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The association between monetary and sexual delay discounting and risky sexual behavior in an online sample of men who have sex with men

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Abstract

Delay discounting is a measure of impulsivity that has been found to be associated with numerous health-related outcomes. To the extent that delay discounting is associated with sexual risk-taking, it might serve as a marker for HIV risk or as the basis for novel HIV prevention interventions. The goal of the current study was to examine the association between monetary and sexual delay discounting and condomless anal intercourse (CAI) in a cross-sectional sample of men who have sex with men. Based on previous findings, we examined whether these associations were age-dependent. Sexual, but not monetary, delay discounting was found to be associated with CAI in the past 12 months. These results suggest that delay discounting is associated with sexual risk-taking. More high risk sexual behaviors and their associations with delay discounting should be investigated in the future.

Keywords

Men who have sex with men; delay discounting; sexual risk; HIV

Introduction

The HIV epidemic in the United States has had a disproportionate impact on men who have sex with men (Centers for Disease Control and Prevention, 2013), with incidence increasing among young MSM in recent years (A. S. Johnson et al., 2014; Purcell et al., 2012). Effective HIV prevention interventions and tools to identify men most in need of prevention interventions are needed.

Delay discounting is a behavioral economic measure of impulsivity that might be related to sexual risk-taking. Delay discounting describes the extent to which an individual prefers small rewards available immediately or at a short delay compared to larger rewards available

after a longer wait. It has been shown to be associated with a number of health-related behaviors and states including smoking initiation (Audrain-McGovern et al., 2009), substance use and abuse (Kirby, Petry, & Bickel, 1999; Madden, Petry, Badger, & Bickel, 1997; Odum, Madden, Badger, & Bickel, 2000; Petry, 2001), relapse following substance use cessation (Yoon et al., 2007), and obesity (Jarmolowicz et al., 2014; Lawyer, Boomhower, & Rasmussen, 2015).

There is growing evidence that delay discounting is related to sexual risk-taking. In an online study, young MSM age 18-24 who reported CAI in the past 12 months had higher monetary discount rates than young men who did not; no effect of monetary discounting was observed among older MSM (J. Jones & Sullivan, 2016). The neural structures involved in impulse control continue to develop into the 20s (Giedd, 2004) and might influence the association between delay discounting and sexual risk-taking. This effect of age may be particularly important given the increasing rates of HIV diagnoses in young MSM (A. S. Johnson et al., 2014).

The results above involved a monetary discounting task; delay discounting of sexual behavior itself has also been investigated. The Sexual Discounting Task (SDT; M. W. Johnson & Bruner, 2012) is designed to measure discounting of condom-protected sex by assessing preferences between condomless sex at no delay and condom-protected sex at delays ranging from one hour to three months. In the delay discounting paradigm, condomless sex is the smaller, sooner reward compared with condom-protected sex which confers the potential additional benefit of long-term HIV/sexually transmitted infection (STI) avoidance. Delay discounting of condom-protected sex may be particularly relevant to HIV/STI transmission given the importance of condom use in combination prevention strategies (Smith, Herbst, & Rose, 2015).

Use of pre-exposure prophylaxis might modify how condom-protected sex is discounted. Given the protection provided against HIV seroconversion by pre-exposure prophylaxis (PrEP), it is possible that men using PrEP might discount condom-protected sex more steeply compared to men who do not use PrEP (i.e., risk compensation). There is limited evidence of risk compensation associated with PrEP use (Carlo Hojilla et al., 2016; Grov, Whitfield, Rendina, Ventuneac, & Parsons, 2015; Sagaon-Teyssier et al., 2016). However, PrEP-using men using mobile dating apps have frequently been found to indicate a preference for CAI (Newcomb, Mongrella, Weis, McMillen, & Mustanski, 2016).

Other studies assessing monetary discounting and sexual behavior in heterosexual populations have been inconsistent, with some studies finding an association (Chesson et al., 2006; M. W. Johnson & Bruner, 2012; Lawyer, 2008; Lawyer & Schoepflin, 2013; MacKillop et al., 2014; Wilson & Daly, 2004) and others finding none (Herrmann, Hand, Johnson, Badger, & Heil, 2014; Holt, Newquist, Smits, & Tiry, 2014). However, the study populations generally comprised undergraduates (Holt et al., 2014; Lawyer, 2008; Lawyer & Schoepflin, 2013; Wilson & Daly, 2004) which precludes an assessment of the effect of age.

The purpose of the current study is to examine the relationship between two forms of delay discounting – monetary and sexual – and CAI. Monetary discounting can be measured more

quickly than sexual discounting and has less social desirability bias compared to sexual discounting tasks (Odum, 2011). To the extent that it is related to sexual risk-taking, it may serve as a valid proxy measure for sexual risk. Based on previous research, we hypothesized that both types of discounting would be associated with CAI and that the association would be stronger among young compared to older men.

Methods

Recruitment

Participants were recruited via Facebook advertisements targeted to men in the United States who indicated that they were interested in men in their profile or whose interests indicated that they might be MSM. Men who clicked the advertisement were taken to the survey introduction page, which included a brief description of the survey and an eligibility screener. Participants were eligible if they identified as male, were 18 years old, and reported having sex with another man in the previous 6 months. Surveys were completed anonymously. This research was determined to be exempt from review by the Emory University IRB.

Delay Discounting Measurements

Monetary delay discounting was assessed via the Monetary Choice Questionnaire (MCQ; Kirby et al., 1999) and sexual delay discounting was assessed via the SDT (M. W. Johnson & Bruner, 2012). The order of the delay discounting tasks was randomized across participants.

The MCQ consists of 27 items of the form “Would you prefer \$24 today or \$35 in 29 days?” The pattern of responding across the 27 items is used to assign a discounting parameter, k . Larger values of k indicate steeper delay discounting, thus a stronger preference for smaller, sooner rewards. Methods proposed by Kirby et al (1999) were used to assign each participant a k value and to exclude nonsystematic responders. Final k values were log-transformed to correct for skewness and obtain an approximately normal distribution.

The SDT measures discounting of condom-protected sex and has been described in detail elsewhere (M. W. Johnson & Bruner, 2012). Participants were shown an array of 41 headshots of men and instructed to select the images of the men that they would be interested in having sex with. Of the selected images, participants were asked to select the man they would most like to have sex with (MOSTSEX). That image was then removed and participants were asked to indicate which man they would least like to have sex with (LEASTSEX). Next, all of the selected images were presented again and a similar procedure was used to identify the man perceived to be most and least likely to have a STI (MOSTSTI and LEASTSTI, respectively).

For each of the four conditions (MOSTSEX, LEASTSEX, MOSTSTI, LEASTSTI) the image of the selected man was displayed and the participant used a visual analog scale (VAS) to indicate their preference between immediate sex without a condom and sex with a condom at 8 different delays: no delay, 1 hour, 3 hours, 6 hours, 1 day, 1 week, 1 month, and 3 months. The VAS was a continuous scale anchored at 0 (immediate condomless sex) and

100 (condom-protected sex at the given delay). Participants clicked on the location of the scale that indicated their preference (i.e., selecting a location close to 0 would indicate a stronger preference for immediate condomless sex compared to condom-protected sex at a given delay). Because there was no time component in the no delay condition, preferences for condomless versus condom-protected sex on the VAS in this condition were used to assess individual condom use preferences. If the same image was selected for more than one condition (e.g., for MOSTSEX and LEASTSTI) then the discounting task was only completed once for that image.

The value selected on the VAS was considered the indifference point between immediate sex without a condom and condom-protected sex at the given delay. In the delay discounting paradigm, the indifference point represents the point at which both options (i.e., immediate condomless sex, delayed condom-protected sex) are equally valuable. In the current study, a higher indifference point for a given condition indicates a stronger preference for condom-protected sex at a delay. The indifference points from the 7 delays were standardized against the 0-delay condition to account for individual condom-use preferences.

These standardized indifference points were then used to determine the area under the curve (AUC; Myerson, Green, & Warusawitharana, 2001) across the 7 delays. Higher AUC indicates less discounting of condom-protected sex. SDT data were checked for orderliness using methods proposed by Johnson and Bickel (M. W. Johnson & Bickel, 2008).

AUC values were highly skewed and clustered. Rank transformations (Conover & Iman, 1981) and Spearman rank correlations have been used in the past as a means of conducting nonparametric statistical analyses with AUC values obtained using the SDT (Herrmann et al., 2014; Herrmann, Johnson, & Johnson, 2015; M. W. Johnson & Bruner, 2012). However, the clustering of responses at the ends of the distribution reduces the utility of a rank transformation. Therefore, AUC values were classified according to the proportion of the available AUC (%AUC) using the following categories: 0.0 %AUC 0.25, 0.25 < %AUC 0.5, 0.5 < %AUC 0.75, 0.75 < %AUC < 1.0, %AUC = 1.0. A categorized %AUC value of 1.0 indicates that there is no discounting of condom-protected sex. In contrast to a data-based criterion such as quartiles, using the same categorization for each condition of the SDT permits across-condition comparison of similar levels of discounting.

Outcome Measures

The primary outcome is CAI with at least one partner in the past 12 months. Participants also reported age, income, educational status, PrEP use, and total number of partners in the past 12 months. Substance use was hypothesized to be an intervening variable between delay discounting and sexual risk-taking and was therefore not a potential confounder in the current analyses.

Analysis Methods

Demographics—Demographic and sexual behavior variables were stratified by CAI status (any CAI in past 12 months versus none) and chi-square tests were used to assess whether any demographic or sexual behavioral variables differed based on CAI status.

Effect of age group—Adjusted prevalence differences (PDs) were estimated for the association between delay discounting and CAI, stratified by age group, using binomial regression for the monetary delay discounting variable. Binomial models did not converge for the sexual delay discounting variable, so Poisson regression with robust variances (Spiegelman & Hertzmark, 2005) was used. Separate models were estimated for each condition of the SDT. All models contained an interaction term to assess the effect of age group.

Effect of current PrEP use—Adjusted PDs were estimated for the association between sexual delay discounting and CAI, stratified by current PrEP use. Due to the small number of men reporting current PrEP use, neither binomial models nor Poisson models with robust variance could be estimated using the categorized SDT %AUC variable. Poisson regression with robust variances was used to estimate PDs for each condition of the SDT using the dichotomous %AUC variable. All models contained an interaction term to assess the effect of current PrEP use.

Results

Demographics

Participant demographics and HIV testing history are reported in Table 1, stratified by CAI status. Overall the age groups were approximately evenly divided (45.3% age 18-24). Participants were mostly white (66.7%) or other/multiracial (17.7%). Most participants (73.2%) had previously been tested for HIV, a lower percentage than is typically observed in surveillance systems (Centers for Disease Control and Prevention, 2014; Sanchez, Sineath, Kahle, Tregear, & Sullivan, 2015). Current PrEP use was reported by 4.8% of participants. Chi-square tests indicated associations between CAI in the past 12 months and marital status ($p=0.0489$), having a main partner ($p<.0001$), ever testing for HIV ($p<.0001$), number of partners reported ($p<.0001$), ever taking PrEP ($p=.0075$), and current PrEP use ($p=.0386$).

Distribution of Delay Discounting Variables

The distribution of the delay discounting variables is presented in Table 2. The log-transformed k value from the MCQ was approximately normal (mean=-4.63, s.d.=1.85). The AUC values for each condition in the SDT were highly skewed and clustered. A large proportion of men did not discount condom-protected sex at any delay across each condition, resulting in a %AUC value of 1.0. Across the four SDT conditions, 37.2%, 53.3%, 60.1%, and 43.7% of men had a %AUC of 1.0 in the MOSTSEX, LEASTSEX, MOSTSTI, and LEASTSTI conditions, respectively (i.e., likelihood of using a condom was not affected by delay for these participants).

Effect of Age Group

Adjusted PDs of CAI for each one-unit change in the log-transformed k value are presented in Table 3. There was no association between increasing monetary delay discounting and prevalence of CAI in the past 12 months for either age group. Having 1-3 sexual partners in the previous 12 months was associated with a 16% (PD=-0.16, CI:-0.22,-0.10) lower prevalence of CAI compared to those with 4+ sexual partners.

Adjusted PDs for the categorized %AUC values stratified by age group are presented in Table 4. Higher %AUC indicates less impulsivity (i.e., greater willingness to wait for a condom). The interaction between age group and delay discounting was not statistically significant for any of the conditions, but prevalence differences for CAI in the past 12 months were generally higher among men age 18-24 compared to men age 25 and older. In general, CAI PDs increased as sexual delay discounting increased. For the MOSTSEX condition, among those age 18-24, there was a 39% higher prevalence (PD=0.39, CI: 0.25,0.53) of CAI in the past 12 months among those with a %AUC between 0.00 and 0.25 compared to those with %AUC of 1.00; for the same comparison among those age 25+ the PD was 0.25 (PD=0.25, CI:0.12,0.37). Among those 18-24 in the MOSTSEX condition, PDs were 0.28 (CI:0.08-0.49), 0.13 (CI:-0.09,0.36), and 0.17 (CI:-0.03,0.36) across categories of increasing %AUC (i.e., less discounting). These same prevalence differences were less consistent among those age 25 and older. Across categories of increasing %AUC for those age 25 and older in the MOSTSEX condition, PDs were 0.04 (CI:-0.16,0.23), 0.22 (CI: 0.05,0.38), and 0.04 (CI:-0.12,0.20). Results for the other three conditions were generally similar with more consistent trends in PDs observed among the younger compared to older age group.

Effect of Current PrEP Use

Adjusted prevalence differences for the dichotomized SDT %AUC are presented in Table 5. Across all SDT conditions, PDs comparing men who discount condom-protected sex to those who do not were higher among men currently on PrEP; however, the effect was only statistically significant for the MOSTSEX condition. In this condition, the PD for men currently on PrEP was 0.50 (CI:0.30,0.70) compared to 0.19 (CI:0.10,0.29) for men who were not currently on PrEP.

Discussion

No association between monetary discounting and CAI was observed; however, all conditions of the SDT were associated with higher prevalence of CAI. There was no statistically significant effect modification by age on the association between discounting of condom-protected sex and CAI; however, there was an effect of current PrEP use. In the MOSTSEX condition, larger PDs were observed comparing men who discounted condom-protected sex to those who do not among men currently on PrEP compared to men not on PrEP.

In a previous online study of MSM, monetary delay discounting was found to be associated with CAI (J. Jones & Sullivan, 2015), and this association was found to be age dependent (J. Jones & Sullivan, 2016). The results of the current study suggest that monetary discounting is not associated with CAI. This is consistent with previous findings that sexual and monetary discounting are not associated (J. Jones, Guest, J. L., Sullivan, P. S., Kramer, M., Jenness, S., Sales, J., In press). Multiple studies have previously demonstrated an association between monetary delay discounting and impulsive health-related behaviors (e.g., substance use and abuse; Baker, Johnson, & Bickel, 2003; Odum et al., 2000; Odum, Madden, & Bickel, 2002; Petry, 2001, 2003) and health states that might result from impulsive behaviors

(e.g., obesity; Jarmolowicz et al., 2014; Lawyer et al., 2015). The lack of association between monetary discounting and sexual behavior might reflect fundamental differences in the decision-making processes that are involved with each behavior. Monetary discounting tasks assess preference for specific quantities of money available at given delays. In comparison, the SDT measures preferences for condom use, a qualitative outcome, with a variety of short-term (e.g., pleasure) and long-term (e.g., avoidance of STIs) consequences. Continued investigation is needed in light of the discrepant results across studies.

The effects of age or PrEP administration on the association between sexual delay discounting and CAI have not previously been reported. Although the prevalence differences for CAI were generally stronger among younger MSM, this effect was not statistically significant. Thus, the current study might have been underpowered to observe an effect of developmental age. In contrast, current PrEP usage had a synergistic effect with sexual discounting in the MOSTSEX condition. There has been concern that PrEP implementation will be accompanied by risk compensation in which individuals are willing to increase risk-taking because they feel protected from harm (Golub, 2014; Underhill, Operario, Skeer, Mimiaga, & Mayer, 2010). It is important to note that PrEP only protects against HIV, not other STIs. Thus, if men who discount condom-protected sex are more likely to engage in CAI (i.e., risk compensation) when taking PrEP, this may result in increased STI incidence in this population. The observation that men on PrEP who discounted condom-protected sex in the MOSTSEX condition had higher CAI PDs compared to men not on PrEP suggests that men might be increasing their risk because they are on PrEP, at least in the context of a man they find very attractive. That is, partner type may affect the extent to which a PrEP-user discounts condom-protected sex.

Few studies have assessed the effects of delay discounting on sexual risk-taking among MSM, even though this population is disproportionately impacted by the HIV epidemic. Herrmann et al. (2015) assessed sexual delay discounting in MSM and found an association between discounting on the SDT and CAI. However, their study sample was relatively small, almost exclusively Caucasian, and was obtained via MTurk. The authors specified that they were seeking MSM in the recruitment posting on MTurk, potentially incentivizing participants to misrepresent their sexual history in order to qualify for the task. Further, it is not clear to what degree MSM on MTurk are representative of other Internet-using MSM or MSM in general; participants recruited via Facebook have been shown to be similar to those recruited via venue-based sampling (Hernandez-Romieu et al., 2014). Selection bias might still be a concern in this study, limiting the generalizability of the results. For example, the study population was highly educated, similar to other online studies using similar recruitment strategies (Dasgupta, Vaughan, Kramer, Sanchez, & Sullivan, 2014; J. Jones & Sullivan, 2015; Vaughan, Kramer, Cooper, Rosenberg, & Sullivan, 2016).

CAI was a common outcome, reported by 68% of the study sample. Although 42% only reported CAI with a main partner, CAI in main partnerships continues to carry risk in the context of partner concurrency (Rosenberg, Rothenberg, Kleinbaum, Stephenson, & Sullivan, 2013) and undiagnosed HIV (Hall, Holtgrave, & Maulsby, 2012). The high prevalence of CAI indicates that there is a need for additional prevention interventions to

reduce sexual risk-taking and reduce transmission of HIV and other STIs. Future studies should also consider more specific risk behaviors, such as CAI with a serodiscordant partner.

The monetary and sexual outcomes in this study were hypothetical. Participants might exhibit different preferences in real-world situations; however, previous delay discounting research has demonstrated that hypothetical and real monetary rewards are discounted similarly (M. W. Johnson & Bickel, 2002). Ethical considerations would prevent the use of real sexual rewards in any study.

The results of the current study indicate that sexual, but not monetary, delay discounting tasks might serve as an indicator of sexual risk. Delay discounting measures might be useful as a means of identifying men at highest risk of HIV/STI who are in greatest need of prevention interventions. To the extent that sexual delay discounting is modifiable, discount rates might serve as either a target for HIV prevention interventions to reduce sexual risk behavior or as an immediately measurable indicator of the effectiveness of risk reduction interventions.

Future studies should continue to explore the nature of the relationship between sexual delay discounting and CAI as well as adapt methods from substance abuse interventions (Bickel, Yi, Landes, Hill, & Baxter, 2011; Black & Rosen, 2011) to assess the feasibility of developing interventions based on sexual delay discounting to reduce CAI.

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References

- Audrain-McGovern J, Rodriguez D, Epstein LH, Cuevas J, Rodgers K, Wileyto EP. Does delay discounting play an etiological role in smoking or is it a consequence of smoking? *Drug and Alcohol Dependence*. 2009; 103(3):99–106. DOI: 10.1016/j.drugalcdep.2008.12.019 [PubMed: 19443136]
- Baker F, Johnson MW, Bickel WK. Delay discounting in current and never-before cigarette smokers: similarities and differences across commodity, sign, and magnitude. *J Abnorm Psychol*. 2003; 112(3):382–392. [PubMed: 12943017]
- Bickel WK, Yi R, Landes RD, Hill PF, Baxter C. Remember the Future: Working Memory Training Decreases Delay Discounting Among Stimulant Addicts. *Biological Psychiatry*. 2011; 69(3):260–265. [PubMed: 20965498]
- Black AC, Rosen MI. A money management-based substance use treatment increases valuation of future rewards. *Addictive Behaviors*. 2011; 36(1–2):125–128. [PubMed: 20826055]
- Carlo Hojilla J, Koester KA, Cohen SE, Buchbinder S, Ladzekpo D, Matheson T, Liu AY. Sexual Behavior, Risk Compensation, and HIV Prevention Strategies Among Participants in the San Francisco PrEP Demonstration Project: A Qualitative Analysis of Counseling Notes. *AIDS Behav*. 2016; 20(7):1461–1469. DOI: 10.1007/s10461-015-1055-5 [PubMed: 25835463]
- Centers for Disease Control and Prevention. HIV Surveillance Report, 2011. 2013; 23
- Centers for Disease Control and Prevention. HIV Risk, Prevention, and Testing Behaviors - National HIV Behavioral Surveillance System: Men Who Have Sex With Men, 20 US Cities, 2011. 2014. Sep, 2014 Retrieved from <http://www.cdc.gov/hiv/library/reports/surveillance/#special>

- Chesson HW, Leichliter JS, Zimet GD, Rosenthal SL, Bernstein DI, Fife KH. Discount rates and risky sexual behaviors among teenagers and young adults. *Journal of Risk and Uncertainty*. 2006; 32(3): 217–230.
- Conover WJ, Iman RL. Rank Transformations as a Bridge Between Parametric and Nonparametric Statistics. *The American Statistician*. 1981; 35(3):124–129. DOI: 10.2307/2683975
- Dasgupta S, Vaughan AS, Kramer MR, Sanchez TH, Sullivan PS. Use of a Google Map Tool Embedded in an Internet Survey Instrument: Is it a Valid and Reliable Alternative to Geocoded Address Data? *JMIR Res Protoc*. 2014; 3(2):e24.doi: 10.2196/resprot.2946 [PubMed: 24726954]
- Giedd JN. Structural magnetic resonance imaging of the adolescent brain. *Ann N Y Acad Sci*. 2004; 1021:77–85. DOI: 10.1196/annals.1308.009 [PubMed: 15251877]
- Golub SA. Tensions between the epidemiology and psychology of HIV risk: implications for pre-exposure prophylaxis. *AIDS Behav*. 2014; 18(9):1686–1693. DOI: 10.1007/s10461-014-0770-7 [PubMed: 24719201]
- Grov C, Whitfield TH, Rendina HJ, Ventuneac A, Parsons JT. Willingness to Take PrEP and Potential for Risk Compensation Among Highly Sexually Active Gay and Bisexual Men. *AIDS Behav*. 2015; 19(12):2234–2244. DOI: 10.1007/s10461-015-1030-1 [PubMed: 25735243]
- Hall HI, Holtgrave DR, Mausbly C. HIV transmission rates from persons living with HIV who are aware and unaware of their infection. *Aids*. 2012; 26(7):893–896. DOI: 10.1097/QAD.0b013e328351f73f [PubMed: 22313960]
- Hernandez-Romieu AC, Sullivan PS, Sanchez TH, Kelley CF, Peterson JL, Del Rio C, Rosenberg ES. The comparability of men who have sex with men recruited from venue-time-space sampling and facebook: a cohort study. *JMIR Res Protoc*. 2014; 3(3):e37.doi: 10.2196/resprot.3342 [PubMed: 25048694]
- Herrmann ES, Hand DJ, Johnson MW, Badger GJ, Heil SH. Examining delay discounting of condom-protected sex among opioid-dependent women and non-drug-using control women. *Drug Alcohol Depend*. 2014; 144:53–60. DOI: 10.1016/j.drugalcdep.2014.07.026 [PubMed: 25190049]
- Herrmann ES, Johnson PS, Johnson MW. Examining Delay Discounting of Condom-Protected Sex Among Men Who Have Sex with Men Using Crowdsourcing Technology. *AIDS Behav*. 2015; 19(9):1655–1665. DOI: 10.1007/s10461-015-1107-x [PubMed: 26066395]
- Holt DD, Newquist MH, Smits RR, Tiry AM. Discounting of food, sex, and money. *Psychon Bull Rev*. 2014; 21(3):794–802. DOI: 10.3758/s13423-013-0557-2 [PubMed: 24338570]
- Jarmolowicz DP, Cherry JB, Reed DD, Bruce JM, Crespi JM, Lusk JL, Bruce AS. Robust relation between temporal discounting rates and body mass. *Appetite*. 2014; 78:63–67. DOI: 10.1016/j.appet.2014.02.013 [PubMed: 24650831]
- Johnson AS, Hall HI, Hu X, Lansky A, Holtgrave DR, Mermin J. Trends in diagnoses of HIV infection in the United States, 2002–2011. *JAMA*. 2014; 312(4):432–434. DOI: 10.1001/jama.2014.8534 [PubMed: 25038362]
- Johnson MW, Bickel WK. Within-subject comparison of real and hypothetical money rewards in delay discounting. *J Exp Anal Behav*. 2002; 77(2):129–146. DOI: 10.1901/jeab.2002.77-129 [PubMed: 11936247]
- Johnson MW, Bickel WK. An algorithm for identifying nonsystematic delay-discounting data. *Exp Clin Psychopharmacol*. 2008; 16(3):264–274. DOI: 10.1037/1064-1297.16.3.264 [PubMed: 18540786]
- Johnson MW, Bruner NR. The Sexual Discounting Task: HIV Risk Behavior and the Discounting of Delayed Sexual Rewards in Cocaine Dependence. *Drug and Alcohol Dependence*. 2012; 123(1–3): 15–21. DOI: 10.1016/j.drugalcdep.2011.09.032 [PubMed: 22055012]
- Jones J, Guest JL, Sullivan PS, Kramer M, Jenness S, Sales J. Concordance between monetary and sexual delay discounting in men who have sex with men. *Sexual Health*. (In press).
- Jones J, Sullivan PS. Impulsivity as a Risk Factor for HIV Transmission in Men Who Have Sex with Men: A Delay Discounting Approach. *J Homosex*. 2015; 62(5):588–603. DOI: 10.1080/00918369.2014.987568 [PubMed: 25402550]
- Jones J, Sullivan PS. Age-Dependent Effects in the Association Between Monetary Delay Discounting and Risky Sexual Behavior. *SpringerPlus*. 2016; 5(1):1–8. DOI: 10.1186/s40064-016-2570-1 [PubMed: 26759740]

- Kirby KN, Petry NM, Bickel WK. Heroin addicts have higher discount rates for delayed rewards than non-drug-using controls. *J Exp Psychol Gen.* 1999; 128(1):78–87. [PubMed: 10100392]
- Lawyer SR. Probability and delay discounting of erotic stimuli. *Behavioural Processes.* 2008; 79(1): 36–42. DOI: 10.1016/j.beproc.2008.04.009 [PubMed: 18556145]
- Lawyer SR, Boomhower SR, Rasmussen EB. Differential associations between obesity and behavioral measures of impulsivity. *Appetite.* 2015; doi: 10.1016/j.appet.2015.07.031
- Lawyer SR, Schoepflin FJ. Predicting domain-specific outcomes using delay and probability discounting for sexual versus monetary outcomes. *Behav Processes.* 2013; 96:71–78. DOI: 10.1016/j.beproc.2013.03.001 [PubMed: 23500484]
- MacKillop J, Celio MA, Mastroleo NR, Kahler CW, Operario D, Colby SM, Monti PM. Behavioral Economic Decision Making and Alcohol-related Sexual Risk behavior. *AIDS Behav.* 2014; doi: 10.1007/s10461-014-0909-6
- Madden GJ, Petry NM, Badger GJ, Bickel WK. Impulsive and self-control choices in opioid-dependent patients and non-drug-using control participants: drug and monetary rewards. *Exp Clin Psychopharmacol.* 1997; 5(3):256–262. [PubMed: 9260073]
- Myerson J, Green L, Warusawitharana M. Area under the curve as a measure of discounting. *Journal of the Experimental Analysis of Behavior.* 2001; 76(2):235–243. DOI: 10.1901/jeab.2001.76-235 [PubMed: 11599641]
- Newcomb ME, Mongrella MC, Weis B, McMillen SJ, Mustanski B. Partner Disclosure of PrEP Use and Undetectable Viral Load on Geosocial Networking Apps: Frequency of Disclosure and Decisions About Condomless Sex. *J Acquir Immune Defic Syndr.* 2016; 71(2):200–206. DOI: 10.1097/qai.0000000000000819 [PubMed: 26761520]
- Odum AL. Delay discounting: I'm a k, you're a k. *J Exp Anal Behav.* 2011; 96(3):427–439. DOI: 10.1901/jeab.2011.96-423 [PubMed: 22084499]
- Odum AL, Madden GJ, Badger GJ, Bickel WK. Needle sharing in opioid-dependent outpatients: psychological processes underlying risk. *Drug and Alcohol Dependence.* 2000; 60(3):259–266. [PubMed: 11053760]
- Odum AL, Madden GJ, Bickel WK. Discounting of delayed health gains and losses by current, never- and ex-smokers of cigarettes. *Nicotine & Tobacco Research.* 2002; 4(3):295–303. [PubMed: 12215238]
- Petry NM. Delay discounting of money and alcohol in actively using alcoholics, currently abstinent alcoholics, and controls. *Psychopharmacology.* 2001; 154(3):243–250. DOI: 10.1007/s002130000638 [PubMed: 11351931]
- Petry NM. Discounting of money, health, and freedom in substance abusers and controls. *Drug and Alcohol Dependence.* 2003; 71(2):133–141. DOI: 10.1016/s0376-8716(03)00090-5 [PubMed: 12927651]
- Purcell DW, Johnson CH, Lansky A, Prejean J, Stein R, Denning P, Crepaz N. Estimating the population size of men who have sex with men in the United States to obtain HIV and syphilis rates. *The Open AIDS Journal.* 2012; 6:98–107. DOI: 10.2174/1874613601206010098 [PubMed: 23049658]
- Rosenberg ES, Rothenberg RB, Kleinbaum DG, Stephenson RB, Sullivan PS. The implications of respondent concurrency on sex partner risk in a national, web-based study of men who have sex with men in the United States. *J Acquir Immune Defic Syndr.* 2013; 63(4):514–521. DOI: 10.1097/QAI.0b013e318294bcce [PubMed: 23591633]
- Sagaon-Teyssier L, Suzan-Monti M, Demoulin B, Capitain C, Lorente N, Preau M, Spire B. Uptake of PrEP and condom and sexual risk behavior among MSM during the ANRS IPERGAY trial. *AIDS Care.* 2016; :1–8. DOI: 10.1080/09540121.2016.1146653
- Sanchez HT, Sineath CR, Kahle ME, Tregear JS, Sullivan SP. The Annual American Men's Internet Survey of Behaviors of Men Who Have Sex With Men in the United States: Protocol and Key Indicators Report 2013. *JMIR Public Health Surveill.* 2015; 1(1):e3.doi: 10.2196/publichealth.4314 [PubMed: 27227126]
- Smith DK, Herbst JH, Rose CE. Estimating HIV Protective Effects of Method Adherence With Combinations of Preexposure Prophylaxis and Condom Use Among African American Men Who

- Have Sex With Men. *Sex Transm Dis*. 2015; 42(2):88–92. DOI: 10.1097/OLQ.0000000000000238 [PubMed: 25585067]
- Spiegelman D, Hertzmark E. Easy SAS calculations for risk or prevalence ratios and differences. *Am J Epidemiol*. 2005; 162(3):199–200. DOI: 10.1093/aje/kwi188 [PubMed: 15987728]
- Underhill K, Operario D, Skeer M, Mimiaga M, Mayer K. Packaging PrEP to Prevent HIV: An Integrated Framework to Plan for Pre-Exposure Prophylaxis Implementation in Clinical Practice. *Journal of Acquired Immune Deficiency Syndromes*. 2010; 55(1):8–13. [PubMed: 21423876]
- Vaughan AS, Kramer MR, Cooper HL, Rosenberg ES, Sullivan PS. Completeness and Reliability of Location Data Collected on the Web: Assessing the Quality of Self-Reported Locations in an Internet Sample of Men Who Have Sex With Men. *J Med Internet Res*. 2016; 18(6):e142.doi: 10.2196/jmir.5701 [PubMed: 27283957]
- Wilson M, Daly M. Do pretty women inspire men to discount the future? *Proc Biol Sci*. 2004; 271(Suppl 4):S177–179. DOI: 10.1098/rsbl.2003.0134 [PubMed: 15252976]
- Yoon JH, Higgins ST, Heil SH, Sugarbaker RJ, Thomas CS, Badger GJ. Delay discounting predicts postpartum relapse to cigarette smoking among pregnant women. *Exp Clin Psychopharmacol*. 2007; 15(2):176–186. DOI: 10.1037/1064-1297.15.2.186 [PubMed: 17469941]

Table 1

Sample demographics, relationship characteristics, and HIV testing history overall and stratified by CAI in the past 12 months.

	Total (N=1,012)		CAI Past 12 months (N=691)		No CAI Past 12 months (N=321)		Chi-square p-value ²
	N	%	N	%	N	%	
Age							
18-24	458	45.3	305	44.1	153	47.7	0.2945
25+	554	54.7	386	55.9	168	52.3	
Race/Ethnicity							
Black	76	7.5	49	7.1	27	8.4	0.6424
Hispanic	82	8.1	52	7.5	30	9.4	
White	675	66.7	467	67.6	208	64.8	
Other/Multiracial	179	17.7	123	17.8	56	17.5	
Education							
High school or less	209	20.7	135	19.5	74	23.1	0.1901
At least some college	802	79.3	556	80.5	246	76.9	
Income							
<\$15,000/year	260	29.0	175	27.8	85	31.8	0.2207
\$15,000/year	637	71.0	455	72.2	182	68.2	
Marital Status [*]							
Married/domestic partner	120	11.9	93	13.5	27	8.4	0.0489
Widowed/Divorced/Separated	19	1.9	11	1.6	8	2.5	
Never married	872	86.3	587	85.0	285	89.1	
Main partner							
Yes	386	43.5	305	51.2	81	27.8	<.0001
No	468	52.8	271	45.5	197	67.7	
Don't know	33	3.7	20	3.4	13	4.4	
Number of partners reported [*]							
1-3	607	60.6	374	54.1	233	75.2	<.0001
4+	394	39.4	317	45.9	77	24.8	
Ever tested for HIV [*]							
Yes	740	73.2	538	78.0	202	62.9	<.0001

	Total (N=1,012)	CAI Past 12 months (N=691)	No CAI Past 12 months (N=321)	Chi-square p-value ²
No	271	26.8	152	22.0
Ever tested positive for HIV			119	37.1
Yes	48	6.5	36	6.7
No	688	93.5	501	93.3
Ever used PrEP			187	94.0
Yes	61	7.1	51	8.7
No	799	92.9	536	91.3
Currently using PrEP			263	96.3
Yes	41	4.8	34	5.8
No	819	95.2	553	94.2
			266	97.4

* Statistically significant at alpha = .05

Table 2

Distribution of delay discounting variables

		<u>Monetary Delay Discounting</u>										
		Mean	Median	Standard Deviation								
<u>Ink</u>		-4.53	-4.63	1.85								
					<u>Sexual Delay Discounting</u>							
		<u>MOSTSEX</u>		<u>LEASTSEX</u>	<u>MOSTSTI</u>		<u>LEASTSTI</u>					
		N	%	N	N	%	N	%	N	%	N	%
0 < %AUC	0.25	132	22.1	48	7.4	32	4.5	87	14.2			
0.25 < %AUC	0.50	62	10.4	34	5.2	24	3.4	59	9.6			
0.50 < %AUC	0.75	76	12.7	68	10.5	56	7.8	70	11.4			
0.75 < %AUC < 1.00	1.00	105	17.6	153	23.6	173	24.2	129	21.0			
%AUC = 1.00		222	37.2	346	53.3	429	60.1	268	43.7			

Table 3

Adjusted prevalence differences for CAI and monetary delay discounting.

	PD	95% CI	p-value
ln <i>k</i> , one-unit increase			
Age 18-24	-0.003	(-.030, 0.024)	0.8435
Age 25+	-0.001	(-0.023, 0.021)	0.9312
Poverty			
Yes	-0.02	(-0.09, 0.05)	0.5695
No	Ref		
Education			
At least some college	0.02	(-0.06, 0.11)	0.6244
High School or less	Ref		
Number of Partners			
1-3	-0.16	(-0.22, -.10)	<.0001
4+	Ref		

*
Binomial regression

Table 4

Adjusted prevalence differences for CAI and each condition of the SDT by category, stratified by age group. Lower AUC values indicate greater sexual delay discounting.

	MOSTSEX			LEASTSEX			MOSTSTI			LEASTSTI		
	PD (95% CI)	p-value		PD (95% CI)	p-value		PD (95% CI)	p-value		PD (95% CI)	p-value	
Age 18-24 %AUC												
0.0 %AUC	0.39 (0.25, 0.53)	<.0001		0.23 (0.03, 0.43)	0.0252		0.30 (0.09, 0.52)	0.0059		0.35 (0.21, 0.50)	<.0001	
25.0 < %AUC	0.28 (0.08, 0.49)	0.0057		0.25 (0.06, 0.45)	0.0114		0.20 (-0.03, 0.43)	0.0874		0.28 (0.09, 0.47)	0.0036	
50.0 < %AUC	0.13 (-0.09, 0.36)	0.2495		0.21 (0.03, 0.39)	0.0246		0.18 (-0.02, 0.37)	0.0794		0.14 (-0.10, 0.38)	0.2483	
75.0 < %AUC	0.17 (-0.03, 0.36)	0.0936		0.19 (0.05, 0.34)	0.0085		0.19 (0.05, 0.32)	0.0079		0.09 (-0.07, 0.26)	0.2715	
1.0	Ref			Ref			Ref			Ref		
Age 25+ %AUC												
0.0 %AUC	0.25 (0.12, 0.37)	0.0001		0.29 (0.14, 0.44)	0.0001		0.22 (0.06, 0.38)	0.0082		0.27 (0.14, 0.39)	<.0001	
25.0 < %AUC	0.04 (-0.16, 0.23)	0.7195		0.28 (0.10, 0.46)	0.0025		0.32 (0.23, 0.40)	<.0001		0.12 (-0.06, 0.30)	0.1897	
50.0 < %AUC	0.22 (0.05, 0.38)	0.0090		0.08 (-0.12, 0.27)	0.448		0.06 (-0.13, 0.25)	0.5369		0.01 (-0.16, 0.18)	0.8995	
75.0 < %AUC	0.04 (-0.12, 0.20)	0.6068		0.05 (-0.07, 0.18)	0.3998		0.01 (-0.11, 0.13)	0.8993		0.04 (-0.12, 0.19)	0.6464	
1.0	Ref			Ref			Ref			Ref		
Poverty												
Yes	-0.07 (-0.17, 0.03)	0.1545		-0.04 (-0.14, 0.05)	0.3395		-0.07 (-0.16, 0.01)	0.101		-0.07 (-0.17, 0.03)	0.1726	
No	Ref			Ref			Ref			Ref		
Education												
Some college	0.12 (0.00, 0.23)	0.0423		0.04 (-0.07, 0.15)	0.4612		0.04 (-0.07, 0.14)	0.4735		0.06 (-0.05, 0.18)	0.2718	
High School or less	Ref			Ref			Ref			Ref		
Number of Partners												
1-3	-0.14 (-0.22, -0.05)	0.0015		-0.18 (-0.25, -0.10)	<.0001		-0.2 (-0.27, -0.13)	<.0001		-0.15 (-0.23, -0.07)	0.0003	
4+	Ref			Ref			Ref			Ref		

* Poisson regression with robust variances

Table 5

Adjusted prevalence differences for CAI and each condition of the SDT by category, stratified by current PrEP use.

	MOSTSEX*			LEASTSEX			MOSTSTI			LEASTSTI		
	PD (95% CI)	p-value		PD (95% CI)	p-value		PD (95% CI)	p-value		PD (95% CI)	p-value	
Any Discounting												
Current PrEP Use	0.50 (0.30, 0.70)	<.0001		0.32 (0.05, 0.59)	0.0221		0.23 (0.02, 0.45)	0.0338		0.29 (−0.01, 0.59)	0.0612	
Not using PrEP	0.19 (0.10, 0.29)	<.0001		0.15 (0.06, 0.23)	0.0008		0.12 (0.04, 0.21)	0.0041		0.17 (0.08, 0.26)	0.0002	
Age												
18-24	−0.06 (−0.16, 0.04)	0.2381		−0.02 (−0.11, 0.07)	0.6330		−0.03 (−0.12, 0.06)	0.5429		−0.07 (−0.17, 0.02)	0.1235	
25+	Ref			Ref			Ref			Ref		
Poverty												
Yes	−0.11 (−0.22, 0.00)	0.0542		−0.05 (−0.15, 0.06)	0.3738		−0.08 (−0.18, 0.02)	0.1001		−0.08 (−0.19, 0.03)	0.1582	
No	Ref			Ref			Ref			Ref		
Education												
At least some college	0.15 (0.03, 0.27)	0.0119		0.08 (−0.04, 0.20)	0.2110		0.09 (−0.03, 0.20)	0.1471		0.12 (0.00, 0.25)	0.0480	
High School or less	Ref			Ref			Ref			Ref		
Number of Partners												
1-3	−0.18 (−0.27, −0.09)	<.0001		−0.18 (−0.26, −0.09)	<.0001		−0.22 (−0.30, −0.14)	<.0001		−0.18 (−0.27, −0.09)	<.0001	
4+	Ref			Ref			Ref			Ref		

Poisson regression with robust variances;

* Effect of current PrEP use statistically significant