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ORIGINAL PAPER

Reactions to Testing HIV Negative: Measurement and Associations with Sexual Risk Behaviour Among Young MSM Who Recently Tested HIV Negative

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Abstract Receiving an HIV-positive test result is associated with reduced condomless anal sex (CAS), but little is known about negative test results. The recent development of the Inventory of Reactions to Testing HIV Negative confirmed that there are diverse reactions to receiving a negative test result, which have implications for risk behaviour. The goals of the current study were to validate the measure in a sample of young men who have sex with men who recently tested HIV-negative ($N = 1113$) and to examine its associations with CAS. Factor analysis identified four factors, three of which were the same as the original factors (Reinforced Safety, Luck, and Invulnerability) and one that was novel (Reinforced Risk). Construct validity was demonstrated with associations between subscales and constructs from the IMB model of HIV prevention. Lower Reinforced Safety and higher Luck and Reinforced Risk were associated with more CAS. Associations between Reinforced Safety and Luck with CAS were stronger for those who reported more lifetime HIV tests. Findings highlight the importance of reactions to testing HIV-negative and suggest that they become more important with repeated testing.

Keywords HIV · Testing · Risk behaviour · Young men who have sex with men

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Introduction

The rate of HIV among men who have sex with men (MSM) in the US continues to increase despite the overall rate remaining stable [1]. In 2013, MSM accounted for 81 % of estimated HIV diagnoses among all males (ages 13 and older) and, among those infected, only 49 % of young MSM (YMSM) ages 18–24 knew of their infection [2]. To address these growing concerns, the CDC has expanded initiatives to increase HIV testing, especially for MSM, recommending that they get tested at least once a year and every 3–6 months if sexually active [2]. Research on the psychological and behavioural consequences of HIV testing has generally focused on responses to testing HIV-positive and large-scale studies and meta-analyses find that receiving an HIV-positive test result is associated with a subsequent reduction in condomless anal sex (CAS) [3–8]. In contrast, there has been relatively little attention to responses to testing HIV-negative. Given the increased emphasis on regular HIV testing among MSM, it is important to understand the potential iatrogenic effects of testing HIV-negative in order to prevent unintended consequences.

Among the few studies that have examined responses to testing HIV-negative, initial findings indicated that receiving an HIV-negative test result was associated with immediate relief of anxiety [9] and less hopelessness over

the next year [10]. Although meta-analyses report inconsistent or null effects of testing HIV-negative on HIV risk behaviour [3, 6], there is some evidence that it may increase risk. For instance, one study found that testing HIV-negative was associated with an increase in gonorrhea incidence 6 months later [11] and several studies found that repeated HIV-negative test results were associated with increased sexual risk behaviour among MSM [12–14]. It has also been suggested that there may be heterogeneity in how people respond to HIV test results [15], which may help explain the mixed findings in the literature.

Until recently, there was no way to quantify diverse reactions to testing HIV-negative. Mustanski et al. [16] developed the Inventory of Reactions to Testing HIV Negative (IRTHN) in a sample of MSM in New York City recruited on a geospatial smartphone application for MSM to meet. Factor analyses revealed three types of reactions: (1) Reinforced Safety, or the belief that testing negative reinforced past decisions to have safer sex and to continue safer sex in the future; (2) Luck, or the belief that testing negative represented "dodging a bullet;" and (3) Invulnerability, or the belief that multiple negative test results produced feelings of immunity or difficulty in becoming infected. Importantly, reactions to testing HIV-negative were associated with HIV risk behaviour. Higher Reinforced Safety was associated with less CAS, suggesting that it is protective to believe that you have agency over your sexual health based on the decisions that you make. In contrast, higher Luck and Invulnerability were associated with more CAS. The belief that testing negative is the result of luck rather than the result of specific behaviours reflects a lack of a sense of agency. Further, the belief that you are invulnerable to becoming infected is also indicative of risk, as it suggests that you will remain healthy regardless of engagement in transmission risk behaviours. The development of the IRTHN represented an important step in quantifying diverse reactions to testing HIV-negative, but there are several characteristics of the sample used to develop the measure that limit the generalizability of the findings and our understanding of reactions to testing HIV-negative.

First, given that nearly half of the sample used to develop the measure had not been tested for HIV within the past three months, the measure may have captured how some individuals thought they would react as opposed to their actual reaction. Responses also may have been influenced by how individuals behaved in the weeks or months between testing and completing the measure. Additionally, given that recency of testing was based on self-report, it is possible that even more time had elapsed between testing and completing the measure than reported. To address these limitations, the current study sought to validate the IRTHN in a large sample of YMSM, all of whom were confirmed to have recently tested negative for HIV. By focusing on YMSM, the current study targeted the demographic group at greatest risk for HIV.

In addition to testing the factor structure of the IRTHN in a new sample, we also tested its construct validity by examining associations between its subscales and theoretically relevant variables from the Information, Motivation, and Behavioural Skills (IMB) model of HIV prevention [17]. The IMB model posits that the fundamental determinants of engaging in HIV preventive behaviour are: (1) having HIV-related information and prevention knowledge; (2) being motivated to reduce risk; and (3) having the necessary skills to engage in preventive behaviour. We expected that YMSM with more knowledge, motivation, and skills to engage in preventive behaviours would report higher Reinforced Safety, lower Luck, and lower Invulnerability.

Finally, most research in this area has focused on reactions to a single HIV test result, but there is evidence that receiving multiple HIV-negative test results is associated with increased risk behaviour [12, 13]. Mustanski et al. [16] found that the Luck subscale of the IRTHN was positively associated with CAS for MSM who reported two to four lifetime HIV tests, but not for those who reported five or more tests. Thus, Luck might be particularly important for those who have not been tested many times. Given our limited understanding of how reactions to HIV-negative test results influence risk behaviour, additional investigation of whether associations differ depending on one's HIV testing history is warranted.

Although there has been increased emphasis on regular HIV testing among MSM, the CDC no longer requires HIV screening programs in health-care settings to provide risk-reduction counseling [18]. Given limited resources for HIV prevention services, it is important to be able to identify who needs these services the most. If reactions to testing HIV-negative are associated with HIV risk behaviour, then they can help to identify MSM who are most in need of risk-reduction counseling and the key beliefs that should be addressed during counseling. This has the potential to facilitate immediate connection to counseling at the point of contact between the person being tested and the person conducting the test.

The Current Study

The primary goals of the current study were: (1) to examine the factor structure and construct validity of the IRTHN in a large sample of YMSM who recently tested HIV-negative; and (2) to examine its associations with HIV risk behaviour. Our analytic approach began with conducting an exploratory factor analysis (EFA) on a random half of the sample and then a confirmatory factor analysis (CFA)

on the other random half of the sample. Even though Mustanski et al. [16] had already identified three factors, we began with an EFA for several reasons. The three factors that they identified were based on 11 of the original 16 items, because they eliminated five items through the process of factor analysis. Several of the items that they eliminated were related to engaging in more risk behaviour after receiving an HIV-negative test result, which represented a hypothesized fourth factor that was not confirmed in that sample. As noted, a large proportion of their sample completed the measure at least three months after receiving an HIV-negative test result. As such, it is possible that the measure captured how they thought they would react as opposed to their actual reactions. Responses may have also been influenced by how individuals behaved in the weeks or months between testing and completing the measure. For these reasons, our approach to measurement validation began with an EFA to further explore the factor structure in a sample that had just recently received an HIV test. The following hypotheses were tested:

(1) We hypothesized that we would identify the three latent factors that were identified in the initial factor analyses (Reinforced Safety, Luck, and Invulnerability) and possibly a fourth factor that represented the belief that it was acceptable to engage in more risk behaviour after receiving an HIV-negative test result.
(2) We hypothesized that YMSM who had more HIV knowledge, more motivation to reduce risk, and more skills to engage in preventive behaviours would report higher Reinforced Safety, lower Luck, and lower Invulnerability.
(3) We hypothesized that lower Reinforced Safety, higher Luck, and higher Invulnerability would be associated with more CAS with casual partners.
(4) Based on Mustanski et al. [16], we hypothesized that number of lifetime HIV tests would moderate the association between Luck and CAS, such that higher Luck would be associated with more CAS for those who reported fewer lifetime HIV tests, but not for those who reported more lifetime HIV tests.

Methods

Participants

Participants included 1113 YMSM (ages 18–29) who completed baseline measures prior to an ongoing multisite randomized controlled trial comparing two versions of an online HIV prevention program. All participants who completed the baseline measures were included in these analyses regardless of whether or not they enrolled in the trial. Eligibility criteria included: (1) MSM, defined as a birth male who identifies as male and self-reports having CAS with another male in the last six months; (2) 18–29 years old; (3) HIV-negative based on an HIV test at the baseline assessment; (4) able to read English at an 8th grade level; and (5) has an e-mail address to be contacted for retention purposes. Participants in behaviourally monogamous relationships lasting longer than six months were excluded based on the assumption that individuals in long-term monogamous relationships require interventions tailored to their specific needs. Demographic characteristics of the sample are presented in Table 1

Procedure

Participants were recruited in three ways. First, staff at participating community-based organizations (CBOs) in three US cities (Atlanta, Chicago, and New York City) described the study after delivering an HIV-negative test result. Individuals who were interested were provided a tablet or paper

Table I Demographic characteristics of the sample ($N = 1113$)

Demographic characteristic	Mean (SD) or percent
Age	24.07 (3.00)
Sexual orientation	
Gay	86.1 %
Bisexual	11.9 %
Heterosexual	0.4 %
Other	1.7 %
Race/ethnicity	
White	34.3 %
Black	25.4 %
Hispanic	30.5 %
Asian	3.7 %
Native American	0.4 %
Other	2.2 %
Multi-racial	3.4 %
Highest level of education	
Did not complete high school	2.2 %
High school	41.6 %
College degree	44.9 %
Graduate degree	11.3 %
US region	
Midwest	32.5 %
Northeast	33.5 %
South	29.6 %
West	4.4 %
Serious relationship	19.5 %
Current student	37.3 %
Currently employed	78.0 %

form to screen for eligibility and collect contact information. Second, project staff conducted in-person and online recruitment in the three cities mentioned above. Third, a nationwide advertisement was placed on a geospatial smartphone application for MSM to meet. All potential participants completed an eligibility screener and an HIV test in order to determine eligibility. Participants were offered two options for completing the HIV test: (1) they could do it in-person at one of our facilities or participating CBOs; or (2) they could do it on their own using a self-test. Those who opted to self-test were sent tests and required to provide a photograph of the result to confirm their HIV-negative status. If participants tested HIV-negative, they were invited to complete a baseline assessment, which included a series of online questionnaires. Participants had the option of completing them at home or at one of our offices. The intervention will not be described in detail here, because this article focuses on the data collected prior to participation in the intervention.

Measures

Demographic Characteristics

Participants were asked to report their age, sexual identity, and race/ethnicity as part of the eligibility screener as well as their relationship status, whether they were students, and whether they were employed as part of the baseline assessment (see Table 1 for response options). For analyses, sexual identity was recoded as 0 = gay and 1 = other (bisexual, heterosexual, and other). The latter three groups were combined due to low endorsement of heterosexual and other. Additionally, given that all participants had to endorse CAS with another male in the last six months in order to be included in the study, the other group represents YMSM who do not identify as gay. Race/ethnicity was re-coded into four groups for analyses: White, Black, Hispanic, and Other (Asian, Native American, Other, and Multi-racial). All racial/ethnic groups other than White, Black, and Hispanic were collapsed into a single group due to low representation of those groups.

Number of Lifetime HIV Tests

Participants were asked to report how many times they had been tested for HIV in their lives. To reduce outliers, values were Winsorized at three standard deviations. As such, values greater than 45 were set to equal 43 (1.6 % of the data). The mean and standard deviation were 9.21 and 8.60, respectively. The mode and median were 10.00 and 6.00, respectively.

Sexual Behaviour

Participants were asked if they had anal sex within the past 3 months. If they responded yes, then they were asked a series of questions about their most recent partner(s) for up to three partners. For each partner, they were asked what their relationship was with that partner. Response options included: serious relationship (defined as boyfriend or someone you dated for a while and feel very close to), casually dating but not serious, sleeping with this person but not dating, one night stand, and stranger/anonymous person. They were also asked how many times they did not use a condom as the insertive and receptive partner during anal sex with that partner within the past 3 months. The numbers of insertive and receptive CAS acts with casual partners (all categories listed above except serious relationship) were summed across partners to calculate the total number of CAS acts with casual partners within the past 3 months. To reduce outliers, values were Winsorized at three standard deviations. As such, values greater than 36 were set to equal 36 (1.2 % of the data). The mean and standard deviation were 3.62 and 5.88, respectively. The mode and median were 0.00 and 2.00, respectively.

The Inventory of Reactions to Testing HIV Negative (IRTHN) [16]

The IRTHN is a 16-item measure of reactions to testing HIV negative. Each item begins with one of three stems: (1) "A negative HIV test means…;" (2) "After a negative HIV test result, I feel…;" or (3) "The more times I test negative for HIV…" The first 11 out of 16 items are preceded by the following instructions: "For each statement below, please tell us how much you agree or disagree about the effects of HIV testing on your health beliefs and sexual behaviour." The final 5 out of 16 items are preceded by the following instructions: "The following statements are about your feelings as a result of receiving more than one negative HIV test result in your lifetime." Each item is rated on a 1–5 scale (1 strongly disagree, 5 strongly agree) and subscale scores are computed by calculating the mean across responses to the respective subscale items. The IRTHN has three subscales: Reinforced Safety (4 items), Luck (3 items), and Invulnerability (4 items). Mustanski et al. [16] reported the following Cronbach's alphas: .74 for Reinforced Safety, .70 for Luck, and .79 for Invulnerability.

HIV Knowledge

Knowledge of HIV was assessed using a 26-item measure adapted from the Brief HIV Knowledge Questionnaire [19]. The measure was developed to evaluate at-risk populations' knowledge of sexual behaviour transmission and prevention of HIV. Of the 26 items, 12 were taken from the Brief HIV Knowledge Questionnaire [19] with minor rewordings (references to specific sexes were removed); 11 were taken from Mustanski et al. [20], who added them to

update the measure to reflect new understanding of HIV transmission and common misunderstandings found in previous research; and three were added for the purposes of the current study to reflect content included in the HIV prevention program as well as longer measures of HIV knowledge [21]. Correct answers were coded as 1 and incorrect or uncertain responses were coded as 0. Composite scores were calculated to reflect the number of correct responses. A similar version of the measure has been used in previous research on YMSM [20]. Cronbach's alpha in the current study was .77.

Behaviour Change Intentions

Behaviour change intentions were assessed with four items used in previous research on MSM focused on likelihood of using condoms [22]. Participants were presented with the stem, "How likely is it that you will…" followed by four items: (1) keep condoms nearby? (2) tell your partner that you need to use condoms? (3) use a condom? and (4) use a condom even if your partner does not want to? Items were rated on a 1–4 scale (1 very unlikely, 4 very likely) and total scores were computed by calculating the mean across responses. Cronbach's alpha in the current study was .86.

Risk Reduction Self-efficacy

Risk reduction self-efficacy was assessed with five items used in previous research on MSM [22]. Participants were presented with the stem, "In a situation in which you typically have sex, how confident are you that you would be able to…" followed by five items: (1) be sure you and your partner agreed to safer sex before sex began; (2) be sure you had condoms with you; (3) get your partner to use a condom during anal sex; (4) use a condom yourself during anal sex; and (5) refuse to have anal sex without a condom. Items were rated on a 1–7 scale (1 extremely unconfident, 7 extremely confident) and total scores were computed by calculating the mean across responses. Cronbach's alpha in the current study was .84.

Analytic Plan

SPSS Version 23 was used to split the sample into two random subsamples of approximately equal size (subsample 1, $N = 550$; subsample 2, $N = 563$). Mplus Version 7.2 was then used to conduct an EFA on subsample 1 with the default Geomin oblique rotation and maximum likelihood estimation. We requested output for models with one to six factors and selected the best-fitting model based on: (1) Cattell's scree test (eigenvalues ≥ 1.0); (2) lower values on standard fit indices, including likelihood-based information criteria (AIC and BIC) and residual-based fit indices (RMSEA and SRMR); and (3) conceptual consideration of item loadings and factors. Items with factor loadings equal to or greater than 0.40 were considered meaningful contributions to a factor. After selecting the best-fitting model, we removed items that did not load onto any factors or that cross-loaded onto multiple factors. We then ran a second EFA to examine fit of the chosen factor solution without the poorly fitting items.

Next, we utilized subsample 2 to conduct a CFA based on the results of the EFA. Items with non-meaningful factor loadings were set to zero in the CFA. Good fit is indicated by a comparative fit index (CFI) and Tucker Lewis index (TLI) greater than 0.90 and a root mean square error of approximation (RMSEA) and a standardized root mean square residual (SRMR) less than 0.06 [23–26].

Then, SPSS was used to compute subscale scores for the identified factors by calculating the means across responses for the full sample. After computing subscale scores, we examined their associations with demographic characteristics and constructs from the IMB model of HIV prevention using Pearson correlations (for continuous variables), independent-samples t tests (for dichotomous variables), and ANOVAs (for non-dichotomous categorical variables). Finally, we ran a series of negative binomial regression analyses to examine the associations between the subscale scores and CAS with causal partners. We also tested whether lifetime number of HIV tests moderated the associations between subscale scores and CAS with causal partners. To do so, we re-ran the negative binomial regression analyses including the main effect of lifetime number of HIV tests and its interaction with each subscale (in separate models for each subscale). Moderation analyses were conducted using Mplus, because of its ability to test simple slopes for significant interactions.

Results

Exploratory Factor Analyses

Results of the EFAs on subsample 1 are presented in Table 2. In the first EFA, we determined that a four-factor solution was the optimal fit to the data, because the first four factors were the only ones with eigenvalues greater than 1.0 and the four-factor model had lower values on standard fit indices compared to other models. Model fit indices indicated good fit (RMSEA .06, CFI .96, TLI .92, SRMR .03), with the exception of the Chi squared statistic, which is known to be sensitive to large sample size, $\chi^2(62) = 164.90$, $p < .001$. All but three items (items 2, 9, and 11) met our criteria for a meaningful factor loading ($\geq$0.40) and none cross-loaded onto multiple factors. As

Table 2 Results of the exploratory factor analyses with subsample 1 ($N = 550$)

Item	First EFA				Second EFA			
	RS	L	I	RR	RS	L	I	RR
1. A negative HIV test means that my safe sex behaviours are working	0.52	[a]	[a]	[a]	0.47	[a]	[a]	[a]
2. A negative HIV test means that my past sexual behaviours may not have been that risky after all	[a]	[a]	[a]	[a]	–	–	–	–
3. A negative HIV test encourages me to keep practicing safer sex	0.67	[a]	[a]	[a]	0.68	[a]	[a]	[a]
4. A negative HIV test reinforces my safe sex behaviours	0.79	[a]	[a]	[a]	0.85	[a]	[a]	[a]
5. After a negative HIV test, I feel lucky that I did not get HIV	[a]	0.70	[a]	[a]	[a]	0.69	[a]	[a]
6. After a negative HIV test, I feel like I dodged a bullet	[a]	0.87	[a]	[a]	[a]	0.88	[a]	[a]
7. After a negative HIV test, I feel that I do not need to protect myself	[a]	[a]	[a]	0.59	[a]	[a]	[a]	0.56
8. After a negative HIV test, I feel like it is ok to have more unprotected sex with casual partners ("hookups")	[a]	[a]	[a]	0.77	[a]	[a]	[a]	0.77
9. After a negative HIV test, I feel like I should have protected sex every time	[a]	[a]	[a]	[a]	–	–	–	–
10. After a negative HIV test, I feel like it's ok to have sex with more people	[a]	[a]	[a]	0.50	[a]	[a]	[a]	0.50
11. After a negative HIV test, I feel like I should only have unprotected sex with my long-term partner	[a]	[a]	[a]	[a]	–	–	–	–
The more times I test negative for HIV…								
12. …the less worried I am about contracting it	[a]	[a]	0.49	[a]	[a]	[a]	0.48	[a]
13. …the more I feel that I am immune against HIV	[a]	[a]	0.81	[a]	[a]	[a]	0.81	[a]
14. …the more I feel that it is difficult for me to become infected	[a]	[a]	0.75	[a]	[a]	[a]	0.75	[a]
15. …the more I feel invincible against the disease	[a]	[a]	0.88	[a]	[a]	[a]	0.89	[a]
16. …the more I feel like my luck will run out	[a]	0.44	[a]	[a]	[a]	0.42	[a]	[a]

RS reinforced safety, *L* luck, *I* invulnerability, *RR* reinforced risk

[a] Factor loading <0.40; Items 2, 9, and 11 were removed in the second EFA

such, we removed the three items that did not load onto any factors and ran a second EFA.

A four-factor solution continued to be the best fit to the data and model fit improved without the poorly fitting items (RMSEA .05, CFI .98, TLI .95, SRMR .02, $\chi^2(32) = 71.57, p < .001$). All of the items loaded onto the same factors as in the initial EFA, all factor loadings continued to meet our criteria for a meaningful factor loading, and the factor loadings had similar magnitudes across models. In the second EFA, Factor 1 (items 1, 3, and 4) accounted for 25.84 % of the variance; Factor 2 (items 5, 6, and 16) accounted for 16.38 % of the variance; Factor 3 (items 12, 13, 14, and 15) accounted for 14.25 % of the variance; and Factor 4 (items 7, 8, and 10) accounted for 8.93 % of the variance.

Factors 1, 2, and 3 mapped onto the three factors identified in the original factor analyses of the measure: Reinforced Safety, Luck, and Invulnerability, respectively [16]. The only difference was that Reinforced Safety included a fourth item in the original factor analyses (item 9), but it was dropped from the factor in our sample because its factor loading (0.33) was lower than our pre-determined cut-off. We also identified a fourth factor in our sample (labeled Reinforced Risk), which included items that focused on reinforcing risk behaviour, such as thinking it is okay to have more unprotected sex with casual partners. Overall, the four factors accounted for 65.40 % of the item variance.

Confirmatory Factor Analyses

Results of the CFA on subsample 2 are presented in Table 3. Model fit indices generally indicated good fit (RMSEA .07, CFI .92, TLI .89, SRMR .06, $\chi^2(59) = 202.74, p < .001$). While factor loadings had similar magnitudes as in the EFAs, factor loadings for three items fell below our criteria for a meaningful factor loading (items 1, 10, and 16). As such, we removed the three items and ran a second CFA. Model fit improved for the second CFA (RMSEA .05, CFI .98, TLI .96, SRMR .03, $\chi^2(29) = 65.73, p < .001$). All factor loadings continued to meet our criteria for a meaningful factor loading and the factor loadings had similar magnitudes across models. In the final model, the factors consisted of the following items: Factor 1 (items 3 and 4); Factor 2 (items 5 and 6); Factor 3 (items 12, 13, 14, and 15); and Factor 4 (items 7 and 8).

We found a significant negative association between Reinforced Safety and Invulnerability ($r = -.17, p < .001$)

Table 3 Results of the CFA with subsample 2 ($N = 563$)

Item	First CFA					Second CFA				
	RS	L	I	RR	RV	RS	L	I	RR	RV
A negative HIV test…										
1. …means that my safe sex behaviours are working	0.32	–	–	–	0.89	–	–	–	–	–
2. …means that my past sexual behaviours may not have been that risky after all	–	–	–	–	–	–	–	–	–	–
3. …encourages me to keep practicing safer sex	0.87	–	–	–	0.25	0.92	–	–	–	0.15
4. …reinforces my safe sex behaviours	0.74	–	–	–	0.45	0.70	–	–	–	0.51
After a negative HIV test…										
5. …I feel lucky that I did not get HIV	–	0.63	–	–	0.61	–	0.97	–	–	0.07
6. …I feel like I dodged a bullet	–	0.88	–	–	0.22	–	0.57	–	–	0.67
7. …I feel that I do not need to protect myself	–	–	–	0.67	0.55	–	–	–	0.70	0.51
8. …I feel like it is ok to have more unprotected sex with casual partners ("hookups")	–	–	–	0.76	0.42	–	–	–	0.72	0.48
9. …I feel like I should have protected sex every time	–	–	–	–	–	–	–	–	–	–
10. …I feel like it's ok to have sex with more people	–	–	–	0.34	0.88	–	–	–	–	–
11. …I feel like I should only have unprotected sex with my long-term partner	–	–	–	–	–	–	–	–	–	–
The more times I test negative for HIV…										
12. …the less worried I am about contracting it	–	–	0.48	–	0.77	–	–	0.48	–	0.77
13. …the more I feel that I am immune against HIV	–	–	0.72	–	0.49	–	–	0.72	–	0.49
14. …the more I feel that it is difficult for me to become infected	–	–	0.79	–	0.38	–	–	0.79	–	0.38
15. …the more I feel invincible against the disease	–	–	0.79	–	0.38	–	–	0.79	–	0.38
16. …the more I feel like my luck will run out	–	0.37	–	–	0.86	–	–	–	–	–

RS reinforced safety, *L* luck, *I* invulnerability, *RR* reinforced risk, *RV* residual variance, the variance of each factor is fixed to 1.0 in the standardized version of the model; Items 1, 10, and 16 were removed in the second CFA

and a non-significant association between Luck and Invulnerability ($r = -.03$, $p = .59$). We also found a significant positive association between Reinforced Safety and Luck ($r = .23$, $p < .001$). In regard to our new factor—Reinforced Risk—we found a significant negative association with Reinforced Safety ($r = -.62$, $p < .001$) and a significant positive association with Invulnerability ($r = .43$, $p < .001$). In contrast, Reinforced Risk was not significantly associated with Luck ($r = -.01$, $p = .87$).

Demographic Differences

The rest of the analyses utilized subscale scores based on the identified factor structure. Cronbach's alpha was acceptable for Reinforced Safety ($\alpha = 0.79$), Luck ($\alpha = 0.74$), and Invulnerability ($\alpha = 0.78$), but low for Reinforced Risk ($\alpha = 0.68$). However, Cronbach's alpha tends to be low for scales comprised of only 2–4 items. Age was significantly associated with Reinforced Safety ($r = -.07$, $p = .03$) and Luck ($r = -.08$, $p < .01$), but not the other subscales. Sexual identity was not significantly associated with any of the subscales. Relationship status was significantly associated with Luck, $t(294.80) = 2.70$, $p < .01$, such that single men (*M* 3.89, *SD* 0.95) reported higher Luck compared to partnered men (*M* 3.68, *SD* 1.07). In contrast, it was not significantly associated with any of the other subscales.

Race was significantly associated with Reinforced Safety, $F(3, 1069) = 5.43$, $p < .001$, Luck, $F(3, 1064) = 3.76$, $p = .01$, and Invulnerability, $F(3, 1047) = 3.39$, $p = .02$, but not Reinforced Risk. Post-hoc LSD comparisons indicated that MSM who identified as Black (*M* 4.30, *SD* 0.76) reported higher Reinforced Safety compared to those who identified as White (*M* 4.05, *SD* 0.76, $p < .001$) and Latino (*M* 4.13, *SD* 0.81, $p < .01$), but not Other (*M* 4.19, *SD* 0.80). Additionally, MSM who identified as White (*M* 3.72, *SD* 0.97) reported lower Luck compared to those who identified as Black (*M* 3.92, *SD* 1.01, $p < .01$) and Latino (*M* 3.94, *SD* 0.94, $p < .01$), but not Other (*M* 3.89, *SD* 0.99). MSM who identified as White (*M* 1.82, *SD* 0.69) also reported lower Invulnerability compared to those who identified as Black (*M* 1.98, *SD* 0.81, $p = .01$) and Latino (*M* 1.99, *SD* 0.79, $p < .01$), but not Other (*M* 1.87, *SD* 0.85).

Associations with IMB Constructs

Next, we examined the associations between the subscale scores and constructs from the IMB model of HIV prevention. Higher HIV knowledge was significantly associated with lower Luck ($r = -.12$, $p < .001$), Invulnerability ($r = -.25$, $p < .001$), and Reinforced Risk ($r = -.10$, $p < .01$), but not Reinforced Safety ($r = .01$, $p = .65$). Higher behaviour change intentions were significantly associated with higher Reinforced Safety ($r = .40$, $p < .001$), lower Invulnerability ($r = -.12$, $p < .001$), and lower Reinforced Risk ($r = -.38$, $p < .001$), but not Luck ($r = .06$, $p = .06$). Finally, higher risk reduction self-efficacy was significantly associated with higher Reinforced Safety ($r = .40$, $p < .001$), lower Invulnerability ($r = -.12$, $p < .001$), and lower Reinforced Risk ($r = -.39$, $p < .001$), but not Luck ($r = -.02$, $p = .46$).

Associations with CAS with Casual Partners

Then, we examined the associations between the subscale scores and CAS with causal partners. Given significant bivariate associations between demographic characteristics and subscales, we controlled for age, race/ethnicity, and relationship status. Results are reported as risk ratios (RRs) and 95 % confidence intervals (CIs). More CAS with casual partners was significantly associated with lower Reinforced Safety (RR .70, 95 % CI .63–.76, $p < .001$), higher Luck (RR 1.20, 95 % CI 1.11–1.30, $p < .001$), and higher Reinforced Risk (RR 1.54, 95 % CI 1.40–1.69, $p < .001$). These associations remained significant when all of the subscales were simultaneously included in the same model (for Reinforced Safety, RR .78, 95 % CI .71–.87, $p < .001$; for Luck, RR 1.19, 95 % CI 1.10–1.29, $p < .001$; for Reinforced Risk, RR 1.39, 95 % CI 1.24–1.56, $p < .001$). In contrast, Invulnerability was not significantly associated with CAS with casual partners (in a model without the other subscales, RR 1.07, 95 % CI .97–1.18, $p = .16$; in a model with all of the subscales, RR .94, 95 % CI .85–1.04, $p = .23$).

Finally, we tested whether lifetime number of HIV tests moderated the associations between subscale scores and CAS with causal partners. There was a significant interaction between lifetime number of HIV tests and Reinforced Safety (RR = .98, 95 % CI = .97, .99, p < .001). As shown in Fig. 1, there was a significant negative association between Reinforced Safety and CAS with casual partners for those who reported an average number of lifetime HIV tests (RR = .78, 95 % CI = .68, .89, p < .001) and for those who reported a higher than average number of lifetime HIV tests (RR = .65, 95 % CI = .56, .76, p < .001). In contrast, the association was not significant for those who reported a lower than average number of lifetime HIV tests (RR = .93, 95 % CI = .77, 1.12, p = .45).

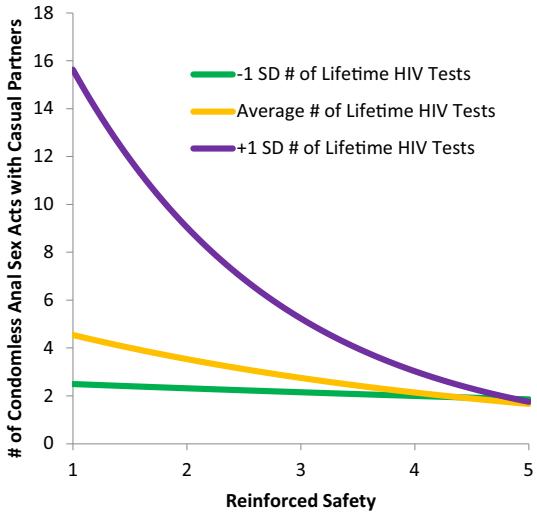

Fig. 1 Association between Reinforced Safety and CAS with casual partners as a function of number of lifetime HIV tests

There was also a significant interaction between lifetime number of HIV tests and Luck (RR = 1.02, 95 % CI = 1.01, 1.03, p < .01). As shown in Fig. 2, there was a significant positive association between Luck and CAS with casual partners for those who reported an average number of lifetime HIV tests (RR = 1.20, 95 % CI = 1.09, 1.31, p < .001) or a higher than average lifetime number of HIV tests (RR = 1.42, 95 % CI = 1.23, 1.64, p < .001). In contrast, the association was not significant for those who reported a lower than average number of lifetime HIV tests (RR = 1.01, 95 % CI = .88, 1.17, p = .89). The other two moderation analyses (for Invulnerability and Reinforced Risk) were not significant.

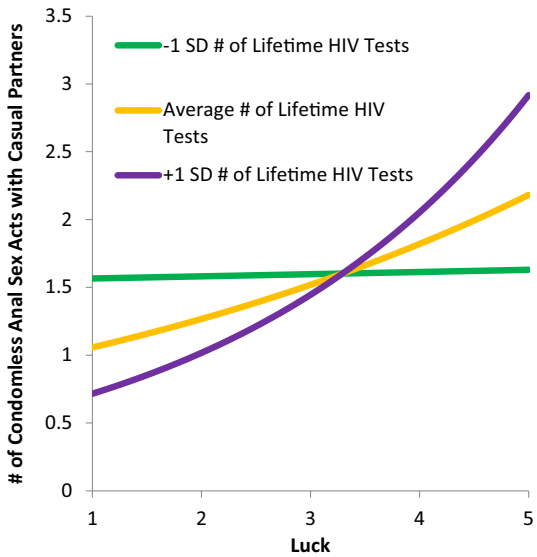

Fig. 2 Association between Luck and CAS with casual partners as a function of number of lifetime HIV tests

Discussion

The current findings support the validity of the IRTHN in a large sample of YMSM who recently tested HIV-negative. In addition to the three latent factors that were identified in the original formulation of the construct (Reinforced Safety, Luck, and Invulnerability) [16], we identified a fourth factor from items that did not map onto the factors in the original analyses. This Reinforced Risk factor represented the belief that it is acceptable to have more condomless sex with casual partners subsequent to receiving an HIV-negative test result. YMSM who endorsed this belief were also more likely to believe that they are immune from becoming HIV infected and less likely to believe that testing negative reinforced past decisions to have safer sex. We also found support for the construct validity of the IRTHN, demonstrating that reactions to testing HIV-negative are associated with knowledge about HIV, motivation to reduce risk behaviour, and behavioural skills to engage in preventive behaviour.

There were several noteworthy demographic differences in reactions to testing HIV-negative. Consistent with Mustanski et al. [16], older YMSM reported lower Luck, suggesting that they tend to "age out" of the belief that they are simply lucky if they test HIV-negative. Neither study had longitudinal data, so it is also possible that this association represents cohort differences rather than developmental change. While there was not a significant association between age and Invulnerability in the current sample, Mustanski et al. [16] found that older MSM reported higher Invulnerability. This difference may be due to the restricted age range in the current sample (18–29 years). It is possible that MSM are more likely to respond to testing HIV-negative with the belief that they are invulnerable as they get older, but this change does not begin until after age 29. In the current sample, older YMSM also reported lower Reinforced Safety. One possible explanation for this is that older YMSM may have received more HIV tests in their lives, which may reduce the reinforcing nature of receiving a negative test result.

We also found that single men reported higher Luck compared to partnered men. This may reflect the possibility that single YMSM engage in more behaviour that they perceive as risky, thus contributing to feeling lucky subsequent to receiving HIV-negative test results. Black YMSM reported higher Reinforced Safety compared to White and Latino YMSM. Engaging in protective behaviours may be particularly reinforcing for Black YMSM, given that they are at increased risk for HIV. Black and Latino YMSM reported higher Luck and Invulnerability compared to White YMSM. These findings are concerning, given that Black and Latino YMSM are at the highest risk for HIV [27]. Endorsement of the belief that an HIV-negative test result is due to luck rather than one's own protective behaviours de-emphasizes the importance of self-agency in protecting oneself. For individuals who express that their test result is due to luck, risk reduction counselors can help them to recognize that they have agency in protecting themselves. Black and Latino YMSM may also feel invulnerable to HIV if they are aware of the fact that their community has the highest rates and they continue to receive HIV-negative test results despite engaging in risk behaviour. Given that Black and Latino YMSM were particularly likely to endorse the beliefs that their results were due to luck and that they were invulnerable to HIV, these beliefs may play a role in perpetuating racial disparities and they may be important to target in this population.

Consistent with Mustanski et al. [16], lower Reinforced Safety and higher Luck were associated with more CAS. In our sample, higher Reinforced Risk was also associated with more CAS. In contrast, we did not find a significant association between Invulnerability and CAS. Given that older men (e.g., those outside of the age range of the current sample) report higher Invulnerability [16], it is possible that restricted range limited the extent to which Invulnerability was associated with CAS. The influences of Reinforced Safety and Luck on CAS were moderated by number of lifetime HIV tests. For YMSM who reported a lower than average number of lifetime HIV tests, Reinforced Safety was not significantly related to CAS. In contrast, for those who reported an average or a higher than average number of lifetime HIV tests, higher Reinforced Safety was significantly associated with less CAS. This suggests that the protective effect of believing that one's safe behaviour was reinforced may be contingent on repeated HIV-negative test results.

Additionally, the belief that an HIV-negative test result is due to chance became a stronger risk factor for CAS as YMSM accumulated more HIV-negative test results throughout their lives. This suggests that Luck may be a particularly important reaction to assess at the time of testing, especially among those who have tested multiple times. The moderation finding for Luck is in contrast to Mustanski et al. [16], who found that Luck was not significantly associated with CAS for MSM who reported five or more lifetime HIV tests (they reported high CAS regardless of Luck), whereas higher Luck was significantly associated with more CAS for those who reported two to four lifetime HIV tests. It is possible that sample differences contributed to these discrepant findings (e.g., the current sample was younger and included more people who endorsed recent CAS). It will be important for future research to continue to examine these interactions to clarify

their direction and identify population characteristics that may explain different findings across studies.

The current findings have important implications for HIV prevention. In 2006, the CDC removed the requirement for prevention counseling as a part of HIV screening programs in health-care settings [18]. A randomized controlled trial found that risk-reduction counseling in conjunction with a rapid HIV-test significantly reduced the number of unprotected sexual partners among the subset of MSM in the sample, although it was not associated with STI reduction [28]. Other studies have similarly shown reductions in HIV risk behaviours associated with structured risk reduction counseling interventions [29, 30]. In an era of scarce resources for HIV prevention services, an alternative between the dichotomy of counseling everyone or counseling no one would be to deliver risk reduction counseling to those who are most likely to benefit from it. Assessing reactions to testing HIV-negative may be a useful way to identify these individuals, especially among YMSM who have tested multiple times. The IRTHN is a brief measure that can be used for this purpose and it can also be used to identify the specific beliefs that may be contributing to an individual's risk behaviour. For instance, if someone receives an HIV-negative test result and expresses that he thinks it is okay to have more condomless sex with casual partners, the counselor would know to target this belief. Thus, in contexts where risk-reduction counseling is not routinely conducted with HIV testing, the IRTHN can be used to determine who to provide counseling to as an additional service. Given that Reinforced Safety was associated with less CAS, counselors can help individuals low in this belief to see the links between safer sex behaviours and reduced risk for HIV. In contrast, given that Luck and Reinforced Risk were associated with more CAS, counselors can highlight the risk in assuming that one's sexual health is the result of luck (as opposed to one's own behaviour) and challenge the belief that a negative test result is license to engage in future HIV risk behaviour. The CDC's recently released web-based tool for illustrating the per-act transmission risk under various selectable conditions (e.g., PrEP use, condom use, HIV/STI status of each partner) could be useful in helping counselors illustrate the associations between risk behaviours and infection potential [31].

The current findings also have implications for biomedical prevention, such as pre-exposure prophylaxis (PrEP). The CDC recommends PrEP for people who are HIV-negative and at high risk for HIV (e.g., MSM who engage in CAS with multiple partners) [32]. Given that Luck and Reinforced Risk were associated with CAS, individuals who endorse these beliefs may be particularly good candidates for PrEP. Finally, the current findings may be able to inform healthcare practices for other diseases. One study found that smokers who received a negative lung cancer screening result were less inclined to quit smoking than those who received an indeterminate test result [33]. Understanding reactions to receiving a negative lung cancer screening result may help to identify individuals who would benefit the most from subsequent counseling. The importance of considering reactions to negative screening and testing results is likely to extend to other health issues as well.

The current findings should be considered in light of several limitations. First, the cross-sectional design of the study limits our ability to make causal inferences. It will be important for future research to examine the prospective associations between reactions to testing HIV-negative and risk behaviour. Second, internal consistency was low for the Reinforced Risk subscale of the IRTHN. Although Cronbach's alpha tends to be low for scales comprised of only 2–4 items, findings related to this subscale should be interpreted in the context of this lower reliability. Third, while our focus on YMSM provides insight into HIV risk factors in a population that is at particularly high risk, it precludes our ability to test developmental differences. Finally, although we replicated the three factors that were identified in the original formulation of the construct, the Reinforced Safety subscale was comprised of two items in our sample versus four items in the original sample used to develop the measure. It is possible that this difference is the result of our sample being larger and/or the various demographic differences between the samples that were previously noted. Given that it demonstrated acceptable internal consistency as well as construct validity in our sample, it is possible that two items are sufficient to measure this construct. However, this is only the second study to utilize the IRTHN, so it will be important for future research to continue to examine the psychometric properties of the measure in different samples. Despite limitations, findings support the validity of the IRTHN and highlight the importance of considering reactions to testing HIV-negative, given their associations with HIV risk behaviour.

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Compliance with Ethical Standards

Conflict of Interest Brian A. Feinstein declares that he has no conflict of interest. Brent A. Johnson declares that he has no conflict of interest. Jeffrey T. Parsons declares that he has no conflict of interest. Brian Mustanski declares that he has no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of

the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors.

Informed consent Informed consent was obtained from all individual participants included in the study.

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