Published in final edited form as:

AIDS Behav. 2016 January ; 20(0 1): 60–73. doi:10.1007/s10461-015-1157-0.

Alcohol expectancies and inhibition conflict as moderators of the alcohol-unprotected sex relationship: Event-level findings from a daily diary study among individuals living with HIV in Cape Town, South Africa

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Abstract

Literature from sub-Saharan Africa and elsewhere supports a global association between alcohol and HIV risk. However, more rigorous studies using multiple event-level methods find mixed support for this association, suggesting the importance of examining potential moderators of this relationship. The present study explores the assumptions of alcohol expectancy theory and alcohol myopia theory as possible moderators that help elucidate the circumstances under which alcohol may affect individuals' ability to use a condom. Participants were 82 individuals (58 women, 24 men) living with HIV who completed daily phone interviews for 42 days which assessed daily sexual behavior and alcohol consumption. Logistic generalized estimating equation models were used to examine the potential moderating effects of inhibition conflict and sex-related alcohol outcome expectancies. The data provided some support for both theories and in some cases the moderation effects were stronger when both partners consumed alcohol.

Keywords

alcohol myopia; alcohol outcome expectancies; event-level; South Africa

Alcohol risk reduction has been identified as a critical strategy in mitigating the global HIV/AIDS epidemic on several levels (1). A growing body of literature suggests alcohol use is associated with increased HIV risk behaviors (2, 3), poor antiretroviral treatment (ART)

adherence (4), and reduced immune response, quickened disease progression, increased infectivity in people living with HIV (PLHIV) (5–7). In sub-Saharan Africa, containing nearly 70% of the world's new HIV infections and 24.7 million PLHIV (8), heavy episodic drinking is the highest in the world and alcohol consumption overall is increasing in many countries (9). The literature from sub-Saharan Africa and elsewhere supports a global association (i.e., those who drink more tend to have more unprotected sex or are more likely to be HIV positive) between alcohol and HIV prevalence and risk (2, 3, 10, 11). However, more rigorous studies using multiple event-level methods (i.e., which temporally sequence alcohol consumption before sex and subsequent unprotected sex) find mixed support for alcohol's effect on unprotected sex (3, 12–15), suggesting the importance of examining potential moderators affecting the relationship between alcohol and unprotected sex.

Situational factors such as partner type, partner alcohol consumption, the quantity of alcohol consumed, social cognitive states before sex (12), as well individual difference factors such as expected outcomes of drinking have been identified as important considerations in understanding the effect of alcohol on unprotected sex in sub-Saharan Africa (16–18). As the aforementioned studies suggest, alcohol may only lead to unprotected sex under certain circumstances or do so more among certain individuals. Two theories proposing psychological moderators as explanations for the circumstances under which consuming alcohol prior to sex may increase the likelihood of having unprotected sex have been tested among a variety of samples mainly in the U.S. Alcohol expectancy theory (19) and alcohol myopia theory (20), which are each summarized below, propose circumstances under which alcohol consumption leads to unprotected sexual behavior. Furthermore, other authors have suggested that these theories may operate in tandem to affect behavior (21). However, little to no multiple event-level research among HIV-positive individuals in Africa has tested either of these theories as moderators of the relationship between alcohol consumption and unprotected sex and the findings may differ from those among HIV negative and primarily North American samples.

Alcohol Outcome Expectancies (AOEs)

According to alcohol expectancy theory (19), drinking alcohol will lead to subsequent unprotected sex only for individuals who believe that alcohol makes them more likely to have unprotected sex. This type of alcohol outcome expectancy will be referred to throughout as sex-risk AOEs. This suggests that alcohol outcome expectancies that relate to sexual risk taking may moderate the relationship between alcohol and unprotected sex.

Support for the moderating role of alcohol outcome expectancies in the relationship between alcohol consumption and unprotected sex has been found among presumed HIV-negative adolescents (22–24). HIV-positive men in the U.S. who endorse sex-risk alcohol outcome expectancies have also been found to be more likely to consume alcohol during instances of unprotected sex than are HIV-positive men who do not endorse sex-risk alcohol outcome expectancies (25). Research among STI clinic patients in South Africa found an association between enhancement expectancies and drinking before sex (17, 18).

Experimental studies in which participants were randomly assigned to conditions of alcohol consumption, placebo, or no beverage have demonstrated that sex-related alcohol outcome expectancies moderate the association between alcohol consumption and social cognitive predictors of condom use. Specifically, among community samples of women (26) and men (27) sex-risk alcohol outcome expectancies moderated the association between actual alcohol consumption and motivation to use condoms.

Alcohol Myopia

Another theory that has been applied to understand the purported association between alcohol and unprotected sex is alcohol myopia theory (20). According to this theory, alcohol reduces individuals' cognitive processing ability and it blocks an *inhibition conflict* response. Inhibition conflict is when individuals possess both strong inhibitory and strong instigatory cues. When an individual drinks alcohol instigatory cues become more easily accessible and require less cognitive processing ability whereas inhibiting cues are often less salient, less accessible, and require further cognitive processing ability to have an influence on behavior. According to Steele and Josephs (20), when individuals' inhibiting or instigatory cues are weak or both are weak consuming alcohol will not affect the resultant behavior. Using a condom, for some individuals, involves an inhibition conflict-- individuals may possess strong instigatory cues such as not wanting to use condoms because sex feels better without condoms but also possess equally strong inhibitory cues such as wanting to protect oneself from disease. Therefore, when individuals who are conflicted about using condoms consume alcohol the short-term instigatory cues such as that sex feels better without a condom are likely more salient than long-term inhibitory cues such as using a condom to protect one's health and thus the short-term instigatory cues have a greater influence on behavior in that situation. This line of reasoning has received some experimental research support. In a laboratory study among young adults, participants who were intoxicated were less able to list negative consequences of unprotected sex than were sober participants (28). Furthermore, MacDonald and colleagues (29), demonstrated in a laboratory study that when aroused, men were more likely to intend to have unprotected sex when intoxicated compared to when sober, whereas when not aroused, men were no more likely to intend to have unprotected sex when intoxicated than when sober.

A difficulty in testing alcohol myopia theory outside of the laboratory lies in how to operationalize inhibition conflict. In laboratory settings researchers have operationalized instigatory cues as sexual arousal (30), (29), which when testing it in a field setting is difficult to obtain real time measures of sexual arousal. Inhibitory cues have been operationalized as intentions to use condoms (29). Dermen and Cooper conceptualized inhibition conflict as feeling undecided about using condoms, which they found to moderate the relationship between alcohol consumption and unprotected sex at last intercourse (23). We propose as slightly different operationalization of inhibition conflict and instigatory and inhibitory cues that can be tested in a field setting.

We suggest that inhibitory cues to unprotected sex can include social-cognitive predictors of condom use including favorable attitudes towards using condoms, strong behavioral intentions to use condoms, and strong self-efficacy to use condoms, as these are factors

which are negatively associated with unprotected sex (31, 32). A positive attitude and strong behavioral intentions and self-efficacy to use condoms would mean that an individual has strong cues that inhibit having unprotected sex. A salient instigatory cue to unprotected sex is the belief that sex feels better without a condom (33). Therefore, using these examples of instigatory and inhibitory cues, individuals who don't use condoms because they believe that sex feels better without a condom (instigatory cue) but also have positive attitudes and strong behavioral intentions and self-efficacy to use condoms (inhibitory cues) may be experiencing inhibition conflict regarding having unprotected sex. Applying alcohol myopia theory (20) in this context we would expect that when individuals are experiencing inhibition conflict they will be more likely to have unprotected sex if they are under the influence of alcohol than if they are sober because the instigatory cues become more salient than the inhibitory cues. This suggests that experiencing inhibition conflict would moderate an association between consuming alcohol prior to sex and subsequent unprotected sex. Furthermore, prior research suggests that inhibitory cues of attitudes, intentions, and self-efficacy may exhibit day-to-day variation. In a daily diary study among college students condom use attitudes and behavioral intentions were found to vary day to day and this daily variation predicted condom use that day (34). This suggests that measuring these constructs daily, prior to sexual activity, may improve the conceptualization of inhibitory cues for unprotected sex. In our conceptualization of inhibition conflict, individuals would be considered to be experiencing inhibition conflict prior to having sexual intercourse if they endorse that sex feels better without a condom as a reason for not using condoms and when their condom use attitudes are positive, behavioral intentions strong, and/or their self-efficacy is strong.

As discussed above, alcohol myopia theory and alcohol expectancy theory both propose circumstances under which consuming alcohol increases the likelihood that sex will be unprotected. We are not aware of any studies using a daily diary methodology to investigate these relationships among PLHIV in sub-Saharan Africa. The daily diary methodology allows us to collect event-level data that temporally sequences discrete instances of alcohol consumption and other predictors such as daily inhibitory cues as occurring before discrete sexual events. Furthermore, with daily diary methodologies we can record instances of alcohol use and instances of unprotected sex close in time to when they occurred, asking participants to recall only the prior 24-hour period or less. In this way the daily diary methodology allows researchers to reduce recall biases and errors (35).

The present study explores the assumptions of alcohol expectancy theory and alcohol myopia theory as possible moderators that help elucidate the circumstances under which alcohol may affect individuals' ability to use a condom. We hypothesized that interactions between endorsing that sex feels better without a condom as a reason for not using condoms and more positive attitudes towards using condoms, stronger intentions to use condoms, and stronger self-efficacy to use condoms on a particular day will moderate the effect of alcohol before sex on unprotected sex. We also hypothesized that the relationship between consuming alcohol before sex and subsequent unprotected sex will be more pronounced for individuals who expect alcohol to affect their sexual behavior.

Methods

Participants and Procedure

Eighty-two HIV-positive individuals (58 female, 24 male) participated in a baseline interview and an intensive longitudinal (42-day) structured daily phone interview, which yielded a possible 3,396 data points (one wave of data collection with 12 participants was shortened to 38-days in duration due to overlap with religious holidays). Potential participants were identified by staff at five HIV service organizations in Cape Town, South Africa and then referred to a native Xhosa speaking research assistant for voluntary potential participation in the study. Research assistants described the study to participants, obtained written informed consent, and then conducted an eligibility screening. Eligibility required being (a) >18 years of age, (b) HIV+, (c) having vaginal or anal sex, (d) consuming alcohol in the prior 30-days, and (e) having access to a phone where they could receive calls every afternoon. Only one member of a couple was allowed to participate. Of those screened, five did not meet the eligibility criteria (4 for sexual inactivity, and 1 for no alcohol in prior 30-days). Two eligible individuals declined participation. The study was approved by institutional review boards in the U.S. and in South Africa.

At the time of enrollment the research assistants set an appointment for participants to come to the research office to complete a baseline interview and receive training on the protocol for the daily phone interviews and incentive schedule. For the daily phone interviews, interviewers called participants each day between 1pm and 6pm and conducted a structured interview in Xhosa, a local language predominant in this area. The time within this window that each participant was called was left up to the interviewers to determine considering participant availability. If a participant was not available on the first phone call attempt the interviewer made up to four attempts to reach the participant that day. If the interviewer could not reach a participant for two consecutive days they made attempts to reach participants through their secondary contact information which they provided at baseline. Participants were compensated with up to 660 Rand (about \$95 USD at the time, including transportation reimbursement to complete the in-person baseline interview), the total amount of which depended upon the number of interview days completed.

Measures

Time-varying variables—Each day participants reported on their drinking and sexual behavior for *last night* (after yesterday's interview, approximately 5 pm yesterday until going to sleep) and for *today* (since waking up until now). For these two time periods participants reported: (a) how many drinks (drink sizes standardized to equate alcohol content across types of alcoholic drinks, 1 drink = 12g of alcohol) they consumed, (b) how many times they had vaginal and anal sex, (c) how many times a condom was used during each type of sex, (d) the type of partner (main/steady, secondary/casual), (e) if the alcohol consumption occurred before/during or after the sexual event(s), and (f) if their partner consumed alcohol before the sexual event (yes, no). The measures were adapted from measures verified to be valid in South Africa and in daily diary studies (36–39). Oral sex was not assessed due to the low frequency of this behavior among HIV-positive samples in South Africa (36). The number of unprotected sex events during each time period (daytime

and evening) was calculated by taking the sum of the number of vaginal and anal sex events minus the sum of the number of times a condom was used during vaginal and anal sex. For the present analysis we use only the last night's sexual behavior and alcohol data so that we can temporally sequence daily inhibitory cues (described below) prior to that evening's behavior, thereby capturing close to real time data on inhibitory cues prior to sexual activity. Daily inhibitory cues for having unprotected sex were assessed prospectively with three separate 5-point semantic differential items: attitudes towards using condoms: "during the next 24 hours using condoms during sexual intercourse with my partner would be" (0 = *very bad*, 4 = *very good*); intentions to use condoms: "if I have sexual intercourse during the next 24-hours, I intend to have my partner and I use latex condoms" (0=*strongly disagree*, 4=*strongly agree*); and self-efficacy for using condoms: "if you were to have sexual intercourse during the next 24-hours, how hard would it be for you to make sure you and your partner use a latex condom?" (0=*very hard*, 4=*very easy*). Previous research has demonstrated that these social cognitive factors vary day to day and that the daily measures are better predictor of that day's behavior (34).

Time-invariant variables measured at baseline—Sex-risk-related alcohol outcome expectancies were measured with seven items assessing participants' global sex-related alcohol outcome expectancies about sexual risk taking (4 items, $\alpha = .74$) and sexual enhancement (3 items, $\alpha = .78$) formatted on a 0 (*strongly disagree*) to 4 (*strongly agree*) scale (full scale $\alpha = .82$). These items were selected from a longer scale of sex-related alcohol outcome expectancies (40). Sample items include: "I am less likely to ask a partner to use a condom after having a few drinks" (sex-risk) and "After a few drinks, I enjoy sex more than usual" (enhancement). We also collected data on the extent to which participants endorsed the following reason for why they don't use condoms "skin-to-skin sex feels better than sex with a condom" which we characterize as a way to determine if an individual has strong instigatory cues for unprotected sex. This was measured on a 0 to 4 point scale ranging from 0: "no this was certainly not a reason" to 4: "yes this was a big reason." In addition we collected data on participants' age, education (no schooling, primary, secondary or >), marital status (unmarried vs. married), socioeconomic status (self-rated on a 4-point continuum ranging from "I do not have enough money to buy food" to "I have money for most of the important things, but not enough money to pay for things like my children's education"), time known HIV positive, and ARV use (yes, no).

Data Analysis Approach

We used generalized estimating equation (GEE) analyses using SPSS version 20 (IBM) to test our hypotheses regarding the moderation of the effect of alcohol before sex on the likelihood sex was unprotected by sex-related alcohol outcome expectancies and by the interaction between daily inhibitory cues and instigatory cues (representing inhibition conflict). Our event-level outcome variable is the number of unprotected sex events. We used the "events within trials" type of response in SPSS which makes the outcome the number of unprotected sex events relative to the number of sex events that day. This yields a likelihood of unprotected sex but also accounts for differences between participants who engaged in, for example, ten unprotected sex acts out of ten sex acts vs. one unprotected sex act out of one sex act. This model uses a binomial distribution with a logit link and an

autoregressive correlation matrix to account for the repeated measurement of participants over time. Continuous variables were grand mean centered. Alcohol before sex was operationalized as a categorical time-varying variable representing 3 drinking categories: neither partner (0), only the participant (1), or both partners (2) drank before sex. This characterization of alcohol use is similar to how we characterized alcohol use in the sample in previous papers (12). Based on our prior findings from this sample showing the effect of alcohol on increasing the likelihood of unprotected sex starting at “moderate risk” levels (12) we categorize the participant’s own drinking as “low risk” or “no drinking” and “moderate or higher risk drinking.” No drinking and “low risk” are categorized in the 0 category for the drinking variable. We adopted risk level categories from the World Health Organization’s categories for level of risk from specific quantities of alcohol (5 categories ranging from no risk to very high risk), with gender-adjusted correspondence between alcohol quantity and risk level (41). Specifically, no risk=0 drinks, Men: low risk=1–2 drinks (1–40g alcohol), moderate risk=3–5 drinks (41–60g alcohol), high risk=6–10 drinks (61–100g alcohol), very high risk=more than 10 drinks (>101g alcohol); Women: low risk = 1–1.7 drinks (1–20g alcohol), moderate risk=1.8–3.3 drinks (21–40g alcohol), high risk=3.4–5 drinks (41–60g alcohol), very high risk=more than 5 drinks (>61g alcohol). Since we only had data on whether or not the participant’s partner “drank alcohol” before sex, partner’s drinking reflected a yes, no classification. Our hypothesized moderators; event-level daily inhibitory cues, instigatory cues, and their interactions, as well as measures of sex-related AOE were included as main effects and in an interaction with the alcohol before sex variable. We also included the following time-varying event level variables in the model partner type (main/steady, casual/secondary) and time invariant sociodemographic variables: age, education, marital status, socioeconomic status, time known HIV positive, and ARV use. Additionally we include days in study (1–42 days) in the model. Our prior analysis of data from this population showed gender differences on the effect of alcohol consumption based on whether the participant, his/her partner, or both drank (12), therefore we ran separate models for men and women. Tests of the model effects are reported in Table 2 and statistically significant interactions are illustrated in Figures 1–6.

Results

Participants’ average age was 32.23 years (SD 7.20, range 21–55 years), 32% were married or in the process of getting married, 22.7% were living with a partner but were not married, 25.3% were single, and 20% were widowed, all were of Xhosa ethnicity, 46.7% had completed primary school or less, 53.4% had completed high school, and 43.8% reported not having enough money for food. On average, participants had known that they were HIV-positive for 36.45 months (SD 30.81, range 1–144) and 59.2% were eligible for and were currently taking ARVs. Of the possible 3,396 data points during the study, participants completed 89.37% of the possible days, yielding 3,035 data points. The mean number of days completed was 37.04 (SD 7.56, range 8–42 days).

Descriptive Statistics

There were 3,890 vaginal and anal sex events and 3,087 unprotected vaginal and anal sex events reported by the 82 participants during the 42-day study. The mean number of sex

events per participant per day was 2.30 (SD 1.23, range 1–11). Of the sexual events which were preceded by alcohol most involved both partners drinking before sex (men 53.9%, women 51.4%), fewer involved only the individual but not his/her partner drinking (men 38.9%, women 36.8%), and a small percentage involved only the individual's partner but not the individual him/herself consuming alcohol before sex (men 6.7%, women 9.5%). For the purpose of this analysis we excluded sex events where only the individual's partner consumed alcohol (340 sexual events) since this is a low number of events and to aid in the interpretation of interaction effects. We also excluded an evening's sexual events if they involved more than one partner (210 events) since we cannot know which events involved a partner drinking alcohol and which did not. Therefore, a total of 3,340 sexual events were included. The mean number of alcohol-involved sexual events per participant by gender are given in Table 1. Means for the time-varying prospective daily measures of inhibitory cues; attitudes, intentions, and self-efficacy to use condoms, along with the means for the time-invariant factors of endorsing that sex without a condom feels better as a reason for not using condoms and sex-related alcohol outcome expectancies are also given in Table 1. Men reported stronger daily prospective intentions to use condoms than did women $\chi^2 (1) = 4.69$, $p < .05$.

Model testing the hypothesized moderation effects

Included in our model testing our hypothesized moderation effects were the main effects of the time-varying factors: alcohol consumption before sex (categorical) and partner type as well as time-invariant sociodemographic factors (taking ARVs, marital status, age, SES, education, time known HIV positive). Adjusted odds ratios and tests of the final model main effects and interactions are presented in Table 2. The main effect for alcohol before sex increasing the likelihood that sex was unprotected was statistically significant for men and women (men $\chi^2 11.19$, $df=2$, $p=0.015$; women $\chi^2 10.24$, $df=2$, $p=0.016$). For both men and women sex was less likely to be unprotected with casual compared to steady partners (men: adjOR 0.57 95% CI 0.39–0.82; $\chi^2 9.04$, $p=0.003$; women: adjOR 0.54, 95% CI 0.41–0.70, $\chi^2 20.22$, $p<0.001$). None of the sociodemographic factors were statistically significant predictors of the outcome and were removed from the final model.

Daily inhibitory cues—There were several statistically significant main effects for daily inhibitory cues on the likelihood sex that day was unprotected among men but not women. More positive prospective attitudes toward using condoms (adjOR 0.42, 95% CI 0.25–0.71, $\chi^2 8.17$, $p=0.004$), stronger intentions to use condoms (adjOR 0.34, 95% CI 0.19–0.59, $\chi^2 13.96$, $p<0.001$) and stronger self-efficacy to use condoms (adjOR 0.45, 95% CI 0.23–0.88, $\chi^2 10.48$, $p=0.020$) on a particular day predicted a lower proportion of sex acts that were unprotected that day.

Among men, several of the daily inhibitory cues moderated the effect of self and partner alcohol consumption before sex on whether or not the sex was unprotected. There was a statistically significant interaction between daily condom use attitudes and alcohol consumption ($\chi^2 15.85$, $df=2$, $p<0.001$). Compared to when neither partner consumed alcohol, on days when both the individual and his partner consumed alcohol before sex, alcohol increasing the likelihood that sex was unprotected on a particular day only on days when

they had strong attitudes towards using condoms (interaction: adjOR 2.55, 95% CI 1.21–6.34; see Figure 1). A similar moderation effect was found with intentions to use a condom among men ($\chi^2 24.79$, $df=2$, $p<.001$). As shown in Figure 2, when only the individual (interaction: adjOR 3.10, 95% CI 1.28–7.47) or when both partners consumed alcohol before sex (interaction: adjOR 4.72, 95% CI 2.47–9.03) alcohol affected the likelihood of condom use on days when they had strong intentions to use condoms.

Daily instigatory cue—The main effect of endorsing the reason of “that sex feels better without a condom” nor the two way interaction of this variable with alcohol were statistically significant. The two way interactions between the instigatory cue and the three inhibitory cues were also not statistically significant. See Table 2 for all test statistics.

Inhibition conflict—Inhibition conflict, as operationalized as the three way interaction between alcohol, inhibiting cues, and instigatory cue was tested separately for attitudes, self-efficacy, and intentions. Among women the three way interaction between daily condom use attitudes, event level alcohol, and endorsing the condom non-use reason of that sex feels better without a condom was statistically significant ($\chi^2 13.54$, $df=2$, $p=0.001$). As shown in Figure 3, among women with low endorsement of not using condoms for sensitivity reasons, on days when they had strong attitudes about using condoms, their or both partners’ consumption of alcohol had little effect on their likelihood of condom use. In the hypothesized situation of inhibition conflict where the participant endorses not using condoms for sensitivity reasons and has strong daily attitudes towards using condoms the likelihood not using a condom increased if she or both her and her partner consumed alcohol before sex. That effect is similar if only she or both partners consumed alcohol before sex. The pattern of effect was also similar for those with low endorsement of not using condoms because of sensitivity on days when they had weak attitudes towards using condoms. For women with high endorsement of not using condoms because of sensitivity, on days when they had weak attitudes towards using condoms the effect of alcohol before sex on the likelihood of using condoms was mainly when both they and their partner consumed alcohol before sex.

The three way interaction between daily condom use self-efficacy, event level alcohol, and endorsing the condom non-use reason of that sex feels better without a condom was statistically significant for men and women (men: $\chi^2 13.10$, $df=2$, $p=0.002$; women: $\chi^2 11.54$, $df=2$, $p=0.003$; see Table 2). As shown in Figure 4, among men in the hypothesized situation of inhibition conflict where the participant endorses not using condoms for sensitivity reasons and has strong daily self-efficacy to use condoms the likelihood not using a condom increased if he or both he and his partner consumed alcohol before sex with the effect being stronger when both partners consumed alcohol. For men with low endorsement of not using condoms for sensitivity reasons on days when they had strong condom use self-efficacy alcohol affected the likelihood of using a condom primarily when both partners consumed alcohol before sex. A similar pattern was observed for men with high endorsement of not using condoms for sensitivity reasons on days when they had weak condom use self-efficacy. Alcohol had little effect on behavior among those with low endorsement of not

using condoms for sensitivity reasons, on days when they had low condom use self-efficacy—the likelihood of not using a condom was high regardless.

Also shown in Figure 4, among women in the hypothesized situation of inhibition conflict where the participant strongly endorses not using condoms for sensitivity reasons and has strong daily self-efficacy to use condoms the likelihood not using a condom increased if she or both she and her partner consumed alcohol before sex. This same pattern appeared, although slightly weaker, for women with low endorsement of not using condoms for sensitivity reasons, on days when their condom use self-efficacy was strong. Alcohol before sex had little effect on the likelihood of not using a condom for women with low endorsement of not using condoms for sensitivity reasons on days when they had weak condom use self-efficacy or for those with high endorsement of not using a condom for sensitivity reasons on days when they had weak condom use self-efficacy.

Sex-related alcohol outcome expectancies (AOEs)—None of the main effects for sex-related alcohol outcome expectancies were statistically significant for men or women. Among men sex-related AOEs moderated the effect of self and partner alcohol consumption before sex on whether or not sex was unprotected (alcohol x sex risk AOEs: χ^2 6.51, df=2, $p=0.029$; alcohol x enhancement AOEs: χ^2 6.25, df=2, $p=0.044$). As shown in Figures 5 and 6, men who endorsed sex-risk and enhancement AOEs showed a stronger positive relationship between both partners consuming alcohol before sex and a greater likelihood that sex was unprotected (sex-risk AOE x alcohol interaction: adjOR 3.44, 95% CI 1.35–11.71; enhancement AOE x alcohol interaction: adjOR 2.55, 95% CI 1.21–6.34). None of the moderating effects for AOEs were statistically significant for women.

Discussion

Although the notion that alcohol consumption prior to sex leads individuals to have unprotected sex makes intuitive sense, data supporting this association is mixed, which suggests that this relationship may be influenced by situational and individual difference factors (12). There has been relatively little research that has investigated situational factors in this association using a methodology which temporally sequences alcohol consumption occurring before events of unprotected sex among PLHIV in sub-Saharan Africa. Our team's prior work amongst the same sample showed that the event-level relationship between alcohol consumption and unprotected sex occurred mainly in instances when the individual consumed alcohol at "moderate" or higher risk levels (>3 drinks for men, >1.8 drinks for women), that drinking by both partners vs. just one further increased the likelihood that sex would be unprotected, and that drinking before sex influenced subsequent sexual behavior with casual/secondary partners more than it did with main/steady partners (12). Our objective in the present paper was to examine potential situational and individual difference moderators of the alcohol—unprotected sex relationship, specifically, moderators consistent with alcohol expectancy theory (19) and alcohol myopia theory (20).

According to alcohol expectancy theory (19), and as we predicted, for individuals who think that drinking alcohol will make them more likely to have unprotected sex, drinking alcohol prior to sexual activity should increase the likelihood that sex would be unprotected. The

data partially supported this moderation effect for men but only when both partners consumed alcohol. Finding a moderation effect is consistent with research among presumed HIV-negative adolescent populations (22, 23, 42) and with the findings from experimental studies of presumed HIV-negative individuals in the community (26, 27). As for why these effects were the strongest, and were only statistically significant, when both partners consumed alcohol more so than only the individual consumed alcohol could reflect additional alcohol expectancies that the individual holds about the effect of alcohol on his partner's behavior. Furthermore, social and cultural norms concerning alcohol consumption and sexual behavior may also be reflected in these expectancies. In South Africa, qualitative data suggests that alcohol is commonly believed to have a profound impact on sexual behavior and safer sexual behavior (16, 43).

We also observed moderating effects from the other sex-related AOE of sexual enhancement. Again, the effect of AOE's increasing the likelihood of sex being unprotected when alcohol was consumed before sex was only observed among men, and only when both partners consumed alcohol. These findings are somewhat consistent with Kalichman et al.'s (17) finding that male STI clinic patients in Cape Town who had high enhancement AOE's also were more likely to use alcohol in sexual contexts. The failure to find moderating effects of AOE's among women may be related to gender-related power differentials in sexual behavior decision making, especially in the context of alcohol consumption. Gender-related power differentials are an important factor in understanding unprotected sexual behavior in South Africa (44–46). In such situations a woman's partner, regardless of if the partner drank alcohol, may have more influence over condom use than she does which could mask potential moderating effects. Couples-based studies using dyadic analyses could shed light on this phenomenon (47), however, these types of studies among similar samples are largely missing in the literature due primarily to the difficulty in conducting such studies.

Other studies have identified AOE's as a moderator of the alcohol—unprotected sex relationship among presumed HIV-negative adolescent populations (22, 23, 42) as well as in experimental studies of presumed HIV-negative individuals in the community (26, 27). However, the present study was the first to evaluate sex-risk alcohol outcome expectancies as a moderator of the alcohol—unprotected sex event-level relationship among HIV-positive individuals in South Africa.

Applying alcohol myopia theory (20) to understand alcohol's effect on sexual behavior suggests that when individuals are experiencing inhibition conflict, meaning that their inhibitory and instigatory cues for having unprotected sex are of similar strength, then alcohol is thought to impact individuals' sexual behavior by reducing the salience of inhibitory cues at the time of the behavior. In the present study we conceptualized instigatory cues as believing that sex with a condom doesn't feel as good as a reason for not using condoms and inhibitory cues as social-cognitive predictors of condom use measured each day: attitudes, behavioral intentions, and self-efficacy. We proposed that inhibition conflict would occur when an individual who strongly endorsed that sex with a condom doesn't feel as good as a reason for not using condoms, also had, on a particular day, strong condom use attitudes, intentions, or self-efficacy. We hypothesized that alcohol before sex would exert its strongest influence on increasing the likelihood of not using a condom on

these days. Therefore, to test the assumptions of alcohol myopia theory using our conceptualization of inhibition conflict, we tested three way interactions between event level alcohol before sex, daily measured social cognitive factors, and endorsing that sex with a condom doesn't feel as good as a reason for not using condoms. For the inhibitory cue of strong condom use self-efficacy we found event-level effects of consuming alcohol before sex on increasing the likelihood of not using a condom under situations of inhibition conflict for both men and women. Among men but not women the effect was more pronounced when both partners consumed alcohol before sex. Our results were not entirely consistent with alcohol myopia theory however, as we also found a similar, although weaker, effect of alcohol before sex on behavior among those with low endorsement of lack of sensitivity as a reason for not using condoms on days when they had strong condom use self-efficacy. Interpreted in line with alcohol myopia theory, this suggests that while self-efficacy may be a valid inhibitory cue, there may be a more salient instigatory cue operating in these situations other than the one we tested in this study. Furthermore, since we did not measure the instigatory cue daily, nor immediately prior to sexual activity, we don't know to what extent it was a salient cue to participants at the time of sex. Among women, for the inhibitory cue of positive daily condom use attitudes we also found that under conditions of inhibition conflict if the woman or both partners consumed alcohol before sex there was an increased likelihood of not using a condom during sex. However, like the inhibitory cue of condom use self-efficacy, we also found that alcohol affected behavior under other circumstances as well. On days when women had more negative attitudes about using condoms and strongly endorsed sensitivity as a reason for not using condoms, alcohol before sex led to increases in the likelihood that they wouldn't use a condom during sex if both they and their partner drank alcohol before sex. This suggests that when both partners drank it may have been easier for the woman's partner to convince her to have sex without a condom.

Comparing our results based on whether only the participant drank before sex or both the participant and his/her partner drank we saw some increased effects of alcohol on behavior when both partners drank but these were not consistent across our results. As noted above, among women on days when they had negative attitudes towards using condoms and if they endorsed sensitivity as a reason for not using condoms the effect of drinking before sex was stronger when both partners drank. This was also the case among men on days when they had strong condom use self-efficacy regardless of if their instigatory cues were weak or strong. In the two way interaction between alcohol and condom use attitudes among men we also observed an increased likelihood of not using a condom during sex when both partners drank alcohol. The moderation of the alcohol effect by enhancement AOE's among men was also stronger when both partners consumed alcohol. Previous research has highlighted the role of partner's drinking in influencing condom use (12) but the present results also suggest that the partner's influence on an individual's cognitive states, inhibitory/instigatory cues, and expectancies about the effect of alcohol on behavior at the time of sex may differ when both the individual and his/her partner have been drinking.

Our study provided some, but not consistent support, for alcohol myopia theory and alcohol expectancy theory. By including constructs from both theories in one statistical model we assumed that the theories my operate in tandem as suggested by Moss and Albery (21)

although because of the already complex interactions terms in the model we did not test interactions between the theories. While our findings were not consistent across alcohol outcome expectancies, the constructs that we conceptualized as inhibitory cues, nor what we conceptualized as an instigatory cue, the data does suggest that the effect of consuming alcohol before sex on condom use may be influenced by alcohol's interaction with social cognitive factors about condom use as well as expectancies about the effects of alcohol on behavior and that the partner's drinking may also influence these factors. Additional research is needed to further elucidate these relationships, perhaps measuring all constructs on a daily basis to better predict behavior and account for day to day variation in these factors.

Our findings have a number of implications for clinical interventions. First, we may assume that individuals who regularly use condoms and have positive condom use attitudes, strong intentions to use condoms, and strong condom use self-efficacy may not be in need of intervention. However, if they consume alcohol before sex their risk of having unprotected sex may be greater than someone who has negative attitudes and weak intentions and self-efficacy to use condoms. Specific interventions addressing condom use when alcohol is involved could be helpful. Second, couples based interventions may be useful to address a potential negative influence of the partner when both partners drink prior to sex. Interventions that attempt to change expectancies about the effect of alcohol on sexual behavior may also be useful, especially for men. Finally, interventions that target reducing inhibition conflict by reducing instigatory cues to unprotected sex while also promoting strong inhibitory cues and making inhibitory cues more salient and the time of sex could also have promise for reducing the negative effect of alcohol before sex on condom use.

Limitations

A limitation of the present approach for operationalizing and testing inhibition conflict in a daily diary study is that it was not possible to measure participants' inhibition conflict immediately prior to sexual activity. In order to do so one would have to collect real-time data just before an event of sexual intercourse which is not feasible. Therefore, it is unknown to what extent participants were actually experiencing inhibition conflict in a given situation. Our measure of an instigatory cue as endorsing that sex without a condom feels better as a reason for not using condoms assumes that at the time of the sexual event the individual desires sexual pleasure, which may not be the case in all situations, and therefore that instigatory cue may not have an effect on behavior. Furthermore, we may not have chosen the best constructs to conceptualize inhibitory and instigatory cues which may explain our inconsistent findings. Readers should therefore use caution when interpreting the data as supporting the assumptions of alcohol myopia theory.

Although the current study was innovative in that it explored within-person associations between alcohol consumption and unprotected sex and moderators of this association, by collecting daily diary data, the reader is cautioned about inferring causality from these associations as other variables that were not assessed (e.g., a partner's influence in condom use decision making, whether the sex was consensual, and use of other contraceptive methods) may also play a role in the associations. Furthermore, while participants were

asked to report if their drinking occurred prior to sexual activity this association was not temporally sequenced by taking time-sequential measurements of these constructs. Doing so is not feasible in the context of sexual behavior.

As with all studies with multiple assessment points participant burden and reactivity are a possible limitation. Daily reporting may lead to increased self-monitoring which may influence the behaviors and variables under study (48). Analyses for the effect of time on unprotected sexual behavior and daily inhibitory cues for unprotected sex were not significant, indicating that the participants did not change on these variables as a function of time. This suggests that measurement reactivity was not a problem in the present study. The accuracy of self-reports of sensitive behaviors such as sexual behaviors is still to some extent unknown and it is unknown if some individuals are more likely to give veridical responses than others. The variables included in the present study were embedded in a larger daily structured daily diary interview that inquired about other health behaviors and aspects of daily life. Therefore, the likelihood of reactivity is decreased since the focus of the daily assessments were spread over multiple targets and participants were unable to access previous day's responses (49, 50).

Another limitation of the present study is that the sample consisted of individuals who were willing to disclose their HIV-status in the semi-public environment of an HIV-service organization. Therefore, it is unknown to what extent the findings would generalize to HIV-positive individuals who have not sought treatment and care services and may experience greater fear of being stigmatized. A final limitation of the present study is that the sample was composed of HIV-positive individuals in South Africa. It is therefore unknown to what extent the observed findings would generalize to other populations such as HIV-positive individuals in other countries and to HIV-negative individuals in Africa or elsewhere. Future daily diary research should be conducted to examine theoretical moderators of the relationship between alcohol consumption and unprotected sexual behavior among other populations.

Conclusion

Despite these limitations, the present daily diary study provided insight into when consuming alcohol before sex may lead to unprotected sex among PLHIV in Cape Town, South Africa by exploring the assertions of alcohol expectancy and alcohol myopia theories. The findings also suggest potential intervention avenues to reduce alcohol-involved unprotected sexual behavior which may include changing sex-related alcohol outcome expectancies as well as strategies to make inhibitory cues to unprotected sex more salient "in the heat of the moment."

Acknowledgments

Funding: Supported by the National Institutes of Mental Health (F31MH072547-01 to S.M.K.) by a research development grant from the Center for Health, Intervention and Prevention at the University of Connecticut, a Grant-in-Aid from the Society for the Psychological Study of Social Issues, and by the Clarence J. Rosecrans Research Scholarship from the American Psychological Foundation.

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Figure 1.
Moderation of the effect of alcohol on the likelihood sex is unprotected by daily condom use attitudes among men

Figure 2. Moderation of the effect of alcohol on the likelihood sex is unprotected by daily intentions to use condoms among men

Negative/positive: -1/+1 standard deviation; Low/High: -1/+1 standard deviation

Figure 3.

Three way interaction between alcohol before sex, daily condom use attitudes, and endorsement of sensitivity as a reason for not using condoms among women

Figure 4.

Three way interaction between alcohol before sex, daily condom use self efficacy, and endorsement of sensitivity as a reason for not using condoms

Figure 5.
Moderation of the effect of alcohol on the likelihood that sex is unprotected by sex-risk AOE among men

Figure 6.
Moderation of the effect of alcohol on the likelihood that sex is unprotected by enhancement AOE among men

Table 1

Descriptive Statistics

	Men	Women	Test for gender difference
	Mean (SD)	Mean (SD)	
Mean number of alcohol-involved sex events over 6-weeks	40.91 (31.34)	46.62 (33.31)	$F_{(1,81)} = 0.01$
Proportion of alcohol-involved sex events that were unprotected	0.80 (.12)	0.78 (.16)	$F_{(1,81)} = 0.58$
Daily attitudes towards using condoms [†]	2.22 (1.02)	2.44 (.95)	$\chi^2 (1) = 1.30$
Daily self-efficacy to use condoms [†]	1.62 (.82)	1.52 (.85)	$\chi^2 (1) = 1.16$
Daily intentions to use condoms [†]	2.04 (.85)	1.75 (.85)	$\chi^2 (1) = 4.69^*$
Condom non-use reason: feels better without [†]	2.14 (1.18)	2.10 (1.33)	$F_{(1,81)} = 0.90$
Sex-risk AOE [†]	2.64 (.53)	2.25 (1.00)	$F_{(1,81)} = 2.85$
Enhancement AOE [†]	2.81 (.75)	2.32 (1.08)	$F_{(1,81)} = 3.14$

[†] mean of scale items which were on a 0–4 scale,

* $p < 0.05$

Table 2

Model Testing the Time-Invariant and Time-Varying Variables Predicting the Proportion of Sex Acts that Were Unprotected Per Person per Day over Time and Potential Moderating Effects

	Men		Women	
	AdjOR (95% CI)	χ^2 test of model effect	AdjOR (95% CI)	χ^2 test of model effect
Time-invariant factors				
Sex-risk AOE	1.47 (0.65–2.56)	2.67, p=0.110	1.32 (0.91–1.92)	2.49, p=0.115
Enhancement AOE	1.32 (0.73–2.38)	0.88, p=0.347	1.33 (0.88–2.04)	0.50, p=0.478
Condom non-use reason: feels better without	1.02 (0.66–1.59)	0.01, p=0.920	1.17 (0.99–1.38)	3.62, p=0.057
Time-varying factors				
Partner Type		9.04, p=0.003		20.22, p<.001
Main/Steady (ref.)	1		1	
Casual/Secondary	0.57 (0.39–0.82)		0.54 (0.41–0.70)	
Alcohol before sex				
Neither partner (ref.)	1	11.19, df=2, p=0.015	1	10.24, df=2, p=0.016
Self (moderate > risk level)	2.05 (1.71–2.92)		1.76 (1.17–2.31)	
Both partners	2.38 (1.85–3.24)		1.86 (1.22–1.91)	
Condom use attitudes	0.42 (0.25–0.71)	8.17, p=0.004	0.98 (0.71–1.37)	0.01, p=0.940
Self-efficacy in using condoms	0.45 (0.23–0.88)	10.48, p=0.020	0.77 (0.57–1.02)	3.32, p=0.068
Intentions to use condoms	0.34 (0.19–0.59)	13.96, p<.001	0.70 (0.48–1.01)	3.59, p=0.058
Interactions				
Alcohol x sex-risk AOE		6.51, df=2, p=0.029		0.96, df=2, p=.62
Neither (ref.)	1		1	
Self (moderate > risk level)	1.37 (0.52–3.61)		1.05 (0.66–1.86)	
Both partners	3.44 (1.35–11.71)		1.24 (0.78–1.96)	
Alcohol x enhancement AOE		6.25, df=2, p=0.044		1.77, df=2, p=0.41
Neither (ref.)	1		1	
Self (moderate > risk level)	1.54 (0.62–3.62)		1.44 (0.84–2.45)	
Both partners	2.55 (1.21–6.34)		1.29 (0.76–2.22)	
Alcohol x attitudes		15.85, df=2, p<.001		4.29, df=2, p=0.117
Neither (ref.)	1		1	
Self (moderate > risk level)	2.04 (0.84–4.97)		1.77 (1.01–3.12)	
Both partners	2.93 (1.66–5.16)		1.28 (0.80–2.07)	
Alcohol x self-efficacy		2.70, df=2, p=0.26		5.46, df=2, p=0.065
Neither (ref.)	1		1	
Self (moderate > risk level)	1.51 (0.75–3.03)		1.18 (0.75–1.87)	
Both partners	1.88 (0.89–3.99)		1.47 (1.04–2.07)	
Alcohol x intentions		24.79, df=2, p<0.001		5.57, df=2, p=0.062
Neither (ref.)	1		1	
Self (moderate > risk level)	3.10 (1.28–7.47)		2.07 (1.13–3.82)	
Both partners	4.72 (2.47–9.03)		1.55 (0.94–2.56)	

	Men		Women	
	AdjOR (95% CI)	χ^2 test of model effect	AdjOR (95% CI)	χ^2 test of model effect
Alcohol x condom non-use reason: feels better without		1.33, df=2, p=0.510		4.90, d=2, p=0.086
Neither (ref.)	1		1	
Self (moderate > risk level)	0.91 (0.61–1.35)		0.77 (0.61–0.98)	
Both partners	1.19 (0.71–1.99)		1.02 (0.76–1.35)	
Condom non-use reason: feels better without x attitudes	0.92 (0.57–1.48)	0.005, df=1, p=0.94	1.07 (0.90–1.26)	0.53, df=1, p=0.53
Condom non-use reason: feels better without x self-efficacy	1.53 (0.75–3.13)	1.82, df=1, p=0.18	1.09 (0.85–1.41)	0.49, df=1, p=0.48
Condom non-use reason: feels better without x intentions	1.11 (0.86–1.42)	0.62, df=1, p=0.43	0.96 (0.84–1.11)	0.27, df=1, p=0.61
Condom non-use reason: feels better without x attitudes x alcohol		2.58, df=2, p=0.275		13.54, df=2, p=0.001
Neither (ref.)	1		1	
Self (moderate > risk level)	1.65 (0.68–3.99)		1.34 (0.88–2.05)	
Both partners	0.97 (0.55–1.68)		0.80 (0.54–1.17)	
Condom non-use reason: feels better without x self-efficacy x alcohol				
Neither (ref.)	1	13.10, df=2, p=0.002	1	11.54, df=2, p=0.003
Self (moderate > risk level)	1.36 (0.89–2.07)		1.40 (0.98–1.99)	
Both partners	0.61 (0.30–1.26)		0.90 (0.67–1.21)	
Condom non-use reason: feels better without x intentions x alcohol				
Neither (ref.)	1	2.48, df=2, p=0.289	1	1.29, df=2, p=0.524
Self (moderate > risk level)	1.39 (0.66–2.91)		1.19 (0.80–1.79)	
Both partners	1.47 (0.89–2.43)		0.98 (0.71–1.36)	

AdjOR. Adjusted odds ratios; CI, confidence interval; Ref. Reference category.