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Research on the Effects of Alcohol and Sexual Arousal on Sexual Risk in Men who have Sex with Men: Implications for HIV Prevention Interventions

Stephen A. Maisto¹ and Jeffrey S. Simons²

¹Department of Psychology, Syracuse University, 430 Huntington Hall, Syracuse, NY 13244, USA

²University of South Dakota, Vermillion, SD, USA

Abstract

The purpose of this paper was to describe and appraise the research evidence on the effects of acute alcohol intoxication and sexual arousal on sexual risk behaviors in men who have sex with men (MSM) and to examine its implications for design of HIV prevention interventions that target MSM. Toward that end, the paper begins with a discussion of research on sexual arousal in men and alcohol and their acute effects on sexual behaviors. This is followed by a review of empirical evidence on the combined acute effects of alcohol and sexual arousal in heterosexual men (the large majority of studies) and then in MSM. The empirical evidence and related theoretical developments then are integrated to derive implications for developing effective HIV prevention interventions that target MSM.

Keywords

Alcohol; Sexual arousal; Sexual risk; MSM; HIV prevention

There was an alarming resurgence of high-risk sexual behavior, sexually transmitted diseases (STDs), and new HIV infections among men who have sex with men (MSM) in the early part of the twentieth-first century [1] that has not changed significantly since then [2]. Furthermore, MSM continue to be the subgroup in the United States that is most affected by HIV/AIDS [3–5]. Stemming the tide of new infections among MSM and reducing transmission of STDs and drug resistant HIV strains among MSM already living with HIV are public health priorities.

There is a long-standing interest in clarifying the association between alcohol use and sexual risk, which stems from findings that heavier drinkers tend to engage in sexual risk behaviors more frequently. However, event level studies focusing on the association of alcohol use on specific occasions with high-risk sex have yielded inconsistent results (e.g., [6, 7]). Furthermore, recent findings suggest that the association of alcohol use with risky sexual behavior is best considered a function of the interplay of situational and person variables at the level of the sexual event [6, 8, 9]. The relationship between alcohol and sexual risk is

particularly important for MSM, as they tend to be heavier drinkers than matched groups of heterosexual individuals [5]. An event-level factor in addition to acute alcohol intoxication that would seem to be a critical determinant of sexual risk behaviors is sexual arousal. In fact, as will be described later, for decades sexual arousal has been considered an essential causal factor in human consensual sexual behaviors but has been considered only recently in studies of HIV-related sexual risk behaviors.

The purpose of this paper is to describe and appraise the literature on acute alcohol intoxication and sexual arousal as determinants of sexual risk in MSM and to discuss its implications for the development of behavioral HIV prevention interventions targeting this population. It is important to note that this paper is not intended to be a systematic review of this literature. In this regard, as we show later, there has been an insufficient amount of research published on acute alcohol intoxication, sexual arousal, and sexual risk in MSM to warrant a systematic review. However, considering the relevant research that is available and providing direction for future research seem warranted due to the public health significance of the disproportionately high rates of incidence and prevalence of HIV/AIDS in MSM and implications of research that is available for the development of effective primary and secondary HIV behavioral interventions targeting MSM.

This paper is divided into two main parts. The first part of the paper is an overview of the relation between sexual arousal behavior, acute alcohol effects on sexual behavior, and the combination of acute alcohol and sexual arousal on sexual behavior and sexual risk behaviors in populations not specifically identified as MSM. This information creates the foundation for our discussion of the research on acute alcohol and sexual arousal on sexual risk behaviors in MSM specifically. The second part of the paper is a discussion of the implications of the information presented in Part 1 for the development of HIV prevention interventions that target MSM.

Theoretical Models of Sexual Arousal and Sexual Behavior

Definition of Sexual Arousal in Men

Despite the central importance of the construct “sexual arousal”, sex researchers have found it difficult to reach consensus on a definition. First, there are differences in current conceptions of sexual arousal in men and women [10]; because of that, our emphasis is on sexual arousal in men, in keeping with this paper’s focus on MSM. Second, even in limiting consideration to sexual arousal in men, arriving at a generally accepted definition of this construct has proved elusive. Current thinking is that sexual arousal has biopsychosocial components and thus the complexity of definition. For example, in Toates’s [11] review, he defined sexual arousal as a concept that “refer(s) to the activity within a particular circuit of neurons, which is tied to both sexual motivation and controlling the state of the genitals” (p. 170). In the omnibus model of sexual behavior that Toates presents, the state of arousal is affected by inter-relations among biological, psychological (e.g., cognitions, decision-making processes, perception), and contextual factors. Janssen [12] reviewed the literature on sexual arousal in men and concluded that the data on this question accrued over the last 40 years are so complex that they indicate that “we don’t know” what sexual arousal is (p. 709). This conclusion is not nihilistic regarding the advance or utility of existing knowledge

about sexual arousal and its determinants. Rather, it is a basis for arguing that definitions (and associated operationalizations) of sexual arousal should not be restricted to its measurement by one indicator (e.g., biological) or another (e.g., subjective/psychological), but rather all should be considered admissible evidence toward understanding sexual arousal. Janssen argued that, through such an approach, a more precise and generally accepted definition of sexual arousal would emerge. This approach is in contrast to the perspective that knowledge about sexual arousal will advance only with the establishment of a better-specified definition of the construct [13]. Suffice it to say at this point that it seems most productive to take Janssen's more open perspective in considering the alcohol and sex/sexual risk literatures.

Role of Sexual Arousal in Sexual Behavior

The construct of sexual arousal is critical, of course, because it has been virtually assumed within and outside of scientific writing that it is an essential determinant of sexual behavior. That is, sexual arousal has most often been viewed as motivating (determining) sexual behavior, but, as Janssen [12] noted, sexual arousal is not synonymous with sexual motivation. For example, a biological indicator of sexual arousal in men (erection) may not be accompanied by subjective sexual arousal, such as in nocturnal erections. Nevertheless, it is commonly the case that sexual motivation assumes sexual arousal and vice versa, and sexual motivation is viewed as a primary (but not the only) determinant of sexual behavior. This viewpoint suggests that sexual arousal should be viewed as a mediator of sexual behavior, such that it is the link that connects, say, some internally or externally generated sexual stimulus and sexual behavior response. This is the basic case in the Toates [11] model cited earlier. In that model, arousal is a proximal determinant of sexual behavior, although it is hypothesized that arousal itself is influenced by multiple factors.

As discussed later, empirical studies of alcohol, sexual arousal, and sex or sexual risk have most typically taken the stance that sexual arousal mediates the effects of alcohol on sexual behaviors. However, it is important to note that sexual arousal may also be viewed as a moderator. For example, it could be argued that a variable's (say alcohol intoxication) connection to the occurrence or rate of occurrence of some sexual behavior is most prominent under conditions of heightened sexual arousal (cf. [14]). In that context, the question is framed in a way that sexual arousal serves as a moderator of the alcohol–sex relationship.

Alcohol Intoxication and Sexual Behavior

In Western societies, survey and other observational data show consistently that men perceive that alcohol decreases sexual inhibitions and facilitates sexual behaviors (e.g., [15]). In fact, survey studies show that men who drink and who have adopted the cultural lore about alcohol's effects on sex as part of their own belief system tend to use alcohol before a sexual experience and associate alcohol use with situations involving sexual activity [16]. Survey studies of adult males in Western societies also have shown that alcohol consumption is associated with frequency of sexual behaviors on a global level [17]. That is, across events in a given time interval, say three months, as consumption (say, typical quantity and frequency

of alcohol use) increases, sexual behavior frequency tends to increase. Based on such correlational data, it would seem that alcohol consumption (a) facilitates sexual behavior, and (b) adult men believe that facilitation of sexual activity is one consequence of alcohol use on a given occasion in a given (potentially sexual) context.

Of course, retrospective self-report survey data on typical behaviors over a given period of time do not provide evidence about the association between alcohol use and sexual behaviors on the event/occasion level. However, several studies have been reported that use near-real time data collection methods to test the association between alcohol use and sex. A recent example is Patrick et al.'s [17] Web survey study of college students over the course of seven consecutive semesters using 14-day burst sampling procedures. This study was unique in its collection of near-real time data over the course of 3 years (college year 1–year 4) in the same male and female college students and thus yielding a developmental view of the alcohol–sex connection within—as well as between—persons. In addition, an expanded definition of sex (kissing, oral sex, and penetrative sex) was used. The results showed first that drinking a higher number of drinks and engaging in binge (heavier) drinking were associated with a higher likelihood of all types of sexual activity measured. Second, these associations between consumption and sexual activity were moderated by partner type (attenuated in committed relationships) and positive expectancies about the effects of alcohol on sex (enhanced). This pattern of findings did not vary by participant gender or by semester, so that the results were “developmentally stable.”

Event level data are more useful than global association data in understanding the alcohol–sex relationship, but event level data still are correlational and do not allow causal attributions about relationships among variables. Experimental studies are needed to specify alcohol's actual effects on sex in males. There is a large literature on the effects of alcohol on sexual performance in non-human animals (e.g., [18]) that suggests that there is a negative linear relationship between dose of alcohol and sexual performance in males, which contradicts what many human males believe about alcohol and sex. However, because of the major role that cognitive and other (e.g., emotion) psychological factors play in human sexual activity [11, 19], it is difficult to extrapolate findings about the causal connections between alcohol and sex in male non-human animals to human males. In this regard, experimental studies of alcohol and sex in human adult males were scarce until the 1970s, and since then enough such experimental studies have been published to allow general conclusions to be drawn. This literature also allows conclusions about men's beliefs about alcohol and sex and how they affect men's sexual performance. These experimental studies of course have not investigated actual sexual behavior but rather components of human sexual response (e.g., Kaplan's [20] three-phase model of desire, arousal, and orgasm). The majority of these studies used purported indicators of sexual arousal as their dependent measures.

George et al. [21] provided an excellent summary of findings on the effects of alcohol on sexual response (typically measures of sexual arousal) in men. Studies from the 1970s to about the mid-1980s suggested that alcohol at higher doses, beginning at about blood alcohol concentration (BAC) of .05 %, attenuates sexual arousal in men, as indicated by physiological (e.g., penile tumescence) and self-report measures of sexual arousal. At lower

doses alcohol tends to have no or a slightly facilitative effect on men's sexual arousal. However, studies conducted since the mid-1980s have been inconsistent in their findings and in fact have largely disconfirmed the alcohol attenuation hypothesis, as higher doses of alcohol, up to about BAC = .10 %, often produced little effect on men's sexual arousal, at least for physiological measures.

These inconsistencies in the literature have been attributed to several methodological difficulties in the available laboratory research. Accordingly, George et al. [21] sought to address these methodological problems in their experiment on the effects of alcohol on physiological and self-report measures of sexual arousal in men. In their Study 1, George et al. randomly assigned 65 men to an alcohol (BAC target = .10 %) or no alcohol control condition. Beverage condition was crossed with an instructions factor, which involved asking participants either to maximize their sexual arousal while viewing an erotic video or giving them neutral instructions. Participants watched the video following consumption of their respective beverages while their BACs were ascending to approaching peak level. Penile plethysmography was used to provide a measure of physiological sexual arousal, and participants were asked to provide a self-report of their sexual arousal via responding to a 4-item scale. The results showed that, consistent with the attenuation hypothesis, participants who drank alcohol showed less sexual arousal than men who did not, but the effect was limited to one (peak percentage penile circumference change) of four indexes of physiological sexual arousal. In addition, contrary to predictions, self-reported arousal was rated lower in the maximize condition compared to the neutral condition. No other main effect or interaction was statistically significant.

George et al.'s Study 2 was identical to Study 1, except that the instructional set condition was modified to increase contrast between the two conditions, so that participants were asked to maximize or to suppress their sexual arousal. In addition, the target BAC in the alcohol condition was reduced to .08 %. The results showed that participants given maximize instructions had a larger peak percentage penis circumference change from baseline than did participants in the suppress condition. No other main or interaction effect was found on this or the measure of mean percentage circumference change. For the measure of latency of arousal onset, instructions had their predicted effect in the sober group, but instructional set made no difference among participants who drank alcohol. The measure of latency to peak arousal showed no statistically significant (by conventional standards) differences among the groups. Finally, the self-reported arousal data revealed no significant effects.

George et al. [22] followed up George et al. [21] with a study of how BAC limb (ascending BAC, as alcohol absorption is occurring, or descending BAC, following attainment of peak BAC and alcohol is being eliminated from the body) affect physiological and self-report measures of sexual arousal. As with the majority of research in this area, participants were tested as their BAC was ascending. The question is important, because acute tolerance (e.g., [23]) phenomena could result in reduced alcohol effects on sexual arousal. In this regard, although the evidence seems contingent on the measure of performance that is used, alcohol's stimulating effects on mood and impairment in performance on cognitive-motor tasks tends to be most pronounced when the BAC is ascending. However, recovery in

performance and more sedated/depressive mood tend to occur at the same BAC when the BAC is falling that was associated with impairment when the BAC was rising. Moreover, there is a practical side to the question, as a considerable proportion of sexual activity on an occasion happens following completion of any alcohol consumption that has occurred [22]. In this study, 78 men were randomly assigned to one of four conditions created by the crossing of beverage condition (alcohol, BAC = .08 %, or control) and instructional set (maximize or suppress arousal). Therefore, this study was similar to the George et al. [21] Study 2, except that participants' sexual arousal was measured as their BAC was falling. For physiological measures of arousal, the only significant effect observed was a beverage $\times$ instructions effect on peak percentage circumference change, as instructions affected arousal levels in expected ways among sober participants but not among intoxicated participants. The mean percentage circumference change data showed no effects significant at conventional levels ($\alpha = .05$), and no significant effects were observed in the self-report arousal data.

In summary, the more recent experimental data suggest that alcohol's effects on physiological indexes of sexual response (arousal) tend to be highly circumscribed even at higher doses, and that alcohol shows little effect on self-reported arousal. Instructions to maximize seem to have little effect on physiological and self-report measures of intoxicated men's sexual response. Finally, this more recent research failed to systematically investigate effects of expectancies about the effects of alcohol on sex.

Alcohol, Arousal, and Sexual Risk Behavior

Because the experimental research on alcohol and sex emphasized alcohol's effects on sexual arousal, next to be considered is the *combination* of acute alcohol and sexual arousal effects on sexual behavior. No survey data are available that address the simultaneous action of acute alcohol intoxication and arousal on sexual behavior in general or on sexual risk behavior. However, there are seven reports of eight experimental analogue studies that allow the examination of the relationships among acute alcohol intoxication, sexual arousal, and indicators of sexual risk behaviors in men. These experiments included either both male and female participants or only male participants. As noted earlier, conceptualizations of sexual arousal have considered it a proximal "motivator" of sexual behavior and thus in this context as a mediator of sexual risk behaviors. We have already considered the literature on the acute effects of alcohol on indicators of sexual arousal. Thus the typical design of the experiments discussed next is for participants to consume a dose of alcohol, expose them to a sexual stimulus such as an erotic film (as a manipulated variable or generally) and measure sexual arousal in response to the stimulus, and then test participants' reactions to a situation that involves decisions about engaging in sexual risk behaviors, typically while the BAC still is rising to peak level. Ebel-Lam et al. [24] manipulated sexual arousal, and Wray et al. [25] manipulated autonomic, but not sexual arousal. A summary of the eight experimental studies is presented in Table 1.

There are several points to highlight in reviewing the results of the experiments summarized in Table 1. Participants were heterosexual men and women, or males only, averaging in the young adult age range (typically, mid-20s). Sample sizes seem adequate given the resources

required to conduct this research, although specific power statistics were not provided in any of the reports. Samples' diversity seemed to represent the respective locales where the experiments were conducted. The major independent variable of interest of course was beverage administration, with a good dose range of target BAC, .04–.10 %. Another independent variable of interest, primarily as a hypothesized mediator, was sexual arousal, but as noted it was manipulated in only one of the studies (and autonomic arousal in another); in the others, all individuals were exposed to a sexually arousing stimulus (it should be noted that in several studies instruction to maximize, neutral instructions, or instructions to minimize sexual arousal were manipulated). Physiological sexual arousal (genital response) was measured in about half of the studies, and subjective sexual arousal was measured in all of the studies. The major dependent variable in all of the experiments was likelihood of engaging in risky sex in the analogue situation that was presented in the experiment. This variable also is commonly referred to as "intentions to engage in risky or unprotected sex."

As can be seen in Table 1, six of the experiments tested the arousal as mediator of the alcohol–sexual risk connection, and two tested the moderation hypothesis. Except in Wray et al. [25], the general respective hypothesis was supported with measures of subjective sexual arousal; Wray et al.'s findings may have been due in part to raising alcohol participants to an insufficiently high BAC (.067 %, compared to a target of .08 %), which has yielded inconsistent findings in this literature. However, the specific findings warrant emphasis. In all cases, subjective sexual arousal proved to be a significant mediator or moderator; in the experiments that included both physiological and subjective arousal measurements, only the latter proved to be significantly affected by alcohol. When findings were significant, alcohol's influence on physiological arousal as a direct effect was circumscribed, and as mentioned, the indirect effect of beverage condition → physiological sexual arousal → intentions was never statistically significant. When alcohol affected arousal as part of the indirect effect, it was only at the higher doses administered (.08 or .10 %). In Ebel-Lam et al. [24], which included the manipulation of sexual arousal, the beverage condition (alcohol group target BAC = .08 %) by arousal interaction was statistically significant as predicted, which replicated MacDonald et al.'s [14] finding with arousal as an observational variable, thus providing firmer support for a causal interpretation of the findings. In addition, in one of the experiments in which the mediation hypothesis was confirmed [26], beverage condition's effects were indirect and observed through perception of intoxication; a greater degree of perceived intoxication was associated with a greater degree of arousal, which in turn was associated with a greater degree of sexual risk. Finally, when the experiments included both men and women, the main findings did not vary as a function of sex, so that, for example, no interactions between participant sex and beverage condition or between participant sex and sexual arousal were reported. However, men's likelihood of engaging in risky sex did tend to be at a higher level than that of women's.

It also is important to note that the prediction that alcohol's effects on sexual risk behaviors is positively mediated by sexual arousal is not consistent with the findings reported earlier by George et al. [21, 22] on the direct effects of alcohol on sexual response, in particular on indexes of sexual arousal. Those studies found little support for the hypothesis that alcohol affects either subjective or physiological sexual arousal, either as a facilitator or as an

inhibitor. Nevertheless, several studies summarized in Table 1, some by George and his colleagues, did find evidence for at least a partial mediation effect of subjective sexual arousal (but not physiological) as underlying alcohol's facilitative acute effects on sexual risk intentions. George et al. [27] did address this discrepancy in findings and suggested that in the sexually arousing vignette used in the mediation studies caused participants to focus more on their sexual arousal, but that the vignette used in the earlier sexual response studies had less emphasis on excitatory and inhibitory conflict as much and thus alcohol's effects on subjective arousal were not as powerful. However, in Davis et al.'s [26] experiment they used essentially the same vignette as George et al. [27] and showed no direct effect of alcohol (but did find a positive effect of perceived alcohol intoxication) on subjective sexual arousal in their mediation analyses.

Not included in Table 1 is that most of the studies summarized there were heavily influenced by alcohol myopia theory [28], although they could not be said to be direct tests of it. Briefly, the theory posits that alcohol intoxication tends to facilitate risky sexual behaviors, because in the typical situation that has a moderate-high likelihood of voluntary sexual activity, sexual behavior approach cues (e.g., attractive partner) tend to be most prevalent and tend to draw the individual's attention at the expense of attending to any sex inhibition cues. This attention-biasing effect is hypothesized to be the result of alcohol's acute effects on cognitive processing at moderate or higher BACs. Critical for making decisions about engaging in risky sexual behaviors, sexual arousal has been hypothesized to act in the same way [29–32], so that alcohol and sexual arousal might be viewed as having synergistic effects in this context. Furthermore, arousal, as a motivational construct, may also act to promote “motivated reasoning” [33], which would tend to have the same outcome of focusing attention on impelling cues in a sexual risk situation. In such a context, motivation toward having sex would bias decisions in that direction so that any negative consequences of such behavior would tend to be given less consideration. Therefore, the findings of alcohol–sexual arousal mediation and moderation effects can be interpreted broadly in the alcohol myopia/disruption of cognitive processing of environmental cues framework. Although as noted alcohol expectancies have received relatively little systematic attention in this literature, alcohol expectancy theory also is compatible with myopia theory in explaining alcohol's facilitative effects on sexual risk [34]. In this regard, especially when under the influence of alcohol (or the perception that that is the case), positive expectancies about the effects of alcohol on the initiation of sex and sexual performance could act in conjunction with other impelling cues in the environment, to further direct an intoxicated individual's attention to cues impelling sex rather than to cues inhibiting it.

Summary

In order to provide a foundation for considering the literature on alcohol and arousal effects on sexual risk in MSM, thus far we have described the literature on several topics that allow conclusions that are important in considering the MSM research. Sexual arousal in men was shown to be a complex construct that has defied a generally acceptable operationalization, and that currently it seems best to include physiological and psychological components as relevant. In addition, sexual arousal has been viewed in both theory and empirical studies as a mediator of consensual sexual behavior in humans, although it plausibly could be

construed as a moderator as well. Alcohol's effects on sexual arousal seem complex, despite earlier survey and experimental studies that suggest a negative linear relationship between alcohol dose and arousal in men. Expectancies about the effects of alcohol on sex also seem to be important in alcohol's effects on arousal based on survey and the earlier experimental research, but later experimental studies have not followed up this finding systematically, perhaps due to an emphasis in the more recent research on alcohol myopia theory. It is important to note, however, that hypothesized expectancy effects are not incompatible with alcohol myopia theory's tenets. Finally, the literature on alcohol, arousal, and sexual risk in heterosexual, predominantly young adults suggests (1) that, although there are conflicting data, the arousal mediation hypothesis seems to hold up for the alcohol–sexual risk relationship, but at higher levels (.08 % or higher) of intoxication and for subjective sexual arousal only, (2) cognitions about alcohol and sexual arousal may be important as well, as evidenced by Davis et al.'s [26] findings on perception of intoxication, and (3) when tested, the moderating effect of arousal on alcohol's effects on sexual risk has been substantiated with a target BAC of .08 %. All of these findings were obtained with young adult heterosexual samples and using "intentions" to engage in risky sexual behavior in a hypothetical situation as the dependent variable. This summary sets the stage for review and interpretation of the empirical literature on alcohol, sexual arousal, and sexual risk in MSM.

Alcohol, Sexual Arousal, and Sexual Risk in MSM

The survey literature on the relationship between alcohol use and sexual risk in MSM has been systematically reviewed and reported in several papers, which have led to similar conclusions. Woolf and Maisto's [35] review shows that global association and situational association (focus on alcohol use as part of a complex of events in which high-risk sex occurred) studies are inconclusive. Methodological problems aside, this literature shows inconsistent findings about the connection between alcohol use and sexual risk in MSM, with some studies showing evidence for a positive association, but others reporting null findings, and a few showing a negative relationship. However, Woolf and Maisto did identify one finding that has shown some consistency, and that is a higher likelihood of finding a positive association between heavier alcohol consumption and sexual risk. This finding is evident in Woolf and Maisto's review of event-level studies as well. Vosburgh et al. [36] conducted a review that focused on the more informative event-level studies that updated Woolf and Maisto and extended the latter review by including studies that covered illicit drugs as well as alcohol. Vosburgh et al. found that acute use of only two drugs was consistently associated with sexual risk in MSM in event-level studies: methamphetamine and binge (heavier) levels of alcohol.

Published reports of research on the combined influence of the acute effects of alcohol and sexual arousal on sexual risk in MSM are virtually absent, although this is not due to researchers' failure to consider the influence of sexual arousal (e.g., [31, 32, 37, 38]) and related constructs (e.g., affect; [39, 40]). In this context, there has been one experimental study of the effects of sexual arousal and sexual risk in MSM. In their study conducted via Internet, Shuper and Fisher [30] randomly assigned 67 MSM to an arousal or no arousal video clip manipulation and tested their intentions to engage in hypothetical sexual risk behaviors with men presented in photo and accompanying text profiles. As hypothesized,

participants in the aroused condition tended to report a higher likelihood to engage in sexual risk behaviors with the men depicted in the photos.

Maisto et al. [41] conducted the only study that directly tested the combined influence of alcohol's acute effects and sexual arousal on sexual risk behaviors. In this experimental study, 117 MSM were randomly assigned to one of three beverage conditions (alcohol [target BAC = .07 %], placebo, or control) and a sexual arousal or a neutral film clip condition to form 6 independent groups. Participants in the alcohol/arousal condition achieved an average BAC of .068 %, which did not differ statistically from the BAC of .061 % that participants reached in the alcohol/neutral condition. Following beverage consumption and initial absorption, participants completed a questionnaire measure of risk perception, the Cognitive Appraisal of Risky Events (CARE), with focus on two dimensions, likelihood of positive and negative consequences, respectively, of engaging in sex with a new partner. Participants then were shown two videos, each depicting a hypothetical risky sex situation involving an attractive male character. Post-video ratings were the source of measures of behavioral skills, intentions, and "risk exposure," a new measure derived for this experiment of individuals' responses to progressively high-risk sexual activities with the main character. The responses to the two videos were averaged to form respective single measures of behavioral skills (one measure each to two verbal prompts), intentions, and risk exposure.

Preliminary analyses showed that the placebo and control conditions did not differ in any dependent variable by arousal condition and so were combined to create an alcohol versus no alcohol independent variable in the subsequent analyses. These hierarchical regression analyses also included alcohol sex expectancies, measured as a participant variable in the first session (eligibility confirmation/questionnaires about participant characteristics only) of the experiment. The results of main importance to this paper showed, first, main effects of beverage on both behavioral skills measures, in the predicted direction, as those who drank alcohol showed poorer skills. The beverage x expectancy interaction in one of the skills measures also was in the expected direction, as alcohol's impairing effects on skills was enhanced in individuals who had stronger alcohol sex expectancies. Similarly, as expected, arousal had impairing effects on one of the skills measures, and this same effect was at a trend level in the other. The arousal x beverage interaction was significant and in the expected direction on one of the skills measures, that is sexual arousal enhanced alcohol's impairing effects. Main effects or interactions involving beverage condition or arousal were not statistically significant for any of the four remaining sexual risk measures.

General Conclusions: Part I

Clearly there is a relative dearth of research on the acute effects of alcohol, sexual arousal, and sexual risk in MSM compared to that available on heterosexual men. On the other hand, the MSM research that is available does suggest that the findings of survey and experimental studies of heterosexual and MSM show no major differences. In this regard, the following may be concluded from the body of survey and experimental studies that have been published to date. First, the data generally seem consistent with the predictions of alcohol myopia/impairment of cognitive processing theory of alcohol's acute effects on sexual risk,

although only a minority of studies [14, 24, 42, 43] conducted direct tests of myopia theory. Second, complementing myopia theory with alcohol expectancy theory and the hypothesized action of sexual arousal enhances understanding of alcohol's acute effects on sex, in that both of these constructs appear to have similar effects as alcohol on cognitive processes involved in decisions to engage in sexual behaviors in a given situation. Moreover, expectancy theory helps to explain the effects of perception of intoxication that have been observed on sexual risk. Third, in keeping with a hypothesis of cognitive impairment as underlying alcohol's acute effects on sexual risk (although not tested directly in the studies reviewed here), those effects seem most pronounced at moderately high to high BACs, say at .08 % or higher [44, 45]. Findings at lower BACs likely tend to be weaker or absent.

Future Research

The published research reviewed in this paper has left gaps in knowledge that could be addressed in future research on MSM by attending to several methodological and conceptual points. The first methodological point is to pay more attention to person variables as moderators. We have already cited the importance of an individual's expectancies about the effects of alcohol on the initiation of sex and sexual performance; another such variable is the participant's age. As is evident from our review of the survey and experimental studies cited, the large majority of them recruited participants whose average age was in the young adult range (mid-20s). This is understandable, given that the young adult years are characterized by the highest rates in the life span of heavier drinking, alcohol-related problems, and risky sexual behaviors [46]. However, the Centers for Disease Control and Prevention [47] reported that in recent years, new diagnoses of HIV/AIDS have increased in men 50 years of age or older. Therefore, at least in studying MSM, it seems important to sample a wider age range. In this regard, Maisto et al.'s [41] experiment included a sample of MSM aged 21–50 and showed that age was related to three measures of sexual risk (two behavioral skills measures and perception of negative consequences associated with risky sex), in the direction that older men tended to show greater risk. This finding is consistent with the results of Mustanski's [40] daily diary study of MSM, which showed that alcohol was most strongly related to sexual risk in men who were at least 37 years old (the 75th age percentile in the sample). Heath et al. [48] reviewed the literature on substance use and sexual risk in MSM age 50 or older and found these individuals do engage in risky sex and that its occurrence covaries positively with the consumption of alcohol. Although the studies covered in this review had a number of major methodological problems, this basic finding suggests the need for systematic research on the topic.

The second methodological point concerns the narrow band of sexual risk indicators that have been used in experimental studies of alcohol, sexual arousal, and sexual risk. Intention to engage in sexual risk by far was the modal dependent variable; Maisto et al. [41] used intentions as well as several other sexual risk indicators. It would seem that using a wider range of self-report, behavioral, and psychophysiological measures of sexual risk, as in the case of sexual arousal, would advance the field and broaden generalizability of findings.

The third point is both methodological and conceptual. Many of the studies reviewed in this paper did not address individual differences as part of the research design. From a

methodological perspective, failure to account for individual differences may leave an important percentage in the main outcome variable, sexual risk behaviors, unexplained and relegated to “error” variance. From a theoretical perspective, it could enhance the predictive power of theoretical models of sexual risk if person characteristics were integrated with them [46]. Indeed, a number of studies have investigated the association between personality variables and sexual risk behaviors in both heterosexual and MSM samples (e.g., [37, 39, 40, 42, 46, 49, 50]) and have shown their utility in accounting for variance in sexual risk behaviors. Constructs that have emerged most consistently include sexual sensation seeking, sexual compulsivity, sexual excitation, and sexual inhibition. A construct of particular relevance to this paper is sexual activation, which is interacting components of physiological changes and emotional expressions that motivate behaviors that are fundamental to sexual behavior and reproduction [40, p. 619]. In his daily diary study of MSM, Mustanski found that state sexual activation was associated with the occurrence of sexual risk behaviors and with having multiple sex partners. Trait sexual activation was associated with multiple partner sexual risk. Grov et al.’s [39] daily diary study of MSM also showed a connection between sexual activation and sexual risk, a relationship that was attenuated among individuals who were higher in sexual compulsivity. Overall, it seems that integrating personality constructs with theories of sexual risk behavior would enhance the predictive power of those theories and form the basis for the development of prevention interventions that are more person-specific.

Conceptual Gaps to Address—In this section we present two gaps in theory that warrant attention. The first of these concerns the conceptualization of sexual arousal in men. Earlier it was noted that sexual arousal in men is a complex construct that has been hypothesized to have some overlap with other constructs that are relevant to the occurrence of sexual risk behaviors, as seen in some of the studies described or cited in this paper. Janssen’s [12] paper is an excellent heuristic guide in this regard and provides a model for alcohol–sexual risk researchers to use in developing more nuanced conceptualizations of sexual arousal and their associated operationalization than have been the case in the past. Janssen integrates the literature on sexual arousal in men by proposing that sexual arousal is essential to sexual motivation and has multiple components that do not overlap entirely. In this regard, sexual arousal is proposed to have the components sexual desire, genital response, and subjective sexual arousal, all of which overlap but not perfectly. For example, previous research has shown that the correlation between subjective sexual arousal and genital response is higher in men than it is in women, but studies of men have shown correlations that have a maximum magnitude of .50, or 25 % overlap. Differences in patterns of findings for genital response and sexual arousal were common in the experimental literature reviewed earlier, and understanding this pattern and its relationship to sexual behavior would advance the field considerably.

Probably the most important part of Janssen’s [12] integration of the sexual arousal in men research were his conclusions about designation of sexual arousal as an emotion that can co-exist with other emotional states, both positive and negative, sometimes simultaneously, to influence sexual behavior in complex ways. As cited earlier, there has been some attention to affect as a correlate of sexual risk behaviors in MSM on the event level in the daily diary

studies that Grov et al. [39] and Mustanski [40] reported. These studies provide first-step evidence that affect may influence sexual risk in MSM and pave the way for systematic investigations of alcohol, affect, sexual arousal, and sexual risk in MSM that are guided by more complex conceptualizations of sexual arousal.

The final theoretical gap to be addressed in future research on alcohol, sexual arousal, and sexual risk in MSM (and heterosexual individuals as well) is the absence of research on the dual processes that have been hypothesized to influence sexual arousal. In these models, represented in Bancroft et al. [51] and Toates [11], a complex of excitatory and inhibitory factors influence sexual behavior and its occurrence. One construct that is seen as a determinant of sexual behavior is sexual arousal, which is in keeping with the view that it is a motivational construct. Critically, automatic and conscious cognitive processes are hypothesized to influence sexual arousal itself. This idea is consistent with recent emphasis on dual process models of self-regulation that are relevant to the effects of alcohol and sexual arousal on sexual risk. Dual-process models posit that self-control may consist of two dimensions, a fast acting, reflexive, “automatic” dimension and a slower acting, deliberative or effortful dimension [52, 53]. Automatic, reflexive, control may emphasize affective processes, and the effortful control dimension may largely consist of higher-order “executive function” (EF) processes [53]. There is increasing understanding that, although overt behavior may be described by a single dimension ranging from highly impulsive to highly controlled, multiple psychological control processes influence behavioral output [54, 55].

There has been renewed interest in the role of automatic or implicit processes in behavior, as there is increased recognition that the “unconscious mind is a pervasive, powerful influence over ... higher mental processes” [56, p. 73]. A long tradition of research in social psychology suggests that individuals are often not aware of factors influencing their behavior [56]. In addition, individuals’ ability to exercise deliberative control and to engage in explicit decision making processes before acting varies widely, both between individuals (e.g., [57, 58]) and within individuals across time [53, 59]. When an individual’s ability, or motivation, to exert self-control is compromised, behavior becomes more closely associated with measures of implicit attitudes or implicit approach tendencies that may not be compatible with his/her explicit goals [55]. In the absence of effortful control, individuals tend to act on “autopilot.” In this regard, implicit approach tendencies are a result of associative learning trials, direct or vicarious, occurring over time that have become dominant responses in given contexts.

As articulated in myopia theory, alcohol intoxication is associated with dose-dependent deficits in executive cognitive functions including working memory, attention, and processing speed [60, 61]. Hofmann and Friese [62] found that alcohol moderated the association between explicit and implicit attitudes and eating behavior. We posit that alcohol may similarly shift the association between sexual behavior and automatic versus effortful decision making processes. When sober, individuals may utilize deliberative processes to decide about sexual behavior based on perceived costs and benefits and personal standards. However, as degree of intoxication increases, the role of deliberative processes decreases and automatic processes increasingly drive behavior. In this regard, higher executive function is associated with decreased sexual risk behavior, but acute intoxication diminishes

this effect [63]. Moreover, as discussed earlier, sexual arousal tends to shift the balance of influence of cognitive processes from the deliberative to the automatic, and automatic processes influence (direction dependent on the operation of other factors such as affect) sexual arousal (cf., Toates and Bancroft models). We propose the field could be advanced considerably by systematically investigating the inter-relationships among these factors and with sexual risk behaviors.

Results of a few recent studies provide supportive evidence for the role of implicit processes in sexual risk behavior. In this regard, two studies by Stacy and colleagues [64, 65] showed that implicit cognition (i.e., spontaneous sex-related word associations) predicted both condom use and number of sexual partners. Furthermore, these effects were attenuated by working memory [64] and affective decision-making ability [65]. In addition, an experiment by Simons et al. [66] showed that acute alcohol intoxication was associated with implicit approach biases toward sexual cues paired with a weaker approach toward condom stimuli. These studies did not focus on MSM but provide supportive evidence of the potential interactions among implicit cognition, executive function, and alcohol intoxication.

Finally, it seems that theoretical developments in this area should include tests of the effects of degrees of sexual arousal measured or manipulated on sexual risk-related decision-making. The same holds for alcohol's pharmacological (or perceived) effects on decisions about sexual behavior. Decades of research show general BAC cut points (e.g., .08 %) and hypothesized decline in cognitive processes. Nevertheless, no study has tested the hypothesized cognitive decline as BAC increases in the context of a study of alcohol intoxication, sexual arousal, and sexual risk.

Theory and Research on Alcohol and Sexual Arousal and HIV Prevention Interventions Targeting MSM

As with other health-related behaviors, dual process theory suggests that two fundamental approaches may be taken to increase the likelihood of occurrence of self-regulated behavior, in this case, the occurrence of protected/safer sex, in a given context. The first is to modify the implicit response tendencies that have resulted from an individual's learning history and that for some individuals may have resulted in a tendency toward engaging in risky sexual behavior. The second approach is to strengthen the behavioral and cognitive processes that underlie inhibiting (regulating) risky dominant implicit response tendencies. Of course, both of these approaches could be combined in a HIV prevention intervention.

Modification of Implicit Response Tendencies

Friese et al. [67] described the dual process model of self-regulated behavior and its application in modification of both implicit and deliberative processes in health-related behavior. To modify implicit response tendencies, Friese et al. discussed three different applications that have been tested, although none to our knowledge as a specific component of a HIV prevention intervention. These three applications are changing automatic associations, changing attentional biases, and changing approach tendencies. *Changing associations* involves shifting the valence of affect associated with, in this case, given sexual

behavior. For example, one goal might be to change the affect associated with condom use from more negative to more positive by associative “re-learning.” *Attentional biases* refer to an individual’s tendency to direct his/her attention more in the direction of one kind of stimulus (say, associated with risky sex) than another (say, use of condoms during sex). Attentional biases are fundamental, because in order for a behavior to be executed, attention to relevant stimuli must occur first. *Changing approach tendencies* involves reconditioning the tendency to approach a tempting stimulus/behavior (e.g., engaging in risky sex) with a neutral or avoidant reaction.

The Friese et al. [67] paper and more recent work [68] show that modifying implicit response tendencies to advance self-regulated health-related behavior still is in its early stages, even though dual process theory has been in the literature and has received excellent research support for well over a decade. And, as we noted earlier, modification of implicit responses relevant to risky sex has not been tested as a complete or part of a HIV prevention intervention. Nevertheless, there is enough work relevant to other health-related behaviors such as alcohol and other drug use [69] to suggest that this is a promising track for HIV prevention interventionists and researchers to pursue.

Strengthening Self-Regulated Behavior

Traditionally, HIV prevention behavioral interventions have emphasized rational decision-making (strengthening the control process in dual process terms) and have been guided primarily by psychosocial theories of behavior in general (social cognitive theory, theory of reasoned action, transtheoretical model) or by general models of health behavior (e.g., health belief model; [70]). Lorimer et al. [71] concluded in their “review of reviews” of the efficacy/effectiveness of behavioral HIV prevention interventions targeting MSM, such interventions show good outcomes for unprotected anal intercourse and frequency of condom use. This was shown to be the case especially for group and community interventions, but with less consistency for individual interventions. Moreover, interventions guided by theory and those that emphasized skills training tended to have better outcomes.

Despite these generally favorable findings, rates of new cases of HIV among MSM have not declined into the twenty-first century, as reviewed earlier. Furthermore, at least post-adolescent MSM tend to be educated well about the connection between sexual behavior and contracting HIV [72], so that the knowledge needed to make decisions about sex that would seem rational based on likely outcomes is prevalent. However, the research reviewed in this paper suggests that one way that at least individual and group-delivered behavioral HIV prevention interventions could show greater efficacy/effectiveness is by including components that address “heat of the moment” decision-making, which tends to deviate from the rational to the more “irrational,” and from the deliberate to the automatic. Essentially, this proposal calls for the need to attend more to contextual factors in sexual situations, such as alcohol intoxication, sexual arousal, emotion, and relationship variables, as well as individual variables, such as condom use negotiation skills and self-efficacy to use those skills. Given the relative lack of attention this idea has been given in HIV prevention research and intervention, it is surprising to discover that it is not new, probably first addressed systematically in the published literature over two decades ago [73]. However, it

is an idea that current HIV prevention researchers and interventionists are expressing far more often (e.g., [72, 74, 75]) and is substantiated by research such as that reviewed in this paper. In the remainder of this paper we discuss attempts that have been made to address “heat of the moment” factors as part of behavioral HIV prevention interventions and promising paths for intervention development.

Gold [31] traced the history of his idea of the importance of situational variables such as sexual arousal and their influence on decisions regarding risky sexual behavior. Gold distinguished between “online” and “offline” factors and decisions about sex. Online factors are those that are prevalent “in the here and now” of a sexual situation, such as mood, sexual arousal, and alcohol or other drug intoxication. Offline variables pertain to factors that affect decision-making outside of or away from the sexual context, such as consideration of possible positive and negative consequences of engaging in unprotected sex and knowledge about HIV/AIDS. Gold argued, as others have more recently, that MSM tend to be well informed about HIV, sexual behavior, and consequences. Nevertheless, they often continue to engage in risky sexual behaviors because of the influence of in the moment thinking on decision-making. As concluded from the research reviewed here, factors such as sexual arousal and alcohol intoxication can result in paying undue attention to sexually impelling cues to the relative neglect of sexually inhibiting cues, and from deliberative thought to automatic thought. The result according to Gold is that individuals often use rapidly generated self-justifications (rationalizations) for having risky sex when confronted with that option. Critically, self-justifications would not be used off-line, that is, they likely would not be a strong influence in making that same choice off-line of whether to engage in risky sex.

One example of a self-justification that MSM endorsed in Gold’s [31] research is “Condoms are such horrible things, and to put one on destroys the magic of sex. Here we are on cloud nine; how can we suddenly interrupt everything just to get a bit of rubber out and roll it on?” (p. 268). The idea that self-justification can exert a powerful influence on sexual behaviors suggests the need for HIV prevention interventions to somehow connect with the sexual encounter context itself, by ethical necessity in a simulated or imaginary way. Gold described an intervention that attempted to do this. A sample of MSM who had an occasion of risky sex, in violation of their own “rules” about sex, were asked to recall one of these risky encounters and were asked to select from a list of possible self-justifications any that were present in the event or the one that was predominant. The men were asked then to re-review the adequacy of the reasoning that the self justification(s) represents now, away from the sexual encounter. This cognitive intervention resulted in fewer safe sex “slips” that were reported by individuals in either a no-intervention or a traditional AIDS education control group. Gold argued and presented additional data to suggest that the after-the-fact review of self-justifications was efficacious because it connected the individual personally with his sexual experience; reviewing self-justifications that failed to connect personally would not be as effective.

Gold’s [31] self-justification intervention was followed up in two clinical trials with high-risk MSM. The intervention was called Personalized Cognitive Counseling (PCC) and was developed by Dilley et al. [76–78]. PCC is a one-session, in-person brief intervention in which a counselor works with the individual to identify and discuss self-justifications for

engaging in risky sex used at the time of a given sexual encounter. Similar to Gold's [31] intervention, the identified self-justifications are reviewed outside the sexual encounter context, or "off-line." PCC was shown efficacious in reducing sexual risk behavior in high-risk, HIV-negative MSM and is considered an empirically supported intervention when used in conjunction with HIV testing. Such data were the bases for Knight et al.'s [79] adaptation of PCC in an effort to reduce the frequency of high-risk sexual encounters in MSM who episodically use alcohol heavily or other drugs, which showed initial promising results.

Andrasik et al. [80] agreed with the idea that situational, in the moment factors are important determinants of sexual behavior and that bringing them into awareness and addressing them are important components of behavioral HIV prevention interventions. As cited earlier, as part of this University of Washington-based research team's experiments that included alcohol administration and induction of sexual arousal, participants were asked to read an erotic story ("vignette") as a way to increase sexual arousal in the laboratory. If the experiment was concerned with sexual risk, the story had a possible risky sex outcome that the participant was asked to respond to as if he or she were the protagonist in the story. In one experiment that involved heterosexual women participants, a sub-sample of them was interviewed post-experimentally about their experiences with the scenario and the laboratory. One of the questions asked the participant to discuss her decisions regarding having unprotected (risky) sex with the story's main character, an attractive male. The results of the qualitative data analyses showed that 62 % of the participants used the scenario as a "reflective tool," as a way to give insight into sexual decision-making in their actual lives. As a prevention intervention, this result shows good alignment with the intent of the analysis of self-justification interventions described earlier, as the idea is to increase awareness of how an individual makes decisions about sex and what factors in the sexual encounter context may influence those decisions. Therefore the Andrasik et al. proposal uses the whole of the sexual encounter via imagery and recall to after-the-fact reflect on a sexual event with the goal of meeting goals set for safe sexual practice in the future. In that regard, Lorimer et al.'s [71] review of reviews of empirical studies of behavioral HIV prevention interventions suggested that behavioral skills to negotiate safe sex are important as a way to follow through on or apply any insight that individuals may have about their decision-making in sexual encounter contexts, an idea that Andrasik et al. suggested.

Read et al. [81] took an initial step in this direction. These authors proposed the creation of a virtual sexual encounter conveyed via an interactive video that includes virtual counselors or guides in prevention interventions that target MSM. This concept captures all of the central points that follow from the preceding parts of this paper: 1. The interactive video projection of a sexual encounter scenario places the individual "in-the-moment" to the degree that is ethically possible, 2. As a result, visceral factors are active, as the scenario is created to induce at least mild sexual arousal, 3. The use of virtual counselors who are empathic yet give direct feedback about behavioral choices can be used to increase behavioral skills and concomitant self-efficacy as needed to handle the situation in a real-life sexual encounter, 4. Coursing through the video is highly personalized, as the path that is followed is dependent on the individual's responses to different prompts, and 5. Capturing a sexual encounter and its associated emotional responses virtually "live" and using that context to learn new behaviors (e.g., skilled condom use negotiation) has a high likelihood of transferring to the

natural environment due to the phenomenon of emotion (sexual arousal) and state-dependent learning (Read et al., based on Bower and Forgas [82]). In addition, it would seem that other contextual factors, such as moderate alcohol intoxication, could be incorporated as part of a prevention intervention. Read et al. presented initial evidence that the interactive video intervention is promising, but, unfortunately, apparently there have been no published follow-up reports of the results of larger tests of the intervention. Nevertheless, the concept seems to capture the implications of current research on sexual arousal and other contextual factors in decisions about sex and thus seems worth pursuing.

Summary

From a dual process theory perspective, HIV prevention interventions targeting MSM (and others) emphasizing deliberative cognitive and behavioral skills enhancement should consider contextual factors that may shift the balance of influence of such factors in decisions about sex toward more automatic processes that may incline the individual toward engaging in unsafe sex despite an individual's goals to the contrary. This may be done in different ways, including increasing awareness of implicit processes and their operation, education, and simulating actual sexual encounter contexts so that regulation-strengthening behavioral and cognitive skills may be acquired in a relevant context. Fortunately, recent HIV prevention work suggests that the field is heading in this direction. Moreover, a complementary intervention is to modify implicit motivations to engage in unsafe sex that may be present and that may become more influential in a given situation as a function of alcohol intoxication, alcohol sex expectancies, sexual arousal, and emotion.

Conclusions

The research on alcohol and sexual arousal effects has advanced our knowledge considerably about how these two sexual event contextual factors influence decision-making about sex in MSM and other populations. There remain gaps in the literature that if addressed in future research would advance knowledge and provide a firmer base for developing behavioral HIV prevention interventions. However, what we do know provides a good foundation for improving HIV prevention interventions by translating this knowledge into "in-the-moment" intervention components. Several such examples were described that give an excellent start to this effort, which, if pursued, likely will enhance the efficacy and effectiveness of behavioral HIV prevention interventions that target MSM and other populations.

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References

1. Wolitski RJ, Valdiserri RO, Denning PH, Levine WC. Are we headed for a resurgence of the HIV epidemic among men who have sex with men? *Am J Public Health*. 2001; 91(6):883–8. [PubMed: 11392927]

2. Beyrer C, Baral SD, van Griensven F, et al. Global epidemiology of HIV infection in men who have sex with men. *Lancet*. 2012; 380(9839):367–77. [PubMed: 22819660]
3. Irwin TW, Morgenstern J, Parsons JT, Wainberg M, Labouvie E. Alcohol and sexual HIV risk behavior among problem drinking men who have sex with men: an event level analysis of timeline followback data. *AIDS Behav*. 2006; 10(3):299–307. [PubMed: 16482407]
4. Koblin BA, Husnik MJ, Colfax G, et al. Risk factors for HIV infection among men who have sex with men. *AIDS*. 2006; 20(5):731–9. [PubMed: 16514304]
5. Patterson DA, Wolf S, Hall M, Golder S. Beliefs and behaviors regarding substance use and HIV risk among men who have sex with men (MSM) in a mid-sized U.S. community. *J HIV/AIDS Soc Serv*. 2009; 8(2):188–201.
6. Cooper ML. Toward a person x situation model of sexual risk-taking behaviors: illuminating the conditional effects of traits across sexual situations and relationship contexts. *J Pers Soc Psychol*. 2010; 98(2):319–41. [PubMed: 20085403]
7. Weinhardt LS, Carey MP. Does alcohol lead to sexual risk behavior? Findings from event-level research. *Annu Rev Sex Res*. 2000; 11:125–57. [PubMed: 11351830]
8. Barta WD, Portnoy DB, Kiene SM, Tennen H, Abu-Hasaballah KS, Ferrer R. A daily process investigation of alcohol-involved sexual risk behavior among economically disadvantaged problem drinkers living with HIV/AIDS. *AIDS Behav*. 2008; 12(5):729–40. [PubMed: 18071894]
9. Venable PA, McKirnan DJ, Buchbinder SP, et al. Alcohol use and high-risk sexual behavior among men who have sex with men: the effects of consumption level and partner type. *Health Psychol*. 2004; 23(5):525–32. [PubMed: 15367072]
10. Graziottin A, Basson R. Sexual dysfunction in women with premature menopause. *Menopause*. 2004; 11(6 Pt 2):766–77. [PubMed: 15543028]
11. Toates F. An integrative theoretical framework for understanding sexual motivation, arousal, and behavior. *J Sex Res*. 2009; 46(2–3):168–93. [PubMed: 19308842]
12. Janssen E. Sexual arousal in men: a review and conceptual analysis. *Horm Behav*. 2011; 59(5):708–16. [PubMed: 21397602]
13. Sachs BD. A contextual definition of male sexual arousal. *Horm Behav*. 2007; 51(5):569–78. [PubMed: 17477922]
14. MacDonald TK, MacDonald G, Zanna MP, Fong G. Alcohol, sexual arousal, and intentions to use condoms in young men: applying alcohol myopia theory to risky sexual behavior. *Health Psychol*. 2000; 19(3):290–8. [PubMed: 10868774]
15. McKay A. Sexuality and substance use: the impact of tobacco, alcohol, and selected recreational drugs on sexual function. *Can J Hum Sex*. 2005; 14:47–56.
16. George WH, Stoner SA. Understanding acute alcohol effects on sexual behavior. *Annu Rev Sex Res*. 2000; 11:92–124. [PubMed: 11351836]
17. Patrick ME, Maggs JL, Lefkowitz ES. Daily associations between drinking and sex among college students: a longitudinal measurement burst design. *J Res Adolesc*. 2014; 25(2):377–86.
18. Frohmader KS, Pitchers KK, Balfour ME, Coolen LM. Mixing pleasures: review of the effects of drugs on sex behavior in humans and animal models. *Horm Behav*. 2010; 58(1):149–62. [PubMed: 20004662]
19. Wilson GT. Alcohol and human sexual behavior. *Behav Res Ther*. 1977; 15:239–52. [PubMed: 339894]
20. Kaplan, HS. Disorders of sexual desire. New York: Brunner/Mazel; 1979.
21. George WH, Davis KC, Norris J, et al. Alcohol and erectile response: the effects of high dosage in the context of demands to maximize sexual arousal. *Exp Clin Psychopharmacol*. 2006; 14(4):461–70. [PubMed: 17115874]
22. George WH, Cue Davis K, Schraufnagel TJ, et al. Later that night: descending alcohol intoxication and men's sexual arousal. *Am J Mens Health*. 2008; 2(1):76–86. [PubMed: 19477772]
23. Schweizer TA, Vogel-Sprott M. Alcohol-impaired speed and accuracy of cognitive functions: a review of acute tolerance and recovery of cognitive performance. *Exp Clin Psychopharmacol*. 2008; 16(3):240–50. [PubMed: 18540784]

24. Ebel-Lam AP, MacDonald TK, Zanna MP, Fong GT. An experimental investigation of the interactive effects of alcohol and sexual arousal on intentions to have unprotected sex. *Basic Appl Soc Psychol*. 2009; 31(3):226–33.
25. Wray TB, Simons JS, Maisto SA. Effects of alcohol intoxication and autonomic arousal on delay discounting and risky sex in young adult heterosexual men. *Addict Behav*. 2015; 42:9–13. [PubMed: 25462647]
26. Davis KC, George WH, Norris J, et al. Effects of alcohol and blood alcohol concentration limb on sexual risk-taking intentions. *J Stud Alcohol Drugs*. 2009; 70(4):499–507. [PubMed: 19515289]
27. George WH, Davis KC, Norris J, et al. Indirect effects of acute alcohol intoxication on sexual risk-taking: the roles of subjective and physiological sexual arousal. *Arch Sex Behav*. 2009; 38(4):498–513. [PubMed: 18431618]
28. Steele CM, Josephs RA. Alcohol myopia: its prized and dangerous effects. *Am Psychol*. 1990; 45(8):921–33. [PubMed: 2221564]
29. Ariely D, Loewenstein G. The heat of the moment: the effect of sexual arousal on sexual decision making. *Behav Decis Mak*. 2006; 19(2):87–98.
30. Shuper PA, Fisher WA. The role of sexual arousal and sexual partner characteristics in HIV+ MSM's intentions to engage in unprotected sexual intercourse. *Health Psychol*. 2008; 27(4):445–54. [PubMed: 18643002]
31. Gold RS. AIDS education for gay men: towards a more cognitive approach. *AIDS Care*. 2000; 12(3):267–72. [PubMed: 10928202]
32. Bancroft, J. The role of theory in sex research. Bloomington: Indiana University Press; 2000.
33. Kunda Z. The case for motivated reasoning. *Psychol Bull*. 1990; 108(3):480–98. [PubMed: 2270237]
34. Moss AC, Albery IP. A dual-process model of the alcohol-behavior link for social drinking. *Psychol Bull*. 2009; 135(4):516–30. [PubMed: 19586160]
35. Woolf SE, Maisto SA. Alcohol use and risk of HIV infection among men who have sex with men. *AIDS Behav*. 2009; 13(4):757–82. [PubMed: 18236149]
36. Vosburgh HW, Mansergh G, Sullivan PS, Purcell DW. A review of the literature on event-level substance use and sexual risk behavior among men who have sex with men. *AIDS Behav*. 2012; 16(6):1394–410. [PubMed: 22323004]
37. Bancroft J, Janssen E, Strong D, Carnes L, Vukadinovic Z, Long JS. Sexual risk-taking in gay men: the relevance of sexual arousability, mood, and sensation seeking. *Arch Sex Behav*. 2003; 32(6):555–72. [PubMed: 14574099]
38. Gold RS. On the need to mind the gap: on-line versus off-line cognitions underlying sexual risk-taking. The theory of reasoned action: its application to AIDS-preventive behaviour. 1993:227–52.
39. Grov C, Golub SA, Mustanski B, Parsons JT. Sexual compulsivity, state affect, and sexual risk behavior in a daily diary study of gay and bisexual men. *Psychol Addict Behav*. 2010; 24(3):487–97. [PubMed: 20853934]
40. Mustanski B. The influence of state and trait affect on HIV risk behaviors: a daily diary study of MSM. *Health Psychol*. 2007; 26(5):618–26. [PubMed: 17845113]
41. Maisto SA, Palfai T, Vanable PA, Heath J, Woolf-King SE. The effects of alcohol and sexual arousal on determinants of sexual risk in men who have sex with men. *Arch Sex Behav*. 2012; 41(4):971–86. [PubMed: 22009480]
42. Davis KC, Hendershot CS, George WH, Norris J, Heiman JR. Alcohol's effects on sexual decision making: an integration of alcohol myopia and individual differences. *J Stud Alcohol Drugs*. 2007; 68(6):843–51. [PubMed: 17960302]
43. Prause N, Staley C, Finn P. The effects of acute ethanol consumption on sexual response and sexual risk-taking intent. *Arch Sex Behav*. 2011; 40(2):373–84. [PubMed: 21318417]
44. Hindmarch I, Kerr JS, Sherwood N. The effects of alcohol and other drugs on psychomotor performance and cognitive function. *Alcohol*. 1991; 26(1):71–9.
45. Morean ME, Corbin WR. Subjective response to alcohol: a critical review of the literature. *Alcohol Clin Exp Res*. 2010; 34(3):385–95. [PubMed: 20028359]

46. Noar SM, Zimmerman RS, Palmgreen P, Lustria M, Horosewski ML. Integrating personality and psychosocial theoretical approaches to understanding safer sexual behavior: implications for message design. *Health Commun.* 2006; 19(2):165–74. [PubMed: 16548707]
47. Centers for Disease Control and Prevention. Questions and answers: the 15% increase in HIV diagnoses from 2004 to 2007 in 34 states and general surveillance report questions. Atlanta, GA: Author; 2007.
48. Heath J, Lanoye A, Maisto SA. The role of alcohol and substance use in risky sexual behavior among older men who have sex with men: a review and critique of the current literature. *AIDS Behav.* 2012; 16(3):578–89. [PubMed: 21390534]
49. Shuper PA, Joharchi N, Rehm J. Personality as a predictor of unprotected sexual behavior among people living with HIV/ AIDS: a systematic review. *AIDS Behav.* 2014; 18(2):398–410. [PubMed: 23835736]
50. Newcomb ME, Clerkin EM, Mustanski B. Sensation seeking moderates the effects of alcohol and drug use prior to sex on sexual risk in young men who have sex with men. *AIDS Behav.* 2011; 15(3):565–75. [PubMed: 20960048]
51. Bancroft J, Graham CA, Janssen E, Sanders SA. The dual control model: current status and future directions. *J Sex Res.* 2009; 46(2–3):121–42. [PubMed: 19308839]
52. Wiers RW, Bartholow BD, van den Wildenberg E, et al. Automatic and controlled processes and the development of addictive behaviors in adolescents: a review and a model. *Pharmacol Biochem Behav.* 2007; 86(2):263–83. [PubMed: 17116324]
53. Lieberman MD. Social cognitive neuroscience: a review of core processes. *Annu Rev Psychol.* 2007; 58:259–89. [PubMed: 17002553]
54. Volkow, ND. Addiction: conflict between brain circuits. Forefront Lecture Series at BC Centre for Excellence in HIV/AIDS; BC, Canada: 2010.
55. Hofmann W, Friese M, Strack F. Impulse and self-control from a dual-systems perspective. *Perspect Psychol Sci.* 2009; 4(2):162–76. [PubMed: 26158943]
56. Bargh JA, Morsella E. The unconscious mind. *Perspect Psychol Sci.* 2008; 3(1):73–9. [PubMed: 18584056]
57. Wills TA, Walker C, Mendoza D, Ainette MG. Behavioral and emotional self-control: relations to substance use in samples of middle and high school students. *Psychol Addict Behav.* 2006; 20(3):265–78. [PubMed: 16938064]
58. Simons JS, Dvorak RD, Batien BD, Wray TB. Event-level associations between affect, alcohol intoxication, and acute dependence symptoms: effects of urgency, self-control, and drinking experience. *Addict Behav.* 2010; 35(12):1045–53. [PubMed: 20685044]
59. Baumeister, RF., Schmeichel, BJ., Vohs, KD., Kruglanski, AW., Higgins, ET. Social psychology: handbook of basic principles. 2. New York, NY: Guilford Press; 2007. Self-regulation and the executive function: the self as controlling agent; p. 516-39.
60. Pihl RO, Paylan SS, Gentes-Hawn A, Hoaken PN. Alcohol affects executive cognitive functioning differentially on the ascending versus descending limb of the blood alcohol concentration curve. *Alcohol Clin Exp Res.* 2003; 27(5):773–9. [PubMed: 12766621]
61. Curtin JJ, Fairchild BA. Alcohol and cognitive control: implications for regulation of behavior during response conflict. *J Abnorm Psychol.* 2003; 112(3):424–35. [PubMed: 12943021]
62. Hofmann W, Friese M. Impulses got the better of me: alcohol moderates the influence of implicit attitudes toward food cues on eating behavior. *J Abnorm Psychol.* 2008; 117(2):420–7. [PubMed: 18489218]
63. Ralevski E, Perry EB, D'Souza DC, et al. Preliminary findings on the interactive effects of IV ethanol and IV nicotine on human behavior and cognition: a laboratory study. *Nicotine Tob Res.* 2012; 14(5):596–606. [PubMed: 22180582]
64. Grenard JL, Ames SL, Stacy AW. Deliberative and spontaneous cognitive processes associated with HIV risk behavior. *J Behav Med.* 2013; 36(1):95–107. [PubMed: 22331437]
65. Ames SL, Grenard JL, Stacy AW. Dual process interaction model of HIV-risk behaviors among drug offenders. *AIDS Behav.* 2013; 17(3):914–25. [PubMed: 22331391]
66. Simons JS, Maisto SA, Wray TB, Emery NN. Acute effects of intoxication and arousal on approach/avoidance biases toward sexual risk stimuli in heterosexual men. *Arch Sex Behav.* 2015

67. Friese M, Hofmann W, Wiers RW. On taming horses and strengthening riders: recent developments in research on interventions to improve self-control in health behaviors. *Self Identity*. 2011; 10(3): 336–51.
68. Wiers RW, Houben K, Fadardi JS, van Beek P, Rhemtulla M, Cox WM. Alcohol cognitive bias modification training for problem drinkers over the web. *Addict Behav*. 2015; 40:21–6. [PubMed: 25218067]
69. Wiers RW, Gladwin TE, Hofmann W, Salemink E, Ridderinkhof KR. Cognitive bias modification and cognitive control training in addiction and related psychopathology: mechanisms, clinical perspectives, and ways forward. *Clin Psychol Sci*. 2013; 1(2):192–212.
70. Noar S. An interventionist's guide to AIDS behavioral theories. *AIDS Care*. 2007; 19(3):392–402. [PubMed: 17453575]
71. Lorimer K, Kidd L, Lawrence M, McPherson K, Cayless S, Cornish F. Systematic review of reviews of behavioural HIV prevention interventions among men who have sex with men. *AIDS Care*. 2013; 25(2):133–50. [PubMed: 22774763]
72. Halkitis PN. Reframing HIV prevention for gay men in the United States. *Am Psychol*. 2010; 65(8):752–63. [PubMed: 21058777]
73. Gold RS, Skinner MJ, Grant PJ, Plummer DC. Situational factors and thought processes associated with unprotected intercourse in gay men. *Psychol Health*. 1991; 5(4):259–78.
74. Bauermeister, JA., Elkington, KS., Huebner, D. Sexuality and HIV/ AIDS prevention. In: Tolman, DL.Diamond, LM.Bauermeister, JA., et al., editors. *APA handbook of sexuality and psychology: person-based approaches*. Vol. 1. Washington, DC: American Psychological Association; 2014. p. 697-724.
75. Moeller RW, Halkitis PN, Pollock JAIV, Siconolfi DE, Barton S. When the emotions really started kicking in, which ended up being a problem: sex, HIV, and emotions among young gay and bisexual men. *J Homosex*. 2013; 60(5):773–95. [PubMed: 23593958]
76. Dilley JW, Schwarcz S, Murphy J, Joseph C, Vittinghoff E, Scheer S. Efficacy of personalized cognitive counseling in men of color who have sex with men: secondary data analysis from a controlled intervention trial. *AIDS Behav*. 2011; 15(5):970–5. [PubMed: 20680432]
77. Dilley JW, Woods WJ, Loeb L, et al. Brief cognitive counseling with HIV testing to reduce sexual risk among men who have sex with men: results from a randomized controlled trial using paraprofessional counselors. *J Acquir Immune Defic Syndr*. 2007; 44(5):569–77. [PubMed: 17310937]
78. Dilley JW, Woods WJ, Sabatino J, et al. Changing sexual behavior among gay male repeat testers for HIV: a randomized, controlled trial of a single-session intervention. *J Acquir Immune Defic Syndr*. 2002; 30(2):177–86. [PubMed: 12045680]
79. Knight KR, Das M, DeMicco E, et al. A roadmap for adapting an evidence-based HIV prevention intervention: personal cognitive counseling (PCC) for episodic substance-using men who have sex with men. *Prev Sci*. 2014; 15(3):364–75. [PubMed: 23412947]
80. Andrasik MP, Otto JM, Nguyen HV, et al. The potential of alcohol “heat-of-the-moment” scenarios in HIV prevention: a qualitative study exploring intervention implications. *Arch Sex Behav*. 2013; 42(8):1487–99. [PubMed: 23740468]
81. Read SJ, Miller LC, Appleby PR, et al. Socially optimized learning in a virtual environment: reducing risky sexual behavior among men who have sex with men. *Hum Commun Res*. 2006; 32(1):1–34.
82. Bower, GH., Forgas, JP. Mood and social memory. In: Forgas, JP., editor. *Handbook of affect and social cognition*. Mahwah, NJ: Lawrence-Erlbaum Associates; 2001. p. 95-120.

Table 1

Summary of findings of experimental studies on alcohol intoxication, sexual arousal, and sexual risk

Authors	Relevant independent variables	Participant characteristics	Results
Davis et al. [42]	Alcohol BAC .10 %, or beverage control (no alcohol instructions)	61 male (51 %) and female college students and community members mean age 24.3 (7.2) years	Men reported greater degree of intentions to engage in risky sex; alcohol's effects on intentions to engage in unsafe sex mediated by perception of arousal cues in the hypothetical sexual risk context
Davis et al. [26]	Alcohol BAC .10 %, or beverage control; limb of BAC curve	150 male (51 %) and female college students and community members mean age 25.2 (3.8) years	Men reported greater degree of intentions to engage in risky sex; alcohol's effects on intentions to engage in unsafe sex mediated through its effects on perception of intoxication, which in turn was positively correlated with subjective sexual arousal; greater perceived intoxication reported on ascending compared to descending limb
Ebel-Lam et al. [24]	Alcohol BAC .08 %, placebo beverage control, or beverage control; exposed to a sexual arousing (magazine story) or neutral condition	79 male college students, mean age 20.0 (1.8) years	Beverage $\times$ subjective sexual arousal interaction: greatest degree of sexual risk intentions in alcohol/arousal group
George et al. [27]	Study 1. Alcohol BAC .04, .08 %, or beverage control	115 male (49 %) and female college students and community members mean age 24.9 (3.6) years	Alcohol's (.08 %) effects on intentions to engage in risky sex mediated through its effects on subjective sexual arousal. BAC .04 % did not differ from .08 % or controls
	Study 2. Alcohol BAC .06, .08, or .10 %, beverage control; instructions to maximize or suppress sexual arousal	165 male college students and community members mean age 25.0 (3.8) years	Alcohol's (.10 %) effects on intentions to engage in risky sex mediated through its effects on subjective sexual arousal (alcohol .10 % > .08 % and controls; .06 % no difference from other groups. No effects of alcohol on genital arousal, genital arousal not related to intentions. Significant instructional effect on physiological genital arousal as predicted
MacDonald et al. [14]	Alcohol BAC .08 % or Beverage Control	358 male college students recruited over seven separate experiments; age data not reported	Beverage $\times$ subjective sexual arousal on intentions; alcohol-high arousal (latter post hoc defined) showed greatest degree of intentions to engage in risky sex
Prause et al. [43]	Alcohol BAC .025, .08 % and beverage control (juice; within-participant design; alcohol given in 1 session, juice the other); high Sexual arousal and neutral film segments. Conditions administered across 2 sessions	44 (48 % male) college students and community members mean age 24.0 (5.8) years	Arousal manipulation seemed effective only with women; more subjective sexual arousal reported to last film segment of the alcohol session, when BAC at .08 %, compared to baseline than during beverage control session; subjective sexual arousal positively related to intentions to engage in risky sex; evidence for alcohol (high BAC) subjective sexual arousal mediation effect on sexual intentions; no alcohol effects on genital arousal
Wray et al. [25]	Alcohol BAC .08 %, placebo, or control (juice) crossed with high or low autonomic arousal to create 6 independent groups. Participants also completed a measure of delayed discounting as a predicted mediator of alcohol or arousal effects on sexual risk	113 undergraduate men mean age 22.3 (1.9) years	No main effects of autonomic arousal (AA) on intentions to engage in unprotected sex, but subjective sexual arousal predicted intentions; participants in the alcohol group reported greater intentions than did placebo participants. Beverage was not related to subjective arousal and thus no mediation effect was found. The beverage $\times$ AA interaction was not

Authors	Relevant independent variables	Participant characteristics	Results
			significant in the prediction of sexual arousal

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