third possibility is that there is heterogeneity in responsiveness to alcohol cues masking underlying differences between sub-groups. For example, a prior study found that subgroups of young adults who have certain genotypes may be especially susceptible to alcohol cues (Kim et al., 2019).

We note several limitations of this study. First, we relied on self-report of prior day recall of drinking quantity, which could have resulted in under- or over-estimation of prior-day drinks consumed. This limitation could be reduced by objectively measuring alcohol content using portable biosensors (Luczak et al., 2018). Related, we did not record onset of drinking time, which could have resulted in Alcohol Stroop and AAT being completed after drinking onset, which has shown to alter AttB scores (Schoemakers et al., 2008) but not AppB scores (Junger et al., 2017). Second, participants were exposed to different text message interventions over the sampling period which could have influenced both their alcohol biases and drinking quantity. Given that the trial is still blinded, we are not able to comment on or measure these effects yet. Third, we used semantic and pictorial alcohol representations that had previously been validated for this population, but these may be outdated or those less commonly encountered in modern young adult drinkers in the US. Fourth, we noted a swiping error rate of 34% in the AppB task, which may be due to over-sensitivity of the software program to finger movements. Fifth, we only were able to measure event-level alcohol consumption two days per week and may have missed drinking days when EMA did not occur. Finally, we did not measure internal and external factors which may influence inhibitory control such as direct exposure to alcohol-related cues (see Fatseas et al. 2015). Future studies should seek to assess other situational predictors which could influence alcohol biases.

To conclude, the present study identifies the opportunities and limitations of mobile measurements of attention and approach biases to alcohol among young adults. Despite the higher than desired rates of attrition over 14 weeks, sub-optimal testing conditions in the natural environment, and learning effects over time, mobile measures of attentional and approach biases appear feasible. We did not find that reaction times to alcohol stimuli were associated with baseline alcohol use or event-level drinking quantity. Future work should explore ways to improve the sensitivity of naturalistic alcohol bias measurement.

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