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In-the-moment drinking characteristics: An examination across ADHD history and race

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Abstract

Background—Adults with a history of childhood attention-deficit/hyperactivity disorder (ADHD) and Black drinkers are at elevated risk for alcohol problems and alcohol use disorder. Processes that increase risk for these distinct populations have not focused on in-the-moment behaviors that occur while drinking. The present study examined in-the-moment drinking characteristics (i.e., location, social context, day, time, drink type, speed of consumption) that may differ for individuals with and without ADHD histories or for Black and White drinkers. We also examined the interplay among these in-the-moment drinking characteristics to further understanding of contexts when risk may be momentarily increased.

Methods—As part of a larger study, 135 individuals ($M_{\text{age}} = 27.81$, 69.6% male, 45.9% ADHD, 69.6% White) completed a 10-day ecological momentary assessment protocol that included self-initiated reports following consumption of an alcoholic drink. Hypotheses were tested using multilevel modeling.

Results—Controlling for multiple demographic covariates, Black drinkers drank significantly more quickly than White drinkers and were more likely to consume hard liquor-containing beverages. Differences in drinking speed remained significant when adjusting for Black drinkers' greater likelihood to consume liquor-containing beverages and momentary experience of discrimination; however, Black drinkers' increased likelihood to consume liquor-containing beverages was no longer significant when adjusting for momentary experience of discrimination. Individuals with ADHD histories did not differ from those without ADHD histories in any in-the-moment drinking characteristics. ADHD and race did not interact to predict any drinking characteristic.

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Conclusions—Differences in speed of alcohol consumption and propensity to consume liquor containing beverages may contribute to increased risk for alcohol problems experienced by Black drinkers compared to White drinkers.

Keywords

racial differences; attention-deficit/hyperactivity disorder; alcohol; drinking characteristics; ecological momentary assessment

Introduction

Problematic alcohol use is costly and prevalent (Rehm et al., 2009). Identifying in-the-moment characteristics of risky drinking may ultimately reduce the negative consequences of use by pinpointing malleable intervention targets associated with adverse drinking outcomes. The current study examined these characteristics (i.e., location, social context, day, time, drink type, speed of consumption) among two distinct groups at heightened risk for alcohol problems: adults with histories of childhood attention-deficit/hyperactivity disorder (ADHD) and Black drinkers.

ADHD and alcohol use problems

ADHD affects about 7% of children (Thomas et al., 2015), and symptoms persist into adulthood for approximately 60% of these children (Sibley et al., 2017). Childhood ADHD is associated with more alcohol problems (e.g., Pedersen et al., 2016) and higher rates of alcohol use disorder (AUD) in adulthood (Groenman et al., 2017; Lee et al., 2011). Multiple explanations for these associations have been posited (Molina & Pelham, 2014), including: elevated trait impulsivity (Pedersen et al., 2016); the existence of a single externalizing spectrum comprising ADHD, conduct disorder, antisocial personality, and AUD comorbidities (Beauchaine, Zisner, & Sauder, 2017; Serra-Pinheiro et al., 2013); and shared genetic liability (Derks, Vink, Willemsen, Van Den Brink, & Boomsma, 2014; Jacob et al., 2006). Although these broad, genetically driven factors contribute significant risk for substance use, that risk likely manifests day to day through micro-level processes such as momentary, contextual drinking characteristics – in other words *how, where, when, and with whom* individuals drink. Studies characterizing the manner in which individuals with ADHD drink are particularly needed considering those with ADHD do not necessarily drink *more frequently* or *more heavily* than those without ADHD (Lee et al., 2011). Rather, individuals with ADHD appear to experience more problems with alcohol than individuals without ADHD at lesser or equivalent levels of drinking. It may therefore be the contextual factors associated with their drinking or behaviors within a drinking episode (e.g., whether individuals tend to drink more quickly or during the work week, which may potentiate more problems) that account for this paradox.

Differences between Black and White drinkers in alcohol problems

Despite substantial heterogeneity in drinking patterns and outcomes amongst Black drinkers (Mulia, Ye, Karriker-Jaffe, Zeng, & Jones-Webb, 2018), on average, Black drinkers tend to have higher rates of morbidity and mortality from alcohol (e.g., Shield et al., 2013) and are at elevated risk for experiencing alcohol-related problems (social, physical, and legal)

compared to White drinkers (e.g., Herd, 2015; Keyes et al., 2012; Mulia et al., 2009), even at equivalent levels of use (Zemore et al., 2016). Zapolski, Pedersen, McCarthy, and Smith (2014) proposed a theoretical model that integrated cumulative life stressors, discrimination, historical context, and neighborhood factors as well as individual differences such as sensitivity to alcohol to understand processes that may place certain Black drinkers at elevated risk for alcohol problems. Zemore and colleagues (2016) found support for an environmental component of this theoretical model demonstrating that lower SES and exposure to prejudice and discrimination partially accounted for the elevated alcohol problems in Black versus White drinkers. Further, these differences in SES and discrimination are embedded in alcohol-related marketing targeting Black drinkers, which may further increase risk for alcohol problems (Rose et al., 2018). Importantly, examining individual factors that may increase risk for Black drinkers given the more general environmental context is necessary. Specifically, examining in-the-moment drinking behaviors for Black drinkers within real-world drinking environments that may differ from White drinkers' may further elucidate why this population experiences disproportionate problems compared to White drinkers, especially given the aforementioned heterogeneity amongst Black drinkers in drinking patterns, habits, and context of use.

Additive effects of risk for Black drinkers with ADHD—Adults with ADHD histories, as well as Black drinkers, each have elevated risk for alcohol problems, but as described above, the possible reasons for their risk are conceptually distinct. A persistent limitation of the literature on risk for alcohol misuse is the examination of these risks in isolation. For example, in a meta-analysis of prospective ADHD risk for substance use, 12 of 27 studies did not describe the samples' racial composition, and 9 of the remaining 15 included samples over 90% White (Lee et al., 2011). The lack of research on Black individuals with ADHD is particularly problematic since there are pronounced disparities in alcohol outcomes between Black and White drinkers, and combined risk could be especially difficult to manage (e.g., overlaying poor cognitive control on repeated experience of discrimination). With no data addressing this topic directly in the literature, exploration of this possibility is warranted.

In-the-moment drinking behaviors: a potential mechanism for increased risk—The disproportionate level of alcohol problems experienced by individuals with ADHD and Black drinkers may in part be explained by *how* these individuals drink. For instance, individuals with ADHD often have relationship difficulties (McQuade & Hoza, 2008) and less regular employment (Hechtman et al., 2016), which may correlate with drinking alone, at home, during the day, and on weekdays – drinking patterns that diverge from typical patterns of use (Lau-Barraco, Braitman, Stamates, & Linden-Carmichael, 2016; Muraven, Collins, Morsheimer, Shiffman, & Paty, 2005; Piasecki et al., 2011; Simons, Gaher, Oliver, Bush, & Palmer, 2005) and may be more likely to cause problems (e.g., interfering with job or familial responsibilities). Moreover, the impulsivity inherent in ADHD and a tendency to overestimate how much time has passed (Barkley et al., 2001) are two qualities which may result in rapid consumption of alcoholic beverages. For example, individuals with higher impulsivity report more loss of control over drinking (Wardell, Quilty, & Hendershot, 2016).

Research measuring in-the-moment drinking behaviors among adults with and without histories of ADHD is needed to test these possibilities.

There is also a dearth of research on racial differences in in-the-moment drinking characteristics. Some findings suggest that compared to White drinkers, Black drinkers report typically consuming liquor-containing beverages rather than wine/beer (Chung, Pedersen, Kim, Hipwell, & Stepp, 2014; Grant & Dawson, 1997; Graves & Kaskutas, 2002; Siegel, Naimi, Cremeens, & Nelson, 2011) and are more likely to drink in public venues versus at home (Herd & Grube, 1993; Nyaronga, Greenfield, & McDaniel, 2009). However, this research is based on retrospective report. Research examining racial differences across drinking characteristics in real time in the natural drinking environment is needed to determine whether global (i.e., not in-the-moment) retrospective reports accurately represent actual drinking behavior for Black drinkers. For example, it is unknown whether Black drinkers consume their alcoholic beverages more quickly than White drinkers and if this is driven by an increased likelihood of consuming liquor as opposed to beer. Additionally, higher rates of unemployment in the Black population (Bureau of Labor Statistics, 2016) may be associated with more weekday versus weekend drinking and more day versus evening drinking, but this has not been tested. These in-the-moment drinking characteristics are mutable and may be amenable to intervention and prevention efforts, such as educating at-risk individuals on which drinking contexts to avoid or how to better pace their drinks.

EMA and drinking characteristics—Momentary methods, like ecological momentary assessment (EMA), may be particularly important for studying in-the-moment drinking characteristics, because they capture different aspects of behavior – and different rates of drinking – than standard self-report (see Shiffman, 2009, for review). Momentary assessment methods in substance use research have revealed stark differences in substance use patterns compared to global reports; for example, global reports of motives for use correspond little to not at all with momentary reports of behavior (Otsuki, Tinsley, Chao, & Unger, 2008; Piasecki, Hufford, Solhan, & Trull, 2007). For instance, in a study of adolescent cigarette smokers, whereas retrospective reports suggested that negative mood precipitated smoking episodes (Mermelstein, 1999), real-time EMA data showed that adolescents were in fact not smoking at times when their mood was more negative (Richmond, Mermelstein, & Metzger, 2012). Further, EMA studies have illuminated typical drinking habits: alcohol use usually occurs on evenings and weekends (Piasecki et al., 2011), at bars, in individuals' homes or at the homes of others, and in the presence of others (Muraven et al., 2005; Piasecki et al., 2011; Simons et al., 2005). EMA, therefore, has the potential to identify whether high-risk drinkers deviate from these norms.

Additionally, understanding how day-to-day drinking behaviors differ from individuals' average, global trends would help identify which types of behaviors may place individuals at risk *when they are drinking* and could inform personalized treatment targets. For example, EMA affords the opportunity to examine interactions between contexts and in-the-moment behaviors, as some drinking characteristics may vary dependent on the context in which they occur (e.g., individuals may drink more quickly dependent on their location). Using EMA to characterize in-the-moment drinking behaviors has additional advantages over retrospective self-report, including reducing recall bias (Ekholm, 2004; Gmel & Daepfen, 2007),

capturing more accurate estimates of alcohol consumption (Searles, Helzer, Rose, & Badger, 2002), and limiting overgeneralizations from specific behaviors that may vary across setting (e.g., beverage type, consumption rate).

Given the demonstrated utility for EMA in understanding substance use generally, and specifically related to in-the-moment characteristics, such methods are clearly needed to understand substance use in the at-risk populations examined here; however, EMA has not been employed to understand in-the-moment drinking behaviors among individuals with ADHD or Black drinkers. EMA research may be especially important for individuals with a history of ADHD given their difficulties with accurate reporting on retrospective, global measures (Hoza et al., 2002). The current study is also uniquely poised to preliminarily explore the possibility that the combined risk of having a history of ADHD and being a Black drinker create higher risk than for either group alone.

Current study—The current study examined differences between drinkers with and without ADHD histories and Black versus White drinkers in in-the-moment drinking characteristics using EMA. Drinking characteristics included when, where, and with whom drinking occurred, as well as what type of drink was consumed and how quickly. These variables were selected as they may increase risk for alcohol problems. Specific hypotheses were: 1) Drinkers with ADHD histories would more often drink alone, at home, during the day, on weekdays, and would drink more quickly than drinkers without ADHD histories; 2) Black drinkers would more often drink away from home, during the day, on weekdays, drink more quickly, and be more likely to consume beverages containing hard liquor compared to White drinkers. Given the possible multiplicative effects of having ADHD and identifying as Black, we secondarily explored the possibility of an interaction between ADHD and race such that drinkers with ADHD histories who are Black, compared to Black drinkers without ADHD and White drinkers, would be the most likely to drink during the day, on weekdays, and drink more quickly. A separate aim of the current study was focused on examining the interplay between context and in-the-moment drinking characteristics. Specifically, how quickly someone drinks may be dependent on the drinking context or type of beverage consumed. Therefore, we examined differences in speed of consumption based on beverage type, and where, when, and with whom drinking occurred. We hypothesized that individuals would drink more quickly when drinking beverages containing hard liquor versus beer/wine. We did not have a priori hypotheses for speed of consumption based on any of the other drinking contexts or differences in these associations across ADHD history or race.

Materials and Methods

Participants

Participants were recruited from the Pittsburgh ADHD Longitudinal Study (PALS; 55 ADHD, 38 nonADHD) and from the community (68 ADHD, 81 nonADHD). Participants were required to be current drinkers (past month use) aged 21–36, and to have consumed an amount of alcohol commensurate with the amount to be administered in a laboratory challenge as part of the broader study (target peak breath alcohol concentration [BrAC]=.08) in the past 6 months. Exclusion criteria included prior/current substance treatment or

attempts to limit drinking, weight over 250 pounds, pregnant or breast feeding, serious medical or psychiatric illness, and current medication contraindicating alcohol use. Finally, to limit group differences in acute alcohol tolerance, participants with and without ADHD histories and across racial groups were matched at recruitment on self-reported past-month drinking behavior.

The full sample that completed the EMA protocol comprised 231 individuals (75.3% male, 49.8% ADHD, 32.9% Black). Twenty-one community-recruited participants lacked informant report of ADHD and were excluded. Seventy-three participants did not report drinking alcohol during the EMA portion of the study and were excluded. Lastly, we excluded 2 participants who did not identify as Black or White. The final sample included 135 individuals ($M_{\text{age}} = 27.81$, 94 [69.6%] male), 62 with childhood ADHD (45.9%) and 41 Black (30.4%). Sixteen participants were Black with childhood ADHD, 46 White with childhood ADHD, 25 Black without ADHD, and 48 White without ADHD.

Study design

Study procedures were approved by the Institutional Review Board at the University of Pittsburgh; all participants provided informed consent.

Participants began a 10-day EMA protocol the Friday after their second laboratory beverage session (i.e., alcohol administration protocol). Participants used their personal or a study smartphone and received in-person instruction on responding to prompts and completing drinking reports. Participants logged alcoholic drinks by self-initiating a post-drink EMA questionnaire. Given increasing intoxication throughout a drinking episode and concern about decreased reliability, post-drink reports were limited to a maximum of four drinks per episode to balance comprehensiveness and accuracy. (Prior research limited post-drink reports to two drinks/episode out of similar concerns; see Ray and colleagues, 2010.) Compensation was based on the proportion of daily prompts completed, up to \$110 for 80% completion or greater. If under 80%, compensation was commensurate with percentage completed (e.g., 50% completion received \$55).

Measures

Childhood ADHD (0=nonADHD, 1=ADHD).—PALS-recruited participants with ADHD were diagnosed with ADHD in childhood based on *DSM-III-R* or *DSM-IV* criteria through parent and teacher symptom rating scales (Disruptive Behavior Disorder Rating Scale; DBD; Pelham, Gnagy, Greenslade, & Milich, 1992), and a semi-structured diagnostic parent interview. PALS-recruited participants without ADHD comprised a demographically matched comparison sample to the ADHD group, with the added exclusion criterion of current or historic ADHD. (For additional details about PALS, see Molina et al., 2017).

Community-recruited participants and an informant (e.g., parent) completed a phone screen that included an 18-item rating scale of *DSM-IV* ADHD symptoms in childhood (Molina et al., 2017). Childhood ADHD was considered present if 1) 6 or more symptoms were present prior to age 12 as reported by the participant and separately by the informant, or 2) both participant and informant reported an ADHD diagnosis in childhood. Participants were

included in the nonADHD group if they and their informant endorsed 5 or fewer symptoms prior to age 12 and an absence of childhood ADHD diagnosis.

Demographics.—Participants self-identified their race (0=White/European American; 1=Black/African American), sex (0=male; 1=female), and age.

Education.—Participants reported their highest level of education attained on the following scale: 1=less than high school graduation, 2=high school graduate or GED, 3=some college, 4=college graduate, 5=post-graduate training.

Employment.—Participants reported their employment status where 0=employed, 1=unemployed.

Income.—Participants estimated their income in dollars on the following scale: 1=under 10,000, 2=10,000–24,000, 3=25,000–39,000, 4=40,000–54,000, 5=55,000–75,000, 6=76,000–100,000, 7=more than 100,000. Income was included in models as a continuous covariate.

In-the-moment drinking characteristics

Time of drinking occurrence.—Post-drink assessments were date-stamped upon initiation; day of week and time of day were extracted. Time of day was dichotomously classified into morning/afternoon (6:00 a.m.–5:59 p.m.; 0), and evening (6:00 p.m.–5:59 a.m.; 1). A dichotomous *weekend* variable indicated whether drinks were consumed during the week (0) or on the weekend (4:00 p.m. Friday–5:59 p.m. Sunday; 1). Weekend thresholds were based on Piasecki and colleagues (2011), but began slightly earlier on Friday to capture drinking behaviors that might start earlier given the conclusion of the work week.

Type of drink.—Participants were asked, “What type of drink did you consume?” with the options beer, wine, malt liquor, hard liquor shot, and mixed drink. Type of drink was dichotomized to reflect whether a participant drank beer/malt liquor/wine (0) or a liquor-containing beverage (1).

Speed of consumption.—As soon as possible after completing an alcoholic drink, participants answered the question, “How long did it take you to drink [the beverage]?” endorsing one of the following time increments in minutes: 1=<2, 2=2–5, 3=6–10, 4=11–15, 5=16–20, 6=21–25, 7=26–30, 8=31–45, 9=46–60, 10=>60. This measurement of speed of consumption improves upon prior research where participants reported drink duration at the end of each day (Quinn & Fromme, 2012).

Social context.—Participants responded to the question, “In the past 15 minutes, who have you been with?” with the options: no one, romantic partner/spouse, family member, friend/acquaintance, boss/teacher, coworker, roommate, other. The variable was dichotomized to reflect whether the drink was consumed alone (1) or with others (0).

Location.—Participants were asked, “Where is your current location?” with the options: home, work, bar/restaurant, outside, other public place, other location, friend’s house, significant other’s house. The variable was dichotomized to indicate whether the participant consumed the drink at home (1) or elsewhere (0).

Momentary perceived discrimination.—As part of the post-drink assessment, a subset of $n = 89$ participants (66% of the full sample; 46% Black) responded to 3 questions assessing perceived discrimination (“Were you treated with less respect than other people?” “Did you receive poorer service than other people at bars, restaurants or stores?” “Were you discriminated against?”) where 0=no and 1=yes. These three questions were combined into a binary perceived discrimination variable in which 0=no, did not experience any discrimination and 1=yes, experienced discrimination.

Analytic Plan

Hypotheses were tested using multilevel modeling with drinks nested within individuals in PROC GLIMMIX (SAS 9.3). The final model for all outcomes included a random intercept at the level of the individual. Age, sex, education, income, employment status, number of drinking days, and number of drinks per drinking day were included as fixed-effect covariates. ADHD history, race, and the ADHD-by-race interaction were modeled as fixed-effect predictors.

Results

Descriptive statistics and between-group comparisons are depicted in Table 1. Participants with ADHD were significantly younger than participants without ADHD. Black participants were less likely to be male, reported lower levels of education, income and frequency of alcohol use, and were more likely to be unemployed than White participants. From the post-drink EMA data, participants reported a total of 758 drinking events, three drinking days on average ($M_{days}=3.35$, range: 1–9), and an average of 5.8 drinks in total (range: 1–38). The mean number of drinks (post drink surveys completed) per drinking day was 1.64 (median: 1, range: 1–4). Frequencies of outcome variables are presented in Table 2. Intraclass correlation coefficients (ICCs) for outcomes ranged from .06–.58 (see Table 3), indicating that our sample provided sufficient variability to test both within- and between-person effects on all outcomes with the exception of weekend drinking, for which there was low between-person variability.

In-the-moment drinking behavior

Drinkers with ADHD histories consumed alcoholic beverages marginally faster ($p = .086$) than drinkers without ADHD histories (Table 3; $M_{ADHD}=16.48$ minutes vs. $M_{nonADHD}=18.24$ minutes; estimated means are interpolated from the categorical scale). Drinkers with ADHD histories completed fewer post-drink surveys throughout the 10-day assessment than drinkers without ADHD histories, $\beta=-0.17$, $p<.001$ ($M_{ADHD}=5.15$ vs. $M_{nonADHD}=6.27$). Drinkers with ADHD histories did not significantly differ from drinkers without ADHD histories in type of beverage or tendency to drink alone, at home, in the evening, or on the weekend.

Compared to White drinkers, Black drinkers consumed alcoholic drinks more rapidly ($p = .032$) than White drinkers (Table 3; $M_{Black}=12.80$ minutes vs. $M_{White}=18.76$ minutes) and were also more likely to report drinking beverages containing liquor compared to beer, malt liquor, or wine (Table 3). Over the 10-day assessment period, Black drinkers completed fewer post-drink surveys than White drinkers, $\beta=-0.38$, $p<.001$ ($M_{Black}=4.15$ vs. $M_{White}=6.46$). Black drinkers did not significantly differ from White drinkers in their tendency to drink alone, at home, in the evening, or on the weekend.

As Black drinkers were more likely to report drinking liquor containing beverages, we conducted a sensitivity analysis to evaluate whether beverage type accounted for Black drinkers' faster drinking speed (in addition to exploring contextual factors as potential explanatory variables discussed below; Table 4). The association between race and speed of consumption remained significant when beverage type was included as a predictor of speed of consumption ($p=.034$). Finally, a large body of research documents that Black individuals experience more discrimination than White individuals (e.g., Kessler, Mickleson, & Williams, 1999) – a finding that was replicated in our sample, albeit with a small number of instances of discrimination (15 instances; $\chi^2 = 7.23$, $p=.007$). To address this potential explanatory variable, we reran the speed of consumption and beverage type analyses while including momentary perceived discrimination in the model for the subset of participants who received the perceived discrimination questions. The association between race and speed of consumption remained significant ($\beta = -1.57$, $p=.02$) when momentary perceived discrimination was included. However, race was no longer a significant predictor of beverage type when momentary perceived discrimination was included in the model ($\beta = 0.11$, $p=.33$).

We did not find significant ADHD-by-race interactions in relation to any in-the-moment drinking characteristics. Several in-the-moment drinking behaviors were predicted by demographic covariates. Unemployed participants were more likely to drink in the evening compared to during the day. Being female, older, and having higher levels of education was related to drinking more slowly. Conversely, higher income was associated with drinking more quickly.

In-the-moment predictors of speed of consumption

Speed of consumption may be dependent on drinking context (e.g., where, when, with whom). Therefore, we explored these variables as random and fixed effect predictors of speed of consumption in a single multilevel regression model. While we did not have any a priori hypotheses about ADHD or race in relation to speed of consumption being affected by context we explored this possibility by testing both fixed and cross-level interactions between setting and ADHD/race. We partitioned each context variable into two variables: a grand mean-centered between-person variable (to examine whether individuals' average drinking tendencies predict speed of consumption) and a within-person variable (to examine whether alterations from individuals' drinking tendencies on a given drinking occasion predict speed of consumption, over and above between-person trends). Results are presented in Table 4. Random effects of context and cross-level interactions of ADHD/race with context were non-significant and were therefore removed from the model. Beverage type

predicted speed of consumption, such that drinking liquor-containing beverages predicted faster consumption. Additionally, drinking away from home predicted faster consumption than did drinking at home, as did drinking during the day compared to during the evening. All significant effects were within-person (rather than between-person), indicating that individuals drank faster *on occasions* when they consumed liquor, drank out of their home, and during the day.

Discussion

This study examined in-the-moment drinking behaviors for adults with and without ADHD histories and for Black and White drinkers, to characterize differences in *how* people drink that may increase risk for alcohol problems. The current study examined day and time of consumption, social context, beverage type, and speed of consumption – characteristics that may increase risk for alcohol problems by inadvertently leading to more alcohol consumption than intended, more rapid escalation in blood alcohol concentration (BAC), or drinking in places or with people that facilitate risk. The current study examined these characteristics in real time using EMA in order to more precisely measure drinking behaviors as they occur in individuals' natural environments (rather than relying on global summaries of behavior over long periods of time). Further, this study integrated drinking characteristics with drinking contexts to examine whether contexts changed behaviors for a given individual.

Results showed that Black drinkers drank significantly more quickly than White drinkers and more often drank liquor-containing beverages. Importantly, the faster speed of drinking among the Black versus White drinkers was not accounted for by their likelihood of drinking liquor. The association between race and beverage type was no longer significant once EMA-measured perceived discrimination was included in the model. While not statistically significant, drinkers with ADHD histories drank marginally more quickly than those without ADHD. No ADHD or race differences were found for day, time, and social context of drinking, and ADHD and race did not interact to predict any drinking characteristics. Analyses that examined the interplay between drinking characteristics showed that within a given individual, drinking away from home, drinking during the day, and drinking liquor-containing beverages predicted faster alcohol consumption.

Black drinkers consumed alcoholic beverages almost a third more quickly and were more likely to drink liquor-containing beverages than White drinkers. These effects remained significant even when education, employment status, and income were covaried. Speed of consumption and type of beverage are certainly related (and were in the current study): liquor-containing drinks are typically lower in volume, making it easier to drink them more quickly. However, as Black drinkers drank significantly more quickly even when accounting for beverage type, other factors might be at play. For example, a recent experimental study found that participants with higher drinking to cope with negative mood motives were more sensitive to depressive statements (versus positive statements), which increased the likelihood of choosing alcohol as a reinforcer over food (Hogarth & Hardy, 2018). Given the higher rates of stress, discrimination (e.g., Kessler, Mickleson, & Williams, 1999; Williams, Yu, Jackson, & Anderson, 1997), and coping motives (Cooper et al., 2008) found among

Black drinkers, this process may be more pronounced in this population. Increased stress, coping motives, and momentary increases in negative mood may fuel quicker alcohol consumption.

We also found that Black drinkers were more likely to drink hard liquor shots and mixed drinks than beer, malt liquor, or wine; this association may be at least partially driven by momentary perceived discrimination, as the association between race and beverage type was no longer significant when including perceived discrimination in the model. Our EMA findings on beverage type are consistent with prior research using retrospective, global, self-report measures of drinking behavior (Chung et al., 2014; Dawson, 1998; Graves & Kaskutas, 2002; Siegel et al., 2011). Importantly, real-time assessment of beverage type allows for the examination of actual beverage consumed as opposed to what individuals may prefer to drink but seldom drink and allows for momentary factors such as discrimination experiences to be incorporated. A recent review paper (Gilbert & Zemore, 2016) synthesized the literature and showed a positive association between discrimination and alcohol use. Our findings raise the possibility that discrimination may alter decisions made proximally to the event that increase risk (e.g., choosing liquor versus beer). However, it may not necessarily be the case that discrimination is in the causal path from race to beverage choice (although that is certainly a possibility); it may be that discrimination is a strong proxy for group status that attenuates the association between race and beverage choice when included as a covariate. Further research is needed to test this possibility. Another reason that Black drinkers may be more likely to consume liquor relative to beer is related to more distal environmental factors. Studies have found that liquor stores are overrepresented in predominantly Black neighborhoods even after accounting for socioeconomic status (e.g., Laveist & Wallace, 2000) which may increase availability of liquor versus beer and ultimately affect beverage choice.

Consuming liquor might elevate risk by increasing difficulty in accurately estimating the amount of alcohol consumed (e.g., “stiff” vs. “light” pours) which could result in unintentional higher BAC. Consistent with this, there is some evidence Black drinkers may considerably underestimate the amount of alcohol they consume (up to 30%; Kerr, Patterson, & Greenfield, 2009). Difficulty estimating alcohol content and more rapid rise in BAC from faster drink consumption may partially account for the increased likelihood of problems, even though Black drinkers drink at lower levels overall than White drinkers (Zapolski et al., 2014). Future research should incorporate measurements of mobile BAC/BrAC, as well as integrate GPS (to directly test whether beverage choice varies as a function of being in a predominantly Black versus White neighborhood).

We also found a trend ($p=.086$) for the ADHD group to drink more quickly than the nonADHD group. While our finding was marginally significant, it is worth noting that prior to the addition of income and education to our analyses these findings were significant ($\beta = -0.87$, $p = .031$). Drinkers with ADHD histories may inadvertently consume alcoholic beverages more quickly than drinkers without ADHD histories, because they overestimate the amount of time that has passed (Barkley et al., 2001). Notably, this tendency may mean that the difference detected in the speed of consumption between drinkers with and without ADHD histories may be conservative. More rapid consumption of alcohol during a drinking

episode may lead to faster escalation of BAC, in turn increasing risk for alcohol problems (e.g., risky decision-making like driving while intoxicated). This association may be particularly pertinent for adults with ADHD, as there is evidence they are more sensitive to the disinhibiting and impairing effects of alcohol (Roberts et al., 2013; Weafer et al., 2009). Individuals with ADHD are prone to experiencing poorer educational and financial outcomes (Hechtman et al., 2016), and future research is needed to more fully understand how and why these factors may affect in-the-moment drinking behaviors in this population, as these background factors reduced the association between ADHD and drinking speed in the current study.

To further understanding how context may affect how someone drinks, we examined contextual effects on speed of alcohol consumption. Our results showed that individuals drink more quickly, on average, on occasions when they drink liquor versus beer/wine, when they drink during the day versus in the evening, and when they drink away from versus at home. Individuals likely, in part, consume liquor-containing beverages more quickly because of the reduced volume of the drink compared to typical servings of beer/wine. Daytime drinking events, in turn, may capture more instances of non-normative drinking that may be associated with faster drinking (e.g., tailgating, sports events) versus more normative consumption patterns that typically take place in the evening (e.g., glass of wine with dinner). Finally, individuals may drink more quickly when away from home because they are more likely to be distracted by others or because of increased attention to the individual's drink (e.g., finishing a drink more quickly to order another from the wait staff). These effects on speed of consumption were entirely explained by within-person rather than between-person variability. For instance, regardless of when a given individual *tended to* drink on average across the 10 days, they drank more quickly on drinking occasions during the daytime versus in the evening. Leveraging EMA to measure in-the-moment drinking behaviors was critical to uncover this nuanced within-person finding, which further extends previous research. These findings did not vary across ADHD history or race.

We explored the presence of interactions between ADHD and race to consider the potential outcome of jointly occurring risk processes. We found no statistically significant interactions (and small effect sizes). However, power to detect them was low in our samples. A power simulation conducted in Mplus using $n=131$ (the observed sample size for this analysis), the observed effect sizes, and observed assessment cluster structure indicated .38 power to detect the interaction effect for speed of consumption analyses. Although it is possible that there is not a multiplicative effect of race and ADHD in relation to real-time drinking characteristics, over and above additive direct effects, these null findings should be interpreted cautiously. Additional research with a larger sample is needed to fully test how Black drinkers with a history of ADHD drink relative to Black drinkers without ADHD and White drinkers.

Limitations

The current study has many strengths, including the use of EMA to measure drinking behaviors and their associated contextual factors in real time, examining between- versus within-person effects, and including two groups that are at risk for alcohol problems and yet

remain underrepresented in the alcohol literature. However, several limitations warrant discussion. First, participants were limited to reporting only the first four drinks of a drinking occasion in order to balance comprehensiveness and accuracy, in line with previous research; hence, the entire drinking episode was not always measured. However, the median number of drinks per drinking occasion was one, which decreases the likelihood that these results were affected by this design. Second, although participants were asked to complete the post-drink assessment as soon as possible upon completing a drink, the speed of consumption variable used in the current study may still be prone to recall bias, as participants estimated the amount of time passed while drinking the beverage. Future research with time stamps or self-reports of the beginning and end of each drink is needed. Third, the sample was comprised of moderate to heavy drinkers, limiting generalizability. Relatedly, during the screening process Black and White drinkers and drinkers with and without ADHD histories were matched on recent drinking behavior. Therefore, the findings of mean-level group differences in self-reported drinking via the in-the-moment post-drink reports across the 10-day period (mean of 4 drinks for Black drinkers vs. 6 drinks for White drinkers; mean of 5 drinks for drinkers with ADHD histories vs. 6 drinks for those without ADHD histories) by design may not generalize to these populations and should be interpreted with caution. Similarly, given our focus on in-the-moment drinking characteristics as opposed to mean-level differences in alcohol use, we focused our analyses on number of post-drink assessments completed which may not be the same as actual frequency and quantity of alcohol use. Fourth, while this study benefits from a comparatively large sample size for EMA research, some of our cell sizes are small when considering potential gender differences across and within race and ADHD. Recruitment of a larger number of Black drinkers as well as more female participants to allow examination of gender differences and increased generalizability are important future steps in this line of research. This is particularly relevant given our finding that female drinkers in this study consumed their drinks more slowly than male drinkers. Finally, alcohol consequences assessed via morning report had low levels of endorsement in this sample, precluding our ability to examine if there were within-person effects of nights when alcohol was consumed more quickly related to increased consequences from use.

Future directions

An important next step will be examining how specific in-the-moment drinking characteristics relate to heavy alcohol use/problems in real-time or the morning after in these populations. Samples with a wider range of alcohol use behavior that do not have explicit recruitment goals of matching across race and ADHD history on recent alcohol use behavior are needed to examine potential differences in quantity of alcohol consumed per occasion and frequency of use for individuals with and without a history of ADHD and Black versus White drinkers, especially given heterogeneity in drinking outcomes in these populations. Additionally, while we examined momentary experiences of discrimination, future research that integrates cumulative life stress and chronic discrimination are needed. This type of research could be conducted to identify individuals within the Black drinking population that may be at elevated risk. Research investigating factors within racial groups that attenuate the speed of drinking or the likelihood of drinking liquor are also important next steps, especially in the context of designing interventions. Extending this line of EMA research

will contribute to our understanding of processes that may increase risk for alcohol problems in these under-studied populations.

Conclusions

To our knowledge, this study is the first to leverage EMA to investigate ADHD and racial differences in in-the-moment drinking characteristics. An especially important and new finding was that Black drinkers drank more quickly than White drinkers, even accounting for beverage type. Black drinkers were also more likely to consume liquor-containing beverages, however this association became non-significant when in-the-moment discrimination was included in analyses. Future studies teasing apart the role of discrimination in type of beverage consumed are needed. In the sample as a whole, drinking away from home and during the daytime led to drinks being consumed more quickly. Differences in in-the-moment characteristics of drinking behavior such as these may contribute to elevated risk for alcohol-related problems among Black drinkers despite lower levels of overall alcohol consumption. Providing psychoeducation (e.g., on drink pacing) to Black drinkers may be particularly helpful given the more rapid alcohol consumption observed in this group. Developing a real-time mobile-health intervention that alerts individuals to potential high-risk contexts for rapid drinking (e.g., time, location) and suggests alternative plans for consumption may hold promise as well.

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Table 1.

Descriptive statistics

	Full sample	nonADHD	ADHD	t/χ^2	<i>p</i>	White	Black	t/χ^2	<i>p</i>
Race (N, % White)	94 (69.63)	48 (65.75)	46 (74.19)	1.13	.35	--	--	--	--
Gender (N, % male)	94 (69.63)	51 (69.86)	43 (69.35)	0.00	.93	71 (75.53)	23 (56.10)	5.10	.02
Age in years, mean (SD)	27.81 (4.20)	27.15 (4.28)	28.58 (3.99)	-1.99	.05	27.78 (4.15)	27.88 (4.35)	-.13	.90
Level of education, mean (SD)	3.56 (1.12)	3.64 (1.07)	3.45 (1.18)	0.99	.32	3.85 (1.00)	2.89 (1.10)	5.03	<.001
Income, mean (SD)	3.49 (1.90)	3.55 (1.97)	3.42 (1.83)	0.39	.70	3.88 (1.95)	2.58 (1.43)	4.32	<.001
Employment status (N, % unemployed)	5 (3.70)	2 (2.74)	3 (4.84)	0.41	.52	1 (1.06)	4 (9.76)	6.05	.01
Frequency of alcohol use, mean (SD)	2.76 (1.46)	2.89 (1.40)	2.61 (1.53)	1.10	.27	3.08 (1.36)	2.02 (1.44)	4.10	<.001
Quantity of alcohol use, mean (SD)	3.36 (2.24)	3.47 (2.24)	3.23 (2.25)	0.61	.55	3.13 (2.03)	3.88 (2.62)	-1.80	.07

Note: Frequency and quantity of alcohol use describe use in the past 30 days.

Table 2.

Proportions of responses for categorical drinking characteristics by ADHD and race

Outcome	ADHD				Race				Total
	nonADHD	%	ADHD	%	White	%	Black	%	%
Alone	84	19	61	20	101	17	44	28	20
With others	354	81	240	80	481	83	113	72	80
Home	182	42	157	52	267	46	72	46	46
Not at home	256	58	144	48	315	54	85	54	54
Evening	355	79	252	81	477	81	130	77	80
Morning/afternoon	92	21	59	19	113	19	38	23	20
Weekend	263	59	171	55	329	56	105	63	57
Weekday	184	41	140	45	261	44	63	37	43
Liquor	146	33	104	33	161	27	89	53	33
Beer/wine	301	67	207	67	429	73	79	47	67

Note: This table reflects all drinking events reported by participants (N = 744). Five drinking episodes did not include a social context or location, hence N = 739 for those variables. Beer/wine includes beer, wine, and malt liquor; liquor includes mixed drinks and hard liquor shots. ADHD: Attention-deficit/hyperactivity disorder.

Table 3.

Odds Ratios and Coefficients from Multilevel Regression Models with 95% Confidence Intervals

Predictor	In-the-moment Drinking Behavior					
	Alone (OR)	Home (OR)	Evening (OR)	Weekend (OR)	Liquor (OR)	Speed of Consumption (B)
Intraclass correlation coefficient	.313	.356	.288	.064	.335	.584
Random σ^2 (SE)						
Level 1: Individual Intercept	1.71 (0.44)	2.03 (0.45)	1.38 (0.38)	0.24 (0.12)	1.39 (0.36)	2.93 (0.49)
Fixed						
Intercept	-1.87*** (-2.49, -1.25)	-0.18 (-0.77, 0.41)	1.97*** (1.39, 2.55)	0.17 (-0.14, 0.48)	-1.32*** (-1.86, -0.78)	5.69*** (5.07, 6.32)
ADHD	1.13 (0.47, 2.72)	1.26 (0.56, 2.80)	1.61 (0.71, 3.68)	1.17 (0.74, 1.85)	1.26 (0.60, 2.66)	-0.73 (-1.72, 0.10)
Race	2.32 (0.68, 7.89)	1.11 (0.36, 3.45)	1.42 (0.46, 4.44)	1.55 (0.78, 3.09)	3.66* (1.32, 10.21)	-1.28** (-2.44, -0.11)
ADHD * Race	0.59 (0.11, 3.14)	0.74 (0.16, 3.52)	0.36 (0.08, 1.61)	0.50 (0.20, 1.29)	1.11 (0.28, 4.45)	0.60 (-0.98, 2.18)
Sex	0.94 (0.42, 2.11)	0.63 (0.30, 1.35)	0.52 (0.25, 1.08)	1.19 (0.77, 1.82)	1.09 (0.56, 2.16)	0.90* (0.11, 1.68)
Age	1.06 (0.97, 1.16)	0.99 (0.91, 1.07)	0.93 (0.85, 1.01)	0.98 (0.93, 1.03)	0.94 (0.87, 1.02)	0.10* (0.02, 0.19)
Education	1.18 (0.81, 1.72)	0.99 (0.71, 1.40)	0.93 (0.66, 1.30)	0.98 (0.80, 1.21)	0.80 (0.58, 1.08)	0.59** (0.23, 0.98)
Employment	0.51 (0.09, 2.98)	1.46 (0.27, 7.72)	0.21* (0.05, 0.92)	1.00 (0.40, 2.54)	2.18 (0.49, 9.64)	-1.36 (-3.15, 0.44)
Income	0.87 (0.70, 1.09)	0.91 (0.75, 1.11)	1.12 (0.92, 1.37)	1.03 (0.92, 1.14)	1.19 (1.00, 1.42)	0.22* (0.42, 0.02)
# drinking days	1.11 (0.92, 1.32)	1.10 (0.93, 1.30)	1.09 (0.93, 1.27)	0.90* (0.82, 0.99)	0.99 (0.85, 1.15)	-0.09 (-0.26, 0.08)
# drinks per day	0.79 (0.61, 1.03)	0.69** (0.55, 0.87)	1.36* (1.05, 1.77)	1.16 (0.97, 1.39)	1.30* (1.04, 1.62)	-0.15 (-0.30, 0.01)

Note: Unstandardized coefficients are presented for model intercepts and for consumption duration. All other parameters are odds ratios. 95% confidence intervals are presented in parentheses. ADHD: Attention-deficit/hyperactivity disorder.

*
p < .05

**
p < .01

p < .001.

Table 4.

Results of Multilevel Regression Model Predicting Speed of Consumption

Predictor	<i>B</i>	<i>SE</i>	<i>df</i>	<i>t</i>	<i>p</i>	95% CI
Intercept	5.22	0.38	118	13.59	<.001 ***	(4.46, 5.98)
ADHD	−0.83	0.43	602	−1.94	.053	(−1.67, −0.01)
Race	−1.30	0.61	602	−2.13	.034 *	(−2.49, −0.09)
ADHD * Race	0.88	0.82	602	1.08	.280	(−0.72, 2.49)
Sex	1.01	0.41	602	2.47	.014 *	(0.21, 1.81)
Age	0.11	0.04	602	2.45	.015 *	(0.02, 0.20)
Education	0.60	0.18	602	3.28	.001 **	(0.24, 0.95)
Employment	−1.12	0.95	602	−1.18	.238	(−2.97, 0.74)
Income	−0.23	0.10	602	−2.24	.025 *	(−0.44, −0.03)
Home						
WP	0.75	0.18	602	4.23	<.001 ***	(0.40, 1.10)
BP	−0.35	0.50	602	−0.95	.487	(−1.34, 0.64)
Evening						
WP	0.38	0.19	602	2.04	.045 *	(0.01, 0.75)
BP	0.60	0.71	602	0.83	.396	(−0.29, 1.95)
Liquor						
WP	−0.98	0.17	602	−6.28	<.001 ***	(−1.31, −0.65)
BP	0.83	0.57	602	0.76	.147	(−0.29, 1.95)
Alone	−0.01	0.20	602	0.09	.970	(−0.40, 0.39)
Weekend	0.19	0.13	602	1.52	.146	(−0.07, 0.46)
# drinking days	−0.11	0.09	602	−0.51	.198	(−0.29, 0.06)
# drinks per day	−0.09	0.08	602	−1.13	.266	(−0.24, 0.07)

Note: Effects significant at $p < .05$ are in bold. Within-person (WP) and between-person (BP) effects are presented for those contexts that were significant predictors of consumption duration. Interaction effects between ADHD/race and the various contexts and drink type were non-significant and were removed from the model; results reported here are from the model excluding non-significant interactions. ADHD: Attention-deficit/hyperactivity disorder.

*
 $p < .05$

**
 $p < .01$

 $p < .001$.