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Cognitive Influences on Sexual Risk and Risk Appraisals in Men Who Have Sex with Men

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Abstract

Objective—Men who have sex with men (MSM) account for more than half of new HIV infections each year. Previous research has linked cognitive variables from the Information, Motivational and Behavioral Skills (IMB) Model to sexual risk behavior, but cognitions may additionally influence risk appraisals of sexual encounters and subsequently potentiate sexual risk. The aim of this study was to use prospective event-level data to examine the direct influence of cognitive variables on sexual risk in MSM, as well as the moderating effects of these variables on the association between unprotected anal intercourse (UAI) and risk appraisals of these encounters.

Methods—143 ethnically diverse MSM were enrolled in a three-month online diary study of sexual behavior. Each week participants reported on specific sexual behaviors that occurred during each of up to three sexual encounters, including type of sexual behavior, condom use, and perceived risk for acquiring HIV during the encounter. All analyses were conducted with Hierarchical Linear Modeling.

Results—Condom use self-efficacy was the only cognitive variable that was directly associated with UAI. However, both HIV knowledge and social norms of condom use contributed to accuracy of risk appraisals. Conversely, MSM who were highly motivated to become/stay safer downplayed the risk associated with their unprotected sexual encounters.

Conclusions—Cognitive variables play an important role in influencing sexual risk in MSM both directly and indirectly via risk appraisals. Addressing these cognitive processes in HIV prevention interventions may help to increase the likelihood of condom use and the accuracy of risk appraisals.

Keywords

HIV/AIDS; sexual risk; men who have sex with men; HIV knowledge; motivation

Men who have sex with men (MSM) are substantially impacted by HIV/AIDS in the United States (CDC, 2011). In 2009, MSM accounted for 61% of new HIV/AIDS diagnoses in the U.S. (Prejean et al., 2011), despite the fact that gay men are estimated to represent 2-4% of

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the general population (Savin-Williams & Ream, 2007). Rates of new infections continue to rise among MSM, while rates of new infections have declined in heterosexuals and injection drug users (CDC, 2011). In the absence of a bio-medical approach that durably prevents HIV, it continues to be important to identify risk factors that can be addressed through behavioral interventions. Although recent findings suggest that primary chemoprophylaxis (Grant et al., 2010) and treatment as prevention (Cohen et al., 2011) can decrease HIV transmission, antiretroviral treatment is not a substitute for the promotion of safer sexual practices.

While an increasingly large body of research has identified a variety of behavioral predictors of sexual risk in MSM (e.g., substance use) (Mustanski, Newcomb, Du Bois, Garcia, & Grov, 2011; Vosburgh, Mansergh, Sullivan, & Purcell, 2012), it is equally important to delineate the cognitive processes that influence perceptions of risk (i.e., risk appraisals) and decisions about condom use, such as HIV knowledge, risk reduction motivation, and perceived social norms. Existing research on these effects has been plagued by an over-reliance on cross-sectional research and examinations of the bivariate associations between single construct measures and sexual risk (cf., Safren et al., 2010; Teng & Mak, 2011). Multivariate models, on the other hand, may help to more precisely determine the variables that contribute the most unique variance to sexual risk behavior. Furthermore, it is unlikely that risk behavior and risk appraisals are static over time within the individual, and longitudinal studies of multiple sexual encounters allow for the analysis of change in behavior and appraisals within-persons. Within-person designs also provide stronger information to inform intervention approaches because they identify factors that determine individual behavior, rather than differences between groups.

The Information, Motivation, and Behavioral Skills (IMB) Model is a widely-used framework for studying HIV risk behavior and developing prevention interventions for MSM (Fisher & Fisher, 1992), and it provides a theoretical framework that links a variety of cognitive processes to HIV risk. The IMB Model asserts that the fundamental determinants of engaging in HIV preventive behaviors are the combined effects of having HIV-related information and prevention knowledge, motivation to become/stay safer, and behavioral skills to engage in prevention behaviors. Having accurate information about transmission and prevention is a necessary but insufficient component of reducing risk, and an individual must have the motivation and skills necessary to utilize this knowledge. Moreover, multiple factors influence motivation to reduce sexual risk, including intentions to use condoms during sexual encounters, social norms surrounding condom use, appraisals of the risk involved with unprotected sex, and evaluations of the severity of the consequences of sexual risk. Finally, the IMB Model discusses the importance of sexual risk-reduction skills, which has typically been measured in the literature as condom use self-efficacy (e.g., Kalichman, Picciano, & Roffman, 2008). Individuals must possess the belief that they are capable of drawing on their knowledge and utilizing risk reduction skills in multiple contexts in order to consistently engage these skills.

Research linking some of the components of the IMB Model to sexual risk has been mixed. Some studies have found that lack of knowledge or erroneous beliefs about HIV/AIDS transmission is positively related to sexual risk (Dilley et al., 2002; Halkitis, Zade, Shrem, &

Marmor, 2004; Huebner & Gerend, 2001) while others have found no association (Halkitis, Siconolfi, Fumerton, & Barlup, 2008; van der Snoek et al., 2006). As would be predicted by the IMB Model, the research literature indicates that sexual risk-reduction knowledge may be a necessary but insufficient factor in reducing one's risk for HIV acquisition. Several studies have found that perceived peer norms for non-condom use are associated with increased sexual risk-taking, particularly in younger samples of MSM (Berg, 2008; Chesney et al., 2003; Kok, Hoppers, Harterink, & De Zwart, 2007; Rosario, Mahler, Hunter, & Gwadz, 1999; Waldo, McFarland, Katz, MacKellar, & Valleroy, 2000). Sexual risk-taking has also been found to be associated with lower perceived severity of becoming infected (van der Snoek et al., 2006) and negative attitudes toward condom use (Kok et al., 2007). Finally, studies have consistently found that low self-efficacy for HIV risk-reduction is linked to sexual risk (Berg, 2008; Chesney et al., 2003; Diaz, Stall, Hoff, Daigle, & Coates, 1996; Dilley, McFarland, Sullivan, & Discepola, 1998; Kok et al., 2007; Mao, Van de Ven, & McCormick, 2004; Waldo et al., 2000; Zea, Reisen, Poppen, Bianchi, & Echeverry, 2005).

Much less attention has been paid to the factors that influence appraisals of risk during sexual encounters. According to the IMB Model, an individual must feel personally vulnerable to HIV acquisition and appraise their behavior as risky in order to engage in HIV risk reduction behaviors (Fisher & Fisher, 1992). These appraisals play an important role in determining future behavior, as it is unlikely that an individual will engage in risk reduction if they do not actually perceive their behavior to be risky. In fact, one study found that the majority of MSM with unrecognized HIV infection in their sample actually perceived themselves to be at low risk for acquiring the virus (MacKellar et al., 2005). This finding highlights the need to identify factors that influence risk appraisals in order to delineate targets for intervention.

Importantly, the bulk of the literature on the effects of cognitive variables on sexual risk has been cross-sectional, which fails to account for changes in sexual risk and risk appraisals within-persons across sexual episodes. Prospective sexual diary studies improve upon this by linking risk appraisals to individual sexual encounters within-persons over time in order to more precisely measure perceptions of risk in varying contexts. Moreover, previous research on the cognitive components of the IMB Model have tended to evaluate their bivariate effects on sexual risk, and multivariate analyses are necessary in order to determine whether certain cognitive variables account for the majority of the variance in sexual risk.

The current study aimed to evaluate the effects of cognitive variables described in the IMB Model on both sexual risk behavior and risk appraisals of sexual encounters. These aims were achieved using prospective data of multiple sexual encounters within-persons using an ethnically diverse sample of MSM enrolled in a sexual diary study spanning three months. We hypothesized that sexual risk behavior (i.e., unprotected anal intercourse; UAI) would be associated with lower endorsement of each of the following variables derived from the IMB model: intentions to use condoms, motivation to become/stay safer, perceived severity of HIV infection, social norms toward condom use, perceived risk at baseline, and condom use self-efficacy. We anticipated no relationship between HIV knowledge and sexual risk.

Next, we hypothesized that having UAI would be associated with a higher likelihood that MSM would appraise these episodes as risky. We additionally tested whether the IMB cognitive variables moderated the association between sexual risk behavior and risk appraisals in order to evaluate whether MSM appraised the riskiness of their actual sexual risk episodes variably based on their scores on these cognitive domains (e.g., do MSM who lack HIV knowledge appraise risk differently than those with more knowledge?). Given the relative dearth of research on the influence of cognitions on risk appraisals in MSM, we considered these moderating analyses exploratory and made no a priori hypotheses about these effects.

Methods

Participants

One hundred forty-three ethnically diverse MSM were enrolled in a longitudinal diary study of sexual behavior. The mean age of the sample was 27.53 ($SD = 7.33$) with an age range of 16 to 40 years. At the time of enrollment, 9.1% of the sample was under the age of 18. Six participants did not report any sexual behavior during the 12-week assessment period, leaving an analytic sample of 137 MSM. See Table 1 for full demographic description of the sample.

Participants were eligible if they met four inclusion criteria: 1) had engaged in oral and/or anal sex with another man within the six months prior to screening; 2) were between the ages of 16 and 40; 3) were not in a sexually-monogamous relationship; and 4) were HIV-negative or of unknown serostatus at the time of enrollment. These criteria were utilized to increase the likelihood that participants would have multiple sexual encounters and/or sexual partners within the assessment period. The age range was limited to 16 to 40 to capture the developmental groups at highest risk for HIV acquisition. HIV-positive MSM were excluded from the study because the psychosocial experiences of HIV-positive MSM likely differ from those of HIV-negative MSM, and cognitive influences on risky sex may also differ based on serostatus.

Procedures & Design

All participants were recruited online via advertisements placed on Craigslist and Facebook that contained a link to an Eligibility Screener. Online recruitment targeted postings in urban areas in the following states within the United States: California, the District of Columbia, Florida, Georgia, Illinois, Louisiana, New York, and Texas. These states contain urban areas with large MSM populations, and each state allows adolescents to receive a variety of medical services without parental consent (including HIV/STI testing; Guttmacher Institute, 2011), which allowed for justification of enrolling MSM ages 16 and 17 without parental consent.

All participants were provided with an Information Sheet that detailed key information regarding research subjects' rights and issues related to confidentiality. Based on details provided in the Information Sheet, we evaluated capacity of minor participants to assent by administering four multiple choice questions during the Eligibility Screener that evaluated

participants' ability to: (1) name things they would be expected to do during the study, (2) explain what they would do if they no longer wished to participate in the study, (3) explain what they would do if they experienced distress during the study and (4) identify potential risks for participating in the study (University of California, 2003; Dunn & Jeste, 2001).

Participants completed baseline measures of between-subjects variables (e.g., IMB cognitive variables) before beginning weekly sexual diaries. Weekly diaries were completed for 12 weeks (as opposed to the typical 4 week duration of daily diaries), which allowed us to observe more sexual behavior and partnerships. Each diary survey detailed the specific activities of up to three sexual encounters from the previous week and situational variables associated with these encounters (e.g., risk appraisals). Participants had 48 hours to complete each diary, and they received an email reminder if they had not completed the diary survey in the first 24 hours. All questionnaires were completed online. Participants were paid up to 60 dollars for participation, pro-rated for participation level. On average, participants completed 83.7% of all dairy surveys. To avoid multiple enrollment of the same participant, contact information was cross-referenced against: date of birth, age, race/ethnicity, geographic location, additional contact information, and IP address. Online advertisements and the eligibility screener did not indicate the necessary requirements for eligibility in order to minimize the potential for faking eligibility (Mustanski, 2001). The protocol was approved by the Institutional Review Board (IRB).

Baseline Measures

General Demographics—The demographic questionnaire assessed participants' age, race/ethnicity, self-reported sexual orientation, and geographic location.

HIV/AIDS Knowledge Questionnaire (HIV-KQ-18; Carey & Schroder, 2002)—

The HIV-KQ-18 is an 18-item true-false self-report instrument assessing knowledge of transmission and prevention. It demonstrates strong internal consistency, test-retest stability, and correlations with other measures of HIV knowledge. The HIV-KQ-18 has been successfully used with young adults (Jaworski & Carey, 2007) and MSM (Mimiaga et al., 2009). Four additional items were added to assess MSM-specific HIV knowledge, and example items included, "A person cannot get HIV from having sex with someone who is HIV-positive but has an undetectable viral load" and "A person cannot get HIV from being the 'top' or insertive partner during anal sex." Cronbach's α in this sample (including additional items) was .73 and the mean number correct was 17.80 ($SD = 3.12$), or 81% correct on average with a standard deviation of 14%.

HIV/AIDS Motivation and Behavioral Skills (Kalichman et al., 2008)—

This is a 17-item self-report measure that assessed: Motivation (i.e., intentions to use condoms, motivation to become/stay safer), Social Norms (i.e., partners', friends', and family members' opinions about condom use), and Behavioral Skills (i.e., condom use self-efficacy). Three additional questions were added to assess perceived severity/consequences of becoming infected with HIV (e.g., "How concerned would you be about your future if you became HIV positive?"). Internal reliabilities of these sub-scales ranged from .57 to .91 (Cronbach's α : Intentions = .91, Social Norms = .69, Self-Efficacy = .85, and Perceived

Severity = .57). Motivation to become/stay safer was assessed with a single item: “How would you describe your motivation to become safer/stay safe?” Perceived riskiness of previous sexual behavior was also assessed with a single item: “Based on your sexual behavior over the past three months, how much do you think you have been at risk for being infected with HIV or other STDs?” Components of the HIV/AIDS Motivation and Behavioral Skills measure were analyzed as separate constructs, as evidence suggests that they may contribute uniquely to HIV risk (Kalichman et al., 2008).

Sexual Diary Measures

Sexual Behavior—Each week participants reported the number of sexual encounters they had during the previous week. Participants reported on specific sexual behaviors (e.g., oral and anal sex) that occurred during each of up to three sexual encounters (i.e., the three most recent sexual encounters) and whether or not a condom was used for each behavior. For these analyses, a risk episode was considered to be unprotected anal intercourse (UAI; coded 1) and a non-risk episode was considered to be protected anal intercourse and/or any oral sex. All other sexual encounters, including all encounters with female partners, were excluded from analyses.

Risk Appraisals—For each sexual encounter reported in weekly diaries, participants evaluate the riskiness of these encounters using the following question: In terms of risk for HIV, how risky do you think this sexual encounter was? Participants responded on a 4-point Likert scale (0 = not risky, 1 = somewhat risky, 2 = risky, and 3 = very risky).

Sexual Partnership Characteristics—HIV status of partner was measured on a 5-point Likert scale (0 = I know this person is HIV-negative, 1 = I think this person is HIV-negative, 2 = I don't know this person's HIV status, 3 = I think this person is HIV-positive, 4 = I know this person is HIV-positive). Partner race was dummy-coded into Black, Latino and Other in order to utilize partner race variables (i.e., Black and Latino race) as covariates. Participants indicated that number of previous sexual encounters with a partner for each sexual encounter detailed in the weekly diaries with a numerical responses, which was winsorized at three standard deviations from the mean to reduce the effects of outliers (winsorized range 0-333).

Analyses

All analyses were conducted using Hierarchical Linear Modeling (HLM) 7.0 statistical software and procedures outlined by Raudenbush and Bryk (2002). HLM is well suited to analyze sexual diary data because it is designed to account for dependency in observations in repeated measures data that contains a nested or multilevel structure. In this case, repeated observations of sexual encounters and risk appraisals (both at Level 1) are nested within participants (Level 2). Two separate models were run in HLM to achieve the aims of the current study. First, we examined the main effects of IMB constructs on sexual risk. In this model, our Level 1 outcome variable was UAI, which was a sexual episode-specific variable. At Level 2, we estimated the main effects of the IMB constructs (i.e., non-time varying constructs) on UAI. The second model examined the effects of IMB constructs on the risk appraisals of sexual encounters during the diary study. In this model, we first

estimated the Level 1 main effect of having UAI on the perceived risk of that sexual encounter. Next we examined the cross-level interactions between the IMB constructs (Level 2) and UAI (Level 1) in describing the episode-specific perceptions of risk.

Maximum likelihood estimation was used to model both dependent variables. In the first model, we used a Bernoulli distribution to estimate UAI as the dependent variable because this technique allows for modeling of binomial distributions. This model accounted for over-dispersion in the dichotomous outcome variable (i.e., the standard deviation of the outcome variable was larger than the mean), and results are presented as odds ratios (OR). In the second model, we used a normal distribution to model risk appraisals as the outcome variable, and results are present as standardized coefficients. All independent variables in both models were entered as uncentered because each of these variables had an interpretable zero value. Robust standard errors were used in estimating significance for all effects.

Results

Participants had approximately one sexual encounter per week ($M = .94$, $SD = 1.26$; range 0-15) and a total of 1,189 episodes observed in the data, 88.2% ($N = 1,049$) of which occurred with male partners. On average, 4.2% of participants reported having more than three encounters during any given week, meaning these analyses captured the majority of participants' encounters during the assessment period. Across all participants, 22% ($N = 231$) of reported sexual encounters with male partners were UAI episodes. 52.9% ($N = 555$) of encounters with male partners occurred with repeat partners and 47.1% ($N = 494$) occurred with new partners.

We first ran an unconditional (null) model of the odds of UAI with no predictor variables entered at Level 1 or Level 2 in order to evaluate the extent to which variability in sexual risk was due to group differences (between-subjects characteristics) or change over time (within-persons factors), which can be expressed as weighted Kappa for dichotomous outcomes (Fleiss & Cohen, 1973). Weighted Kappa was .22, indicating that participants were largely inconsistent in their sexual risk behaviors across episodes. We next tested for reactivity (i.e., behavioral change due to study participation) by entering the week of data collection as a Level 1 variable. The results did not support reactivity in responding ($OR = 0.98$, $p = .329$). Finally, we entered demographic covariates (i.e., age, race/ethnicity) at Level 2 to evaluate group differences in UAI across the 12-week assessment period. Likelihood of UAI was not associated with participant age ($OR = 1.00$, $p = .922$). Compared to White MSM, Black MSM were 55% less likely to report UAI ($OR = .49$, $p = .055$), though this effect was a statistical trend. There were no differences between White MSM and both Latino MSM ($OR = 1.52$, $p = .239$) and Other race MSM ($OR = 1.50$, $p = .434$) in odds of UAI. More details on racial differences in sexual risk for this sample are reported elsewhere (ANONYMIZED FOR REVIEW, 2013).

Cognitive Influences on Sexual Risk Behavior

We first evaluated each bivariate association between cognitive variables and UAI (i.e., Level 2 main effects). Both motivation to become/stay safer ($OR = 0.54$, $p < .001$) and intentions to use condoms ($OR = 0.45$, $p < .001$) were associated with lower odds of UAI,

such that odds of UAI decreased by 46% and 55%, respectively, for each unit increase in the predictor variable (ranges 0-3). Social norms of condom use were similarly associated with lower odds of UAI ($OR = 0.27, p < .001$), such that the odds of UAI decreased by 73% for each unit increase in perceived norms (range 0-4). Finally, condom use self-efficacy was significantly associated with odds of UAI ($OR = 0.52, p < .001$), and the odds of UAI decreased by 48% for each one-unit increase in self-efficacy (range 0-6). All other cognitive variables were not directly associated with UAI, including HIV knowledge ($OR = 0.98, p = .427$), perceived severity of HIV infection ($OR = 0.69, p = .278$), and baseline perceived of risk of acquiring HIV ($OR = 1.47, p = .068$). We next ran a multivariate trimmed model that included all significant bivariate Level 2 main effects (see Table 2). Condom use self-efficacy was the only variable that remained significant in this multivariate model ($OR = 0.67, p < .05$). Social norms ($OR = 0.60, p = .121$), motivation ($OR = 0.87, p = .416$) and intentions ($OR = 0.84, p = .333$) became non-significant.

Cognitive Influences on Risk Appraisals

We first ran an unconditional model with risk appraisal as the outcome variable and calculated the intraclass correlation coefficient (ICC). The ICC was 0.58, indicating that 58% of the variance in risk appraisals was due to individual differences and 42% was due to event-level factors. At Level 1, UAI was associated with higher perceived risk of encounters (coefficient = 0.78, $p < .001$). Several group differences (i.e., Level 2 main effects) in risk appraisals were significant while controlling for UAI. Compared to White MSM, Black MSM perceived their sexual encounters as riskier (coefficient = 0.45, $p < .01$). Neither Latino MSM (coefficient = 0.12, $p = .314$) nor Other race MSM (coefficient = 0.38, $p = .111$) differed from White MSM in perceptions of risk. Perceptions of risk tended to decrease with age (coefficient = $-0.01, p = .05$).

We next entered each cognitive variable into Level 2 of HLM and individually evaluated the moderating effects (i.e., cross-level interactions) of these variables on the association between UAI and risk appraisals. Perceived risk of sexual behavior at baseline was a significant moderator (coefficient = 0.40, $p < .05$), such that individuals with a history of perceived sexual risk at baseline attributed higher perceived risk prospectively when engaging in UAI. HIV knowledge and social norms of condom use both moderated this relationship in a similar manner. Individuals with more HIV knowledge (coefficient = 0.08, $p < .001$) and more supportive social norms for condom use (coefficient = 0.52, $p < .05$) perceived their UAI episodes as riskier than those lower on both of these domains. Conversely, participants who endorsed more motivation to become/stay safer attributed less risk to episodes of UAI than those with less motivation (coefficient = $-0.33, p < .05$). The following cognitive variables were not significant moderators of the relationship between UAI and risk appraisals: perceived severity of HIV infection (coefficient = $-0.40, p = .166$), condom use intentions (coefficient = $-0.05, p = .807$), and condom use self-efficacy (coefficient = $-0.03, p = .802$).

We next entered all significant bivariate moderating effects simultaneously into a multivariate model while controlling for the effects of certain sexual partnership characteristics that may influence perceptions of risk (i.e., sexual partner's perceived HIV

status, race/ethnicity, and number of previous encounters with the partner) (Table 3). In this model, three previously described moderating effects maintained statistical significance at $p < .05$: HIV knowledge (Figure 1; coefficient = .06, $p < .01$), social norms (Figure 2; coefficient = 0.69, $p < .001$), and motivation (Figure 3; coefficient = $-.38$, $p < .001$). The moderating effect of baseline perception of risk (coefficient = 0.20, $p = .139$) became non-significant. Also notable, certain Level 1 sexual partnership characteristic covariates had significant associations with risk appraisals. Participants perceived their sexual encounters with partners they perceived to be HIV-positive as riskier (coefficient = 0.27, $p < .001$). Perceived risk of sexual encounters decreased marginally as the number of previous encounters with the partner increased (coefficient = -0.01 , $p = .097$). Compared to White partners, encounters with Black (coefficient = 0.07, $p = .447$) and Latino partners (coefficient = 0.09, $p = .118$) were not differentially associated with risk appraisals.

HLM makes several assumptions that can be assessed by examining the residual files generated when running analyses. We examined the histograms of the Level 1 residuals and Level 2 empirical Bayes residuals in order to assess the assumption that all error terms are normally distributed. The current data did not violate this assumption. Next, we examined the scatter plots of the Level 1 residuals on all study variables included in the multivariate analysis in order to assess the assumption that the Level 1 residual variance is constant. Again, this assumption was not violated with the current data.

Discussion

The current analyses expand upon previous studies of cognitive influences on sexual risk behavior in MSM in several important ways. First, we were able to more clearly identify which variables accounted for the most variance in sexual risk by utilizing multivariate analyses, and condom use self-efficacy emerged as the only significant predictor of UAI. Additionally, we conducted a novel analysis of the moderating effects of the components of the IMB model on the association between UAI and risk appraisals of these encounters in order to determine whether certain cognitive processes affect the accuracy of risk appraisals. HIV knowledge, social norms of condom use, and motivation to become/stay safer each exerted significant moderating effects, which may have important implications for the maintenance of sexual risk behavior over time.

Consistent with hypotheses and previous research, increased condom use self-efficacy was protective against UAI in both bivariate and multivariate analyses (Berg, 2008; Chesney et al., 2003; Diaz et al., 1996; Dilley et al., 1998; Kok et al., 2007; Mao et al., 2004; Waldo et al., 2000; Zea et al., 2005), but the significant bivariate effects of motivation to become/stay safer, condom use intentions, and social norms of condom use all became non-significant in multivariate analysis. These analyses indicate that while motivation, intentions, and social norms may contribute to the desire to engage in safer sex, the most robust predictor of condom use is likely self-efficacy (i.e., confidence in one's ability to use condoms effectively). The presence of higher levels of these other cognitive processes may very well increase one's self-efficacy, but these analyses indicate that they are not sufficient in influencing condom use directly.

Despite the fact the self-efficacy was the only cognitive variable directly associated with sexual risk behavior, HIV knowledge, social norms of condom use, and motivation to become/stay safer each moderated the relationship between UAI and the risk appraisals of these encounters. These cognitive processes may affect the accuracy of risk appraisals of sexual encounters, and inaccurate appraisals may subsequently promote future sexual risk behavior. For example, MSM with higher HIV knowledge and more supportive social norms of condom use evaluated their UAI encounters as significantly riskier compared to individuals with lower knowledge and less supportive norms, respectively. While HIV knowledge and social norms may not be directly related to sexual risk, interventions that aim to increase HIV knowledge and improve social norms of condom use may increase the accuracy of risk appraisals and subsequently increase perceived vulnerability to HIV infection. These important changes may help deter MSM from engaging in sexual risk behavior in the future.

Motivation to become/stay safer was also a significant moderator of the association between UAI and risk appraisals, but in this case MSM with more motivation appraised their UAI as less risky than individuals with less motivation. At first glance this seems counterintuitive: one would expect that highly motivated individuals would be more vigilant about sexual risk and would therefore evaluate any unprotected sexual encounters as very risky. Alternatively, MSM who had a stronger desire to use condoms and stay HIV-negative may have been downplaying the riskiness of their unprotected sexual encounters through a rationalization process. Using a cognitive dissonance framework (Festinger, 1957), this process of downplaying risk appraisals to better match values and minimize distress associated with risk behavior makes sense. Importantly, this may promote future episodes of sexual risk behavior and provides an important target for cognitive interventions. In accordance with the IMB Model (Fisher & Fisher, 1992), individuals need to feel personal vulnerability to HIV before they are willing to engage in risk reduction behavior change. Intervention efforts that address misappraisals of risk may be necessary in order to induce a sense of personal vulnerability to HIV and decrease sexual risk.

Taken together, the current analyses indicate that cognitive variables are critical components of sexual risk behavior, but these variables contribute to sexual risk in a variety of ways. While condom use self-efficacy was the only variable with a direct effect on sexual risk, other variables had important indirect effects by influencing risk appraisals. Higher levels of HIV knowledge and social norms of condom use appeared to increase accuracy of risk appraisals when engaging in UAI. Conversely, some MSM seemed to make cognitive errors when appraising the risk of their UAI encounters, particularly MSM with more motivation. As we move forward to further investigate these influences and develop effective risk reduction interventions, we must consider the influence of multiple cognitive processes and address direct influences on sexual risk behavior as well as influences on risk appraisals. Both of these intervention targets may be necessary for effective long-term behavior change.

Importantly, the literature has clearly established the need to address a variety of other behavioral variables when promoting safer sexual behavior, including substance use, mental health problems, and sexual partnership characteristics (Mustanski et al., 2011). Furthermore, previous research has identified certain episode-specific cognitions, or self-

justifications, that may influence the likelihood of engaging in sexual risk (e.g., Gold & Skinner, 1992; Nelson, Simoni, Pearson, & Walters, 2011). It is prudent to integrate existing efficacious intervention strategies that address these risk factors into a more comprehensive risk reduction intervention protocol that can be adapted based on the unique needs of the individual (Safren, Blashill, & O’Cleirigh, 2011; Stall, Herrick, Guadamuz, & Friedman, 2009). Additionally, behavioral diaries like the one used in the current study may be adapted into self-monitoring tools to induce behavior change (e.g., by allowing individuals to observe the dissonance between their motivations and behaviors). Self-monitoring tools could be utilized in conjunction with clinical intervention strategies or as stand-alone interventions, but more research is needed to evaluate the conditions under which behavioral diaries can be utilized as intervention tools.

All findings must be considered within the context of several important limitations. With online recruitment, multiple enrollment of participants or faking eligibility is possible. While we adhered to rigorous procedures to minimize these risks, it is not possible to fully rule out these possibilities. Additionally, it is not possible to control the environments in which participants completed online assessments. However, evidence suggests that online data collection is just as accurate as in-person data collection, and it may be perceived as more anonymous and may reduce the effect of social desirability with self-report data (Gosling, Vazire, Srivastava, & John, 2004). In terms of analyses, this study used UAI as a primary outcome, and other outcome variables (e.g., serodiscordant UAI) may provide more nuanced information about sexual risk. Finally, the current study did not include MSM who were in sexually-monogamous relationships, were HIV-positive, or who had not had oral or anal sex with a man within six months of enrollment. Furthermore, we recruited from two websites targeting a limited number of urban areas in the U.S. As such, our results cannot be generalized to the MSM community as a whole.

Despite these limitations, these data highlight the important role that cognitive variables play both in influencing and potentiating sexual risk behavior in MSM. These findings shed light on previous inconsistencies in the literature by providing a more comprehensive view of the effects of cognitive influences on risk. It seems that there are a variety of cognitive variables that are important targets for HIV prevention interventions, particularly condom use self-efficacy, social norms of condom use, HIV knowledge, and misappraisals of risk in individuals who are highly motivated to stay safe. Addressing these cognitive factors in conjunction with other behavioral risk factors may increase the effectiveness of HIV prevention efforts and may be necessary for affecting long-term behavior change.

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Figure 1.
Moderating Effect of HIV Knowledge on the Association Between Odds of Unprotected
Anal Intercourse and Risk Appraisals

Figure 2.
Moderating Effect of Social Norms of Condom Use on the Association Between Odds of
Unprotected Anal Intercourse and Risk Appraisals

Figure 3.
Moderating Effect of Motivation to Become/Stay Safer on the Association Between Odds of Unprotected Anal Intercourse and Risk Appraisals

Table 1
Participant Demographics: Men Who Have Sex with Men Recruited Online, 2011

Variable	% of Full Sample <i>N</i> (%)	% of Analytic Sample <i>N</i> (%)
Age		
16-24	59 (41.3)	57 (41.6)
25-30	36 (25.2)	33 (24.1)
31-40	48 (33.5)	47 (34.3)
Mean (<i>SD</i>)	27.53 (7.33)	27.54 (7.40)
Race/Ethnicity		
White/Caucasian	53 (37.1)	50 (36.5)
Black/African American	32 (22.4)	31 (22.6)
Hispanic/Latino	39 (27.3)	37 (27.0)
Asian/Pacific Islander	6 (4.2)	6 (4.4)
Other or Multi-Racial	13 (9.1)	13 (9.5)
Sexual Orientation		
Gay	111 (77.6)	106 (77.4)
Bisexual	29 (20.3)	28 (20.4)
Heterosexual (same-sex attracted)	3 (2.1)	3 (2.2)
Geographic Region		
Northeast	37 (25.9)	36 (26.3)
Midwest	40 (28.0)	37 (27.0)
West Coast	42 (29.4)	40 (29.2)
South/Southeast	24 (16.8)	24 (17.5)
Total <i>N</i>	143	137

NOTE: There were no significant differences between the full and analytic sample for any of the above described demographic characteristics.

Table 2
Cognitive Influences on Sexual Risk in Bivariate and Multivariate Analyses

Level 2 Main Effects	Bivariate Analysis OR (95% CI)	<i>p</i> value	Multivariate Analysis OR (95% CI)	<i>p</i> value
HIV Knowledge	0.98 (0.91 – 1.04)	.427	—	—
Perceived Severity of HIV Infection	0.69 (0.35 – 1.36)	.278	---	---
Perceived Risk at Baseline	1.46 (0.97 – 2.18)	.068	---	---
Motivation to Become/Stay Safer	0.54 (0.39 – 0.75)	*<.001	0.87 (0.61 – 1.23)	.416
Intentions to Use Condoms	0.45 (0.32 – 0.64)	*<.001	0.84 (0.59 – 1.20)	.333
Social Norms of Condom Use	0.27 (0.16 – 0.46)	*<.001	0.60 (0.31 – 1.15)	.121
Condom Use Self-Efficacy	0.52 (0.38 – 0.71)	*<.001	0.67 (0.46 – 0.97)	*<.05

NOTE: Asterisks denote statistical significance at $p < .05$. Only effects that were statistically significant at $p < .05$ were included in multivariate analysis. OR = Odds Ratio. CI = Confidence Interval

Table 3
Moderating Effects of Cognitive Variables on the Association Between Odds of Sexual Risk and Risk Appraisals: Bivariate and Multivariate Analyses

Level 1 Main Effects and Cross-Level Interactions	Bivariate Analysis Coefficient Value	<i>p</i> value	Multivariate Analysis Coefficient Value	<i>p</i> value
Sexual Partner Perceived HIV Status	---	---	0.27	* $<.001$
Sexual Partner Race (Black)	---	---	0.07	.447
Sexual Partner Race (Latino)	---	---	0.09	.118
Number Previous Sexual Encounter with Partner	---	---	− 0.01	.097
Sexual Risk Behavior (UAI)	0.78	* $<.001$	− 1.80	* $<.01$
X Intentions to Use Condoms	0.05	.807	---	---
X Perceived Severity of HIV Infection	−0.40	.116	---	---
X Condom Use Self-Efficacy	− 0.03	.802	---	---
X Perceived Risk at Baseline	0.40	* $<.05$	0.20	.139
X HIV Knowledge	0.08	* $<.001$	0.06	* $<.01$
X Social Norms of Condom Use	0.52	* $<.05$	0.69	* $<.001$
X Motivation to Become/Stay Safer	− 0.33	* $<.05$	− 0.38	* $<.001$

NOTE: This table presents two separate analyses. The first presents bivariate effects for the Level 1 main effect and cross-level interactions. All effects preceded by an “X” refer to the cross-level interactions between these variables and UAI in describing risk appraisals. The second presents the full multivariate model used to examine all Level 1 main effects and cross-level interactions, including Level 1 covariates. Asterisks denote statistical significance at $p <.05$. Only effects that were statistically significant at $p <.05$ were included in multivariate analysis.