Concordance between monetary and sexual delay discounting in men who have sex with men

Jeb Jones, *Emory University*
Jodie L. Guest, *Emory University*
Patrick S Sullivan, *Emory University*
Michael R Kramer, *Emory University*
Samuel M. Jenness, *Emory University*
Jessica Sales, *Emory University*

Journal Title: Sexual Health

Volume: Volume 15, Number 3

Publisher: CSIRO Publishing | 2018-01-01, Pages 214-222

Type of Work: Article | Post-print: After Peer Review

Publisher DOI: 10.1071/SH17111

Permanent URL: https://pid.emory.edu/ark:/25593/tqvqr

Final published version: http://dx.doi.org/10.1071/SH17111

HHS Public Access

Author manuscript

Sex Health. Author manuscript; available in PMC 2019 June 01.

Published in final edited form as:

Sex Health. 2018 June ; 15(3): 214–222. doi:10.1071/SH17111.

Concordance between monetary and sexual delay discounting in men who have sex with men

Jeb Jones[A,D], **Jodie L. Guest**[A,C], **Patrick S. Sullivan**[A], **Michael R. Kramer**[A], **Samuel M. Jenness**[A], and **Jessica M. Sales**[B]

[A]Department of Epidemiology, Emory University, 1518 Clifton Road, Atlanta, GA 30322

[B]Department of Behavioral Sciences and Health Education, Emory University, 1518 Clifton Road, Atlanta, GA 30322

[C]Department of Family and Preventative Medicine, Emory University, 1648 Pierce Dr NE, Atlanta, GA 30322

Abstract

Background—Delay discounting has been found to be associated with numerous health-related outcomes, including risky sexual behaviour. To date, it is unclear whether delay discounting measured in different domains is associated within individuals. The goal of this study was to assess the concordance of monetary and sexual delay discounting in men who have sex with men.

Methods—Participants completed an online survey, including the Monetary Choice Questionnaire and the Sexual Discounting Task. Linear regression models were used to assess the association between monetary and sexual discount rates.

Results—Sexual discount rates did not predict monetary discount rates. There was a substantial amount of clustering of sexual discount rates, requiring sexual discounting data to be categorised.

Conclusions—Monetary and sexual delay discounting are distinct processes that are not necessarily associated within individuals, and monetary delay discounting is not an appropriate proxy measure for sexual impulsivity. Data from the Sexual Discounting Task are typically rank-transformed for analysis. These data suggest that this might be an invalid method of analysis. Future studies should investigate the distribution of their data to determine if it is appropriate to analyse sexual discounting data as a continuous measure.

Additional keywords

sexual risk; HIV

Introduction

Men who have sex with men (MSM) have the highest group-specific rate of HIV in the United States. MSM are 57.5-fold more likely to be diagnosed with HIV compared with

[D]Corresponding author: jeb.jones@emory.edu.

Conflicts of interest

The authors declare no conflicts of interest.

other men.[1] Although the rate of HIV diagnosis has been declining in most subgroups, including heterosexual women and injection drug users, the rate of diagnoses among MSM has been increasing over the past several years.[2] Diagnoses have been increasing even more rapidly among young MSM and MSM of colour.[2,3] Combination HIV prevention programs that rely on multiple modes of prevention, including increased access to and use of condoms, are the most promising public health strategy to reduce HIV transmission.[4] Impulsivity may play an important role in condom use, and therefore in sexual risk-taking that can lead to HIV transmission.

Impulsivity is a concept that has been defined in multiple ways by different researchers,[5] but is frequently operationalised as delay discounting, or the preference for a smaller reward or consequence available sooner over a more preferred reward available after a longer delay.[6] Broadly, impulsivity can be measured using domain-general or domain-specific assessments.[7] Domain-general assessments focus on impulsivity as a trait of the individual that is present across situations. Domain-specific assessments allow for situational and stimulus-specific factors to contribute to impulsive behaviour. For example, an individual may exhibit self-control and a lack of impulsivity in their management style at work, but make financially impulsive decisions when away from the office. Some empirical evidence suggests that domain-specific measurements of impulsivity are more valid and allow for within-individual variations in behaviour compared with domain-general measurements.[7] That is, individual differences in impulsivity across domains cannot be detected by domain-general measures, and it is unclear how much concordance should be expected between domain-general and domain-specific measures.

Delay discounting is a behavioural economic measure of impulsivity that is associated with many health-related behaviours and conditions, including substance abuse[8–13] and obesity.[14,15] There is growing evidence that delay discounting may be associated with sexual risk-taking.[16–19] Commonly, delay discounting has been measured using a monetary choice task in which respondents select between a given amount of money available immediately or in the near future and a larger amount of money available after a longer delay. Monetary delay discounting tasks, although specific to financial impulsivity, have become a de facto domain-general measurement of impulsivity in the delay discounting paradigm. The frequency with which monetary discounting has been found to be associated with impulsivity in domains other than financial decision-making supports this use of monetary tasks. Domain-specific delay discounting tasks have also been developed. For example, discounting of substance of choice has been measured for specific substances such as heroin[20,21] and alcohol;[22] other tasks have been developed to measure discounting of health outcomes.[9,23] Understanding the relationship between delay discounting and health-related problems may contribute to development of novel public health strategies to reduce morbidity and mortality associated with impulsive behaviour. Indeed, interventions have been developed that reduce delay discounting and substance use;[24,25] similar interventions might be effective in reducing sexual risk-taking.

Domain-specific methods to assess delay discounting of sexual behaviour have also been developed. Tasks measuring delay discounting of access to erotic stimuli[17], the quantity/duration of sexual behaviour[18,26,27] and the attractiveness of a potential sexual partner[28]

have found systematic patterns of responding across a range of delay values. The Sexual Delay Discounting Task (SDT)[19] is a domain-specific delay discounting task that measures discounting of condom-protected sex, a behavioural outcome with direct relevance to HIV and sexually transmissible infection (STI) transmission. By using the SDT, condom-protected sex has been shown to be described by a two-parameter hyperboloid function,[19,29,30] similar to other forms of discounting. This function describes the decay in value of a reward as the delay to the reward increases. In the context of the SDT, the reward is the protection conferred by a condom. Systematic discounting data have been obtained from multiple populations including young adults[29], men who have sex with men[30] and opioid-dependent women.[31] Opioid-dependent women[31] and cocaine users[32,33] have been found to discount condom-protected sex more steeply than non-opioid-using controls.[31] Delay discounting of condom-protected sex, but not money, increases following administration of alcohol[34] and cocaine[35], suggesting domain-specific effects.

The concordance between monetary and sexual discounting is interesting for a couple of reasons. First, it will be important to recognise from a behavioural perspective whether people who tend to discount delayed money also tend to discount delayed access to condoms or sexual activity. If discounting in the two domains tends to be concordant within individuals, then this will provide an indication of the generalisability of domain-specific delay discounting to other domains. Second, to the extent that it is associated with sexual risk-taking, delay discounting might play an important role in reducing risky sexual behaviour and HIV/STI transmission. Delay discounting might be useful as a screening tool to identify individuals who are more likely to engage in risky sex and, to the extent that delay discounting is modifiable, might serve as a target for behavioural interventions. If delay discounting is generalisable across domains, then information about an individual's tendency to discount in one domain (e.g. money) could provide information about their discount rate for other domains (e.g. sexual). The ease of implementation of some monetary discounting tasks compared with sexual discounting tasks and the reduced social desirability bias associated with monetary discounting tasks[36] might make monetary discounting a more desirable screening tool.

Monetary discounting has previously been found to be associated with condomless anal intercourse (CAI) in an online sample of MSM.[37] Given that sexual delay discounting has also been shown to be associated with sexual risk-taking,[17–19] monetary and sexual discounting might be measuring a general tendency to discount across multiple domains. That is, the tendency for monetary discounting tasks to predict impulsivity in domains beyond financial behaviour may translate to sexual discounting as well. In fact, Holt *et al.*[38] found that delay discounting of high-value sexual encounters was correlated with delay discounting of food and money.

There are limited published studies in which both delay discounting and monetary discounting have been measured.[18,19,32,38] In these studies, the concordance between monetary and sexual delay discounting has been unclear; correlations between the two types of discounting have been inconsistent. When statistically significant, the correlations tend to be small.[18,19,32] For example, across two studies,[19,32] correlations between monetary and sexual delay discounting ranged from −0.10 to 0.33. Holt *et al.*,[38] however, observed

relatively large (0.64 and 0.65) and statistically significant correlations between delay discounting of sex and money. The reported studies tend to have small numbers of participants and were not conducted specifically to assess the association between monetary and sexual discounting. Additionally, many studies comprise undergraduate populations,[18,38] raising questions about the generalisability of the results. Given the elevated prevalence and incidence of HIV and STIs among MSM compared with other populations,[2,39] discounting of condom-protected sex, as in the SDT, might differ in MSM compared with other populations as well.

The aim of the current study was to assess the concordance between monetary and sexual delay discounting. To address some of the shortcomings of previous studies, we recruited a large population from a widely used social network and focussed recruitment on MSM, the group with the highest rate of HIV diagnoses in the United States.

Methods

Recruitment

Participants were recruited via Facebook advertisements targeted to men who indicated that they were interested in men in their profile or who 'liked' pages that indicated that they might be MSM. Men who clicked through to the survey were provided with information about the study and completed an eligibility screener. Men were eligible for the study if they were 18 years of age or older, born male, and had sex with a man in the previous 6 months. Participants completed the survey anonymously and were not compensated. This study was determined to be exempt from review by the Emory University Institutional Review Board (IRB).

Delay discounting measures

Monetary delay discounting was measured using the Monetary Choice Questionnaire (MCQ),[40] and sexual delay discounting was measured using the Sexual Discounting Task.[19] The order of the MCQ and SDT was randomised across participants.

Monetary delay discounting

The MCQ consists of 27 dichotomous questions of the form, 'Would you prefer $54 today or $55 in 117 days?' The pattern of responding across the 27 items is used to assign a value of k that describes the rate of monetary discounting in the hyperbolic discounting equation $V = 1/(1+kD)$, where V is the present subjective value of a monetary outcome, D is the delay, and k is a free parameter that describes the rate of discounting.[41] Higher values of k indicate steeper discounting of delayed monetary outcomes.

Sexual delay discounting

The SDT measures the extent to which delayed condom-protected sex is discounted compared with immediately available condomless sex. Prior to completing the task, participants were presented with an array of 41 headshots of different men and instructed to select the men with whom, assuming they liked his personality, they would be interested in having sex. Using language adapted from Johnson and Bruner,[19] participants were instructed

to assume that they were not in a relationship and no one else would be affected if they were to have sex with one of the selected men.

Participants were shown all the selected photos and asked to identify the man they would most like to have sex with (MOSTSEX). That image was then removed and the participant was asked to identify the man he would least like to have sex with (LEASTSEX). All the originally selected images were then presented again and the same procedure was used to identify the man he thought was most likely to have a STI (MOSTSTI) and least likely to have a STI (LEASTSTI). Thus, up to four different images could be selected to satisfy these four conditions and the discounting task was completed for each. If an image was selected for more than one condition, then the discounting task was only completed once for that image. The four different conditions of the SDT represent four different decision-making contexts. This allows for the assessment of condom preferences in different situations, such as with a partner who is perceived to be very attractive or a partner who is perceived to have a high likelihood of having a STI.

For the discounting task, participants indicated on a visual analogue scale (VAS) their preference for sex without a condom immediately versus sex with a condom at 7 different delays: 1 h, 3 h, 6 h, 1 day, 1 week, 1 month and 3 months. The left side of the VAS was always ‘I will definitely have sex now without a condom.’ The right anchor of the VAS was always ‘I will definitely wait < delay > to have sex with a condom.’ An additional condition in which there was no delay for condom-protected sex was used to assess individual condom use preferences.

Analytic methods

The monetary discounting parameter, *k*, was determined by using the method proposed by Kirby and Maraković[42] based on the pattern of responding across the 27 items. Briefly, a participant’s pattern of responding was compared with 10 potential response patterns, each of which is associated with a given value of *k*. A value of *k* was assigned based on the standard pattern that the participant’s responses most closely matched. Participants who matched two patterns equally well were assigned the geometric mean between the two values of *k* associated with those patterns. Responses that did not meet 80% agreement with at least one value of *k* were marked invalid. The distribution of *k* was skewed, so it was log-transformed for analyses.

The selection on the VAS for the SDT was treated as the indifference point between condomless and condom-protected sex. To account for differences in condom preference, the seven delay conditions of the SDT were standardised to the 0-delay condition by dividing the former by the latter, resulting in a standardised area under the curve (AUC). Thus, standardised values were not calculated for participants who selected immediate condomless sex (i.e. 0 on the VAS) in the 0-delay condition. These standardised values were used to determine the AUC for each participant for each condition of the SDT using the method proposed by Myerson *et al*.[43] Lower AUCs indicate steeper discounting of condom-protected sex.

Sexual discounting task data were heavily skewed. A rank transformation was used as in previous studies.[30,31] Rank-transformed variables can take the place of a skewed variable in large-sample statistical methods.[44] However, the rank-transformed AUC was still considerably skewed due to a substantial number of ties, particularly at the ends of the distribution. Therefore, the AUCs were also categorised based on the percent of the total available AUC as follows: $0.00 \leq \%\ AUC \leq 0.25$, $0.25 < \%AUC \leq 0.50$, $0.50 < \%AUC \leq 0.75$, $0.75 < \%AUC < 1.00$, $\%AUC = 1.00$. The same categorisation was used for each SDT condition. Discounting of each condition likely represents somewhat different processes (e.g. sex with most preferred man vs with man most likely to have a STI). Using the same cut-points in each condition allows for the comparison of a given amount of discounting across conditions.

Orderliness of the SDT data was assessed using a method adapted from a study by Johnson and Bickel.[45] Specifically, a participant's data were excluded on a given condition if either of the following two criteria were met: (i) the indifference point for a given delay was >20% higher than the indifference point for the preceding delay; (ii) or the %AUC was >1 (i.e. preference for condoms increased as the delay to condoms increased indicating non-systematic responding). Group median AUCs were fit to the hyperboloid function $V = 1/(1+kD)^s$, which has previously been found to describe sexual discounting data.[19,29–31] In this function, V is the present subjective value of condom-protected sex, D is the delay to condom-protected sex, and k and s are free parameters.

Concordance of monetary and sexual discounting was assessed using linear regression models in which the outcome was the log-transformed k from monetary discounting and the predictor variables were either the rank-transformed AUC or categorised AUC from SDT.

Because of the high prevalence of men who did not discount condom-protected sex, χ^2 tests, stratified by age, were conducted to assess whether men who do not discount condom-protected sex also tend to not discount money (i.e. always choose the larger, later amount).

All analyses were conducted in SAS 9.4 (SAS Institute, Cary, NC, USA).

Results

Demographics

Of 217 287 Facebook impressions, there were 4265 click-throughs to the survey for a click-through rate of 2.0%. Of those who clicked through to the survey, 2684 (62.9%) initiated the survey; 790 (29.4%) of those who initiated the survey did not meet the eligibility criteria. A total of 1012 men provided systematic responses for at least one of the MCQ or SDT.

Demographics of the study population are presented in Table 1. Because the prevalence of no discounting of condom-protected sex was so high, demographic characteristics are dichotomised as no versus any sexual discounting in the MOSTSEX condition. Table 1 is stratified by discounting in the MOSTSEX condition because this condition had the highest proportion of participants discounting condom-protected sex. Approximately half (45.3%) of the participants were under 25 years old and most were white (66.7%) or other/multiracial

(17.7%). Overall, the study population was well educated, with 79.3% reporting at least some college education; however, 29.0% of participants reported an income below the poverty line, defined as <$15 000 per year. Close to half (43.5%) of participants reported a main partner, defined as someone they were committed to above all others. No differences were observed on any of the demographic variables based on discounting (no vs. any) status.

Orderliness and distribution of discounting data

Patterns of responding indicating that a participant did not understand or did not attend to the delay discounting task are typically discarded before analysis. For example, random response patterns or non-monotonic discounting functions indicate that a participant is not responding systematically. Non-systematic responding on the SDT was high and is reported for each condition in Table 2. There was non-systematic responding in 29.6%, 21.2%, 17.4%, and 23.4% of MOSTSEX, LEASTSEX, MOSTSTI and LEASTSTI conditions respectively. Across conditions, 9.0%, 5.7%, 4.6% and 11.6% of participants indicated a preference for immediate condomless sex (i.e. 0 on the VAS) in the MOSTSEX, LEASTSEX, MOSTSTI, and LEASTSTI conditions respectively, and thus did not contribute to analyses involving standardised AUC.

There was a large proportion of participants in each SDT condition that did not discount condom-protected sex; that is, preference for condoms was insensitive to delay. The distribution of the log-transformed k and AUCs from each SDT condition are presented in Table 3. The values for k were approximately normal following the log-transformation; however, the standardised AUC values were skewed due to the clustering of values at the extremes of the distribution. The median standardised %AUC values were 0.83, 1.0, 1.0 and 0.99 for MOSTSEX, LEASTSEX, MOSTSTI and LEASTSTI respectively. Thus, more than half of participants did not discount condom-protected sex in the LEASTSEX and MOSTSTI conditions.

Group median SDT data were well-described by the two-parameter hyperboloid function when non-discounters were excluded from model fitting (R^2 >0.97 for all SDT conditions). When non-discounters were included, there was no least-squares solution obtained for the LEASTSEX and MOSTSTI conditions however, the model fit was good for MOSTSEX (R^2 = 0.99) and LEASTSTI (R^2 = 1.0).

Concordance of monetary and sexual discounting

Results from the linear regression models are presented in Table 4. Overall, there were no significant associations between monetary and sexual delay discounting in either young or older MSM. One category of MOSTSEX (25.0 < % AUC ≤ 50.0) had a statistically significant association with monetary discounting. Given the multiple comparisons present in the current analysis, the statistical significance of this association should be interpreted with caution. Following a Bonferroni correction, none of the results would be statistically significant.

Although non-significant, the effects were in the expected direction. As sexual discounting increased, the mean ln$k$ value also increased; however, these increases tended to be small. For example, a 100-unit decrease in rank in MOSTSEX standardised AUC (i.e. steeper delay

discounting) was associated with a 0.09 increase in the log-transformed *k*. Similarly, men with a MOSTSEX standardised %AUC between 0.0 and 0.25 had a mean ln*k* that was 0.29 units higher than men with a standardised AUC = 1.0. These trends were generally consistent across the SDT conditions.

The results of the χ^2 tests assessing the concordance of any-versus no-monetary and sexual discounting are presented in Table 5. Only one of the tests was significant, indicating that any monetary discounting is associated with any discounting of condom-protected sex in the MOSTSEX condition. As above, this result would not be statistically significant following corrections for multiple comparisons.

Discussion

In an online sample of MSM, we found no association between monetary and sexual delay discounting. The results of previous studies in which both monetary and sexual discounting have been assessed have been inconsistent. However, none of the four conditions in the SDT was found to be associated with monetary delay discounting, as measured by the MCQ.

The lack of concordance between these two measures suggests that the two delay discounting tasks are measuring separate behavioural processes or that delay discounting in one domain (e.g. economic) does not indicate delay discounting in other domains (e.g. sexual). These results suggest that monetary delay discounting tasks are unlikely to be useful tools to identify individuals most likely to engage in risky sexual behaviour and, therefore, most in need of prevention interventions to reduce HIV/STI transmission. Monetary discounting tasks have the benefit of reduced social desirability bias compared with sexual discounting tasks and could provide a method for identifying people who tend to be impulsive in economic decision-making as well as other decision-making contexts. However, these results suggest that with regard to the discounting of condom-protected sex, monetary discounting is uninformative.

Previous research has demonstrated that there may be an association between monetary discounting and impulsive behaviour in other domains. Numerous studies have demonstrated an association between substance use and abuse and monetary delay discounting.[12,22,23,46–48] Further, interventions have been developed that reduce monetary delay discounting and subsequent substance use.[24,25] Monetary delay discounting is also associated with eating behaviours and body mass.[14,15,49,50] Thus, the lack of concordance between monetary and sexual discounting appears to represent a divergence in the trend for economic impulsivity to generalise to impulsivity in other domains. However, associations have been observed between monetary discounting measured using the MCQ and reporting multiple CAI partners,[37] a three-question monetary discounting task and multiple sexual risk behaviours,[16] and the MOSTSTI condition of the SDT and monetary discounting measured using an adjusting-amount procedure.[19] Many studies have been underpowered to examine these relationships in multivariable models.

The current analysis demonstrates that monetary and sexual delay discounting are not associated. Combined with the inconsistent results of previously published studies,[19,32] this

indicates that there is not a clear answer with respect to whether to use general- or domain-specific impulsivity tasks when assessing sexual impulsivity. Of particular importance is the wide range of magnitudes of correlation coefficients observed, ranging from slightly negative[32] to relatively strong and positive.[38] Given this uncertainty, investigators may consider using both measures, recognising the strengths and limitations of each. Neglecting to use one measure might result in missing important associations between sexual behaviour outcomes, especially if multiple sexual risk indicators other than condomless sex are being included in the sexual behaviour outcome assessment. Indeed, certain forms of sexual risk-taking (e.g. condom use, number of partners, concurrent partners) may be differentially related to domain-general or domain-specific impulsivity tasks, as some may be more closely linked to an individual's personality traits, while other sexual behaviours may be more strongly related to the characteristics of situation- or stimulus-specific factors.

One possibility for the lack of concordance between sexual and monetary discounting is that social desirability bias may affect the current results. The SDT specifically asks participants to indicate a preference between condom-protected and condomless sex. Unlike the MCQ in which participants are merely expressing a preference between amounts of money at various delays, there is a clearer 'right' answer in the SDT: wait for a condom to be available. In the current study, a substantial proportion of men selected that they would always prefer to wait for a condom regardless of the delay for each of the four SDT conditions. Whether this reflects a true preference that is indicative of his behaviour or an unwillingness to express a preference for condomless sex in some situations is unclear. Social desirability might also affect responding to monetary tasks, such that the 'correct' answer is also somewhat inherent in these tasks as well. However, the effect of social desirability bias should be reduced in an anonymous, online survey, and participants in previous studies have indicated preferences for condomless sex in laboratory-based[19] and online settings.[31] The lack of concordance between monetary and sexual discounting persisted in analyses in which men who did not discount condomless sex were excluded (data not shown).

The SDT also represents a more complex decision-making scenario than does the MCQ. The MCQ presents a series of dichotomous choices between different amounts of money available at different delays. The only difference in the outcomes is quantitative – the amount of money and the delay to receipt. The SDT, in contrast, requires participants to indicate a preference between two outcomes that are *qualitatively* different: sex with or without a condom. In addition to the qualitative difference in the two outcomes, the SDT might also rely on decision-making with regard to likelihood of HIV/STI acquisition. Although the SDT includes conditions specific to perceived STI risk (MOSTSTI and LEASTSTI), it is likely that HIV/STI risk plays a role in a man's preference in the other conditions as well. This is likely to be especially true in a MSM population for whom condoms exclusively serve the purpose of preventing transmission of HIV/STIs given that pregnancy is not a concern.

Other sexual discounting tasks have been developed in which the delayed outcome is sex with a more attractive partner,[28] a greater quantity (i.e. longer duration) of sex[18] or access to erotic stimuli.[17] These tasks, particularly those with more quantitative outcomes, might be

more highly correlated with monetary discounting. In fact, discounting of the quantity of sexual activity has been shown to correlate with monetary discounting.[18]

There was a high rate of non-systematic or uninformative responding on the SDT in the present study; up to 39% in the MOSTSEX condition including those who had a value of zero in the zero-delay condition and thus could not contribute to analyses with standardised AUC. A value of zero in the zero-delay condition is not non-systematic *per se*, but these participants are uninformative with respect to the association between monetary and sexual discounting. Previous studies have reported non-systematic responding, but at a lower rate. For example, Herrmann *et al*.[30] conducted a survey of MSM recruited through Amazon's Mechanical Turk service. In that study, 89% of respondents' data were systematic; however, the authors did not report how many participants were excluded from analyses involving standardised AUC due to preference for immediate CAI in the 0-delay condition. Thus, it is unclear how many participants' data were excluded for being uninformative. Further, previous studies do not report excluding participants with AUC >1.0.[19,30,31] AUC values greater than 1.0 indicate non-systematic responding in which the preference for condom-protected sex increases with delay. Thus, it is not clear how much more non-systematic responding was present in the current study compared with others. It is possible that the sequential administration of two relatively complex delay-discounting tasks was an excessive participant burden.

This study has several strengths. We were able to recruit a large sample of MSM to complete both the SDT and MCQ, obtaining a larger sample size than most studies of delay discounting. The study population was diverse with respect to race, age, educational attainment and income. Using Facebook advertisements to recruit men to participate in research studies has been demonstrated to result in a minimally biased study population that is similar to participants obtained via venue-based, time-space recruitment.[51] Participants completed the survey anonymously, which should reduce any social desirability bias associated with reporting sexual history and completing the SDT.[52]

This study also has limitations. The SDT uses a response modality (i.e. VAS) that may not be as familiar to participants as other question types (e.g. radio button, checkbox). It is unclear whether the high proportion of non-systematic responding on the SDT was due in part to participants' lack of familiarity with this type of question. The lack of a VAS practice session might have influenced the results of the current study. However, only 3% of the responses on the MCQ were invalid, indicating that participants were capable of providing systematic discounting data. Participants completed the survey anonymously, so we are unable to use IP addresses to check for duplicate responses. Because participants were not compensated for participating, it is unlikely that one would take the survey multiple times.

In conclusion, in a large, online study of MSM, we found no concordance between monetary and sexual delay discounting. This indicates that monetary delay discounting is unlikely to be a reliable indicator of sexual risk and that interventions centred on monetary delay discounting may be less likely to have an effect on sexual risk-taking. Further, the present study indicates that impulsive sexual behaviour may be qualitatively different from other impulsive behaviours that have previously been found to be associated with monetary

discounting. Researchers are encouraged to use both general- and domain-specific measures when measuring impulsivity in the context of sexual behaviour and to carefully examine their data to ensure they use appropriate analysis methods. Future studies should continue to investigate whether other measures of sexual discounting are associated with monetary discounting, and how multiple measures of discounting relate to various risk behaviours.

Acknowledgments

This research was conducted in partial fulfillment of the requirements of the Doctor of Philosophy degree at Emory University for the first author, Jeb Jones.

Research reported in this publication was supported by the National Institute Of Allergy And Infectious Diseases of the National Institutes of Health under Award Number F31AI122973 (PI: Jones). The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

References

1. Rosenberg ES, Grey JA, Sanchez TH, Sullivan PS. Rates of prevalent HIV infection, prevalent diagnoses and new diagnoses among men who have sex with men in US states, metropolitan statistical areas, and counties, 2012–2013. JMIR Public Health and Surveillance. 2016; 2(1):e22.doi: 10.2196/publichealth.5684 [PubMed: 27244769]
2. 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):432–4. DOI: 10.1001/jama.2014.8534 [PubMed: 25038362]
3. Purcell DW, Johnson CH, Lansky A, Prejean J, Stein R, Denning P, Gau Z, Weinstock H, Su J, Crepaz N. Estimating the population size of men who have sex with men in the United States to obtain HIV and syphilis rates. Open AIDS J. 2012; 6:98–107. DOI: 10.2174/1874613601206010098 [PubMed: 23049658]
4. Sullivan PS, Carballo-Diéguez A, Coates T, Goodreau SM, McGowan I, Sanders EJ, Smith A, Goswami P, Sanchez J. Successes and challenges of HIV prevention in men who have sex with men. Lancet. 2012; 380(9839):388–99. DOI: 10.1016/S0140-6736(12)60955-6 [PubMed: 22819659]
5. Duckworth AL, Kern ML. A meta-analysis of the convergent validity of self-control measures. J Res Pers. 2011; 45(3):259–68. DOI: 10.1016/j.jrp.2011.02.004 [PubMed: 21643479]
6. Madden GJ, Johnson PS. A delay-discounting primer. In: Bickel GJMWK, editorImpulsivity: the behavioral and neurological science of discounting. Washington, DC, USA: American Psychological Association; 2010. 11–37.
7. Tsukayama E, Duckworth AL, Kim B. Resisting everything except temptation: evidence and an explanation for domain-specific impulsivity. Eur J Pers. 2012; 26(3):318–34. DOI: 10.1002/per.841
8. Odum AL, Madden GJ, Badger GJ, Bickel WK. Needle sharing in opioid-dependent outpatients: psychological processes underlying risk. Drug Alcohol Depend. 2000; 60(3):259–66. DOI: 10.1016/S0376-8716(00)00111-3 [PubMed: 11053760]
9. Odum AL, Madden GJ, Bickel WK. Discounting of delayed health gains and losses by current, never- and ex-smokers of cigarettes. Nicotine Tob Res. 2002; 4(3):295–303. DOI: 10.1080/14622200210141257 [PubMed: 12215238]
10. Bickel WK, Marsch LA. Toward a behavioral economic understanding of drug dependence: delay discounting processes. Addiction. 2001; 96(1):73–86. DOI: 10.1046/j.1360-0443.2001.961736.x [PubMed: 11177521]
11. Epstein LH, Richards JB, Saad FG, Paluch RA, Roemmich JN, Lerman C. Comparison between two measures of delay discounting in smokers. Exp Clin Psychopharmacol. 2003; 11(2):131–8. DOI: 10.1037/1064-1297.11.2.131 [PubMed: 12755457]
12. Heil SH, Johnson MW, Higgins ST, Bickel WK. Delay discounting in currently using and currently abstinent cocaine-dependent outpatients and non-drug-using matched controls. Addict Behav. 2006; 31(7):1290–4. DOI: 10.1016/j.addbeh.2005.09.005 [PubMed: 16236455]

13. Kirby KN, Petry NM. Heroin and cocaine abusers have higher discount rates for delayed rewards than alcoholics or non-drug-using controls. Addiction. 2004; 99(4):461–71. DOI: 10.1111/j.1360-0443.2003.00669.x [PubMed: 15049746]
14. 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; 78:63–7. DOI: 10.1016/j.appet.2014.02.013 [PubMed: 24650831]
15. Lawyer SR, Boomhower SR, Rasmussen EB. Differential associations between obesity and behavioral measures of impulsivity. Appetite. 2015; 95:375–82. DOI: 10.1016/j.appet.2015.07.031 [PubMed: 26235925]
16. Chesson HW, Leichliter JS, Zimet GD, Rosenthal SL, Bernstein DI, Fife KH. Discount rates and risky sexual behaviors among teenagers and young adults. J Risk Uncertain. 2006; 32(3):217–30. DOI: 10.1007/s11166-006-9520-1
17. Lawyer SR. Probability and delay discounting of erotic stimuli. Behav Processes. 2008; 79(1):36–42. DOI: 10.1016/j.beproc.2008.04.009 [PubMed: 18556145]
18. Lawyer SR, Schoepflin FJ. Predicting domain-specific outcomes using delay and probability discounting for sexual versus monetary outcomes. Behav Processes. 2013; 96:71–8. DOI: 10.1016/j.beproc.2013.03.001 [PubMed: 23500484]
19. Johnson MW, Bruner NR. The sexual discounting task: HIV risk behavior and the discounting of delayed sexual rewards in cocaine dependence. Drug Alcohol Depend. 2012; 123(1–3):15–21. DOI: 10.1016/j.drugalcdep.2011.09.032 [PubMed: 22055012]
20. Madden GJ, Bickel WK, Jacobs EA. Discounting of delayed rewards in opioid-dependent outpatients: exponential or hyperbolic discounting functions? Exp Clin Psychopharmacol. 1999; 7(3):284–93. DOI: 10.1037/1064-1297.7.3.284 [PubMed: 10472517]
21. 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):256–62. DOI: 10.1037/1064-1297.5.3.256 [PubMed: 9260073]
22. Petry NM. Delay discounting of money and alcohol in actively using alcoholics, currently abstinent alcoholics, and controls. Psychopharmacology (Berl). 2001; 154(3):243–50. DOI: 10.1007/s002130000638 [PubMed: 11351931]
23. Petry NM. Discounting of money, health, and freedom in substance abusers and controls. Drug Alcohol Depend. 2003; 71(2):133–41. DOI: 10.1016/S0376-8716(03)00090-5 [PubMed: 12927651]
24. Black AC, Rosen MI. A money management-based substance use treatment increases valuation of future rewards. Addict Behav. 2011; 36(1–2):125–8. DOI: 10.1016/j.addbeh.2010.08.014 [PubMed: 20826055]
25. Bickel WK, Yi R, Landes RD, Hill PF, Baxter C. Remember the future: working memory training decreases delay discounting among stimulant addicts. Biol Psychiatry. 2011; 69(3):260–5. DOI: 10.1016/j.biopsych.2010.08.017 [PubMed: 20965498]
26. Lawyer SR, Williams SA, Prihodova T, Rollins JD, Lester AC. Probability and delay discounting of hypothetical sexual outcomes. Behav Processes. 2010; 84(3):687–92. DOI: 10.1016/j.beproc.2010.04.002 [PubMed: 20385215]
27. Jarmolowicz DP, Bickel WK, Gatchalian KM. Alcohol-dependent individuals discount sex at higher rates than controls. Drug Alcohol Depend. 2013; 131(3):320–3. DOI: 10.1016/j.drugalcdep.2012.12.014 [PubMed: 23312341]
28. Jarmolowicz DP, Lemley SM, Asmussen L, Reed DD. Mr. right versus Mr. right now: a discounting-based approach to promiscuity. Behav Processes. 2015; 115:117–22. DOI: 10.1016/j.beproc.2015.03.005 [PubMed: 25804220]
29. Dariotis JK, Johnson MW. Sexual discounting among high-risk youth ages 18–24: implications for sexual and substance use risk behaviors. Exp Clin Psychopharmacol. 2015; 23(1):49–58. DOI: 10.1037/a0038399 [PubMed: 25545764]
30. 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):1655–65. DOI: 10.1007/s10461-015-1107-x [PubMed: 26066395]

31. 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]
32. Johnson MW, Johnson PS, Herrmann ES, Sweeney MM. Delay and probability discounting of sexual and monetary outcomes in individuals with cocaine use disorders and matched controls. PLoS One. 2015; 10(5):e0128641.doi: 10.1371/journal.pone.0128641 [PubMed: 26017273]
33. Koffarnus MN, Johnson MW, Thompson-Lake DG, Wesley MJ, Lohrenz T, Montague PR, Bickel WK. Cocaine-dependent adults and recreational cocaine users are more likely than controls to choose immediate unsafe sex over delayed safer sex. Exp Clin Psychopharmacol. 2016; 24(4): 297–304. DOI: 10.1037/pha0000080 [PubMed: 27454677]
34. Johnson PS, Sweeney MM, Herrmann ES, Johnson MW. Alcohol increases delay and probability discounting of condom-protected sex: a novel vector for alcohol-related HIV transmission. Alcohol Clin Exp Res. 2016; 40(6):1339–50. DOI: 10.1111/acer.13079 [PubMed: 27129419]
35. Johnson MW, Herrmann ES, Sweeney MM, LeComte RS, Johnson PS. Cocaine administration dose-dependently increases sexual desire and decreases condom use likelihood: the role of delay and probability discounting in connecting cocaine with HIV. Psychopharmacology (Berl). 2017; 234(4):599–612. DOI: 10.1007/s00213-016-4493-5 [PubMed: 27921140]
36. Odum AL. Delay discounting: I'm a k, you're a k. J Exp Anal Behav. 2011; 96(3):427–39. DOI: 10.1901/jeab.2011.96-423 [PubMed: 22084499]
37. 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]
38. 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]
39. Centers for Disease Control and Prevention. Sexually transmitted disease surveillance. Atlanta: U.S. Department of Health and Human Services; 2016.
40. 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. DOI: 10.1037/0096-3445.128.1.78 [PubMed: 10100392]
41. Mazur JE. An adjusting procedure for studying delayed reinforcement In Commons ML, Mazur JE, Nevin JA, Rachlin H, editors Quantitative analyses of behavior: the effects of delay and of intervening events on reinforcement value. Hillsdale, NJ: Erlbaum; 1987. 55–73.
42. Kirby KN, Maraković NM. Delay-discounting probabilistic rewards: rates decrease as amounts increase. Psychon Bull Rev. 1996; 3(1):100–4. DOI: 10.3758/BF03210748 [PubMed: 24214810]
43. Myerson J, Green L, Warusawitharana M. Area under the curve as a measure of discounting. J Exp Anal Behav. 2001; 76(2):235–43. DOI: 10.1901/jeab.2001.76-235 [PubMed: 11599641]
44. Conover WJ, Iman RL. Rank transformations as a bridge between parametric and nonparametric statistics. Am Stat. 1981; 35(3):124–9. DOI: 10.1080/00031305.1981.10479327
45. Johnson MW, Bickel WK. An algorithm for identifying nonsystematic delay-discounting data. Exp Clin Psychopharmacol. 2008; 16(3):264–74. DOI: 10.1037/1064-1297.16.3.264 [PubMed: 18540786]
46. 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):382–92. DOI: 10.1037/0021-843X.112.3.382 [PubMed: 12943017]
47. Dallery J, Raiff BR. Delay discounting predicts cigarette smoking in a laboratory model of abstinence reinforcement. Psychopharmacology (Berl). 2007; 190(4):485–96. DOI: 10.1007/s00213-006-0627-5 [PubMed: 17205320]
48. Heyman GM, Gibb SP. Delay discounting in college cigarette chippers. Behav Pharmacol. 2006; 17(8):669–79. DOI: 10.1097/FBP.0b013e3280116cfe [PubMed: 17110793]
49. Dassen FC, Houben K, Jansen A. Time orientation and eating behavior. Unhealthy eaters consider immediate consequences, while healthy eaters focus on future health. Appetite. 2015; 91:13–19. DOI: 10.1016/j.appet.2015.03.020 [PubMed: 25814191]
50. Dassen FC, Jansen A, Nederkoorn C, Houben K. Focus on the future: episodic future thinking reduces discount rate and snacking. Appetite. 2016; 96:327–32. [PubMed: 26431684]

51. Hernandez-Romieu AC, Sullivan PS, Sanchez TH, Kelley CF, Peterson JL, Del Rio C, Salazar LF, Frew PM, 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]

52. Booth-Kewley S, Edwards JE, Rosenfeld P. Impression management, social desirability, and computer administration of attitude questionnaires: does the computer make a difference? J Appl Psychol. 1992; 77(4):562–6. DOI: 10.1037/0021-9010.77.4.562

Table 1

Demographic characteristics of the study population overall and dichotomised by sexual discounting status

	Total		Any sexual discounting[A]		No sexual discounting[A]		χ^2 *P*-value[B]
	n	%	*n*	%	*n*	%	
Age (years)							
18–24	458	45.3	251	47.1	98	44.1	0.46
25+	554	54.7	282	52.9	124	55.9	
Race/Ethnicity							
Black	76	7.5	27	5.1	21	9.5	0.13
Hispanic	82	8.1	43	8.1	19	8.6	
White	675	66.7	363	68.1	147	66.2	
Other/Multiracial	179	17.7	100	18.8	35	15.8	
Education							
High school or less	209	20.7	118	22.2	38	17.1	0.12
At least some college	802	79.3	414	77.8	184	82.9	
Income							
<$15 000/year	260	29.0	143	30.4	53	27.2	0.41
≥$15 000/year	637	71.0	328	69.6	142	72.8	
Marital status							
Married/domestic partner	120	11.9	60	11.3	28	12.6	0.75
Widowed/Divorced/Separated	19	1.9	9	1.7	5	2.3	
Never married	872	86.3	463	87.0	189	85.1	
Main partner							
Yes	386	43.5	209	44.4	79	40.9	0.46
No	468	52.8	244	51.8	109	56.5	
Don’t know	33	3.7	18	3.8	5	2.6	

[A] On the MOSTSEX condition in which the participant identifies the man he would most like to have sex with;

[B] Comparing any versus no sexual delay discounting.

Table 2

Reasons that no standardised area under the curve (AUC) value was obtained for each Sexual Discounting task (SDT) condition

MOSTSEX, Condition representing the man the participant would most like to have sex with; LEASTSEX, Condition representing the man the participant would least like to have sex with (among those men identified as sexually desirable); MOSTSTI, Condition representing the man the participant perceives as most likely to have a STI; LEASTSTI, Condition representing the man the participant perceives as least likely to have a STI

	MOSTSEX		LEASTSEX		MOSTSTI		LEASTSTI	
	n	**%**	***n***	**%**	***n***	**%**	***n***	**%**
20% Criterion	262	25.9	160	15.8	108	10.7	199	19.7
%AUC >1	110	10.9	126	12.5	111	11.0	95	9.4
Total non-systematic	299	29.6	214	21.2	176	17.4	237	23.4
Missing data	56	5.5	108	10.7	96	9.5	90	8.9
Zero-delay condition = 0	91	9.0	58	5.7	46	4.6	117	11.6

Table 3

Mean, median, minimum and maximum values for the log-transformed *k* and %AUC for each sexual delay discounting task (SDT) condition

AUC, Area under the curve; MCQ, Monetary Choice Questionnaire; MOSTSEX, Condition representing the man the participant would most like to have sex with; LEASTSEX, Condition representing the man the participant would least like to have sex with (among those men identified as sexually desirable); MOSTSTI, Condition representing the man the participant perceives as most likely to have a STI; LEASTSTI, Condition representing the man the participant perceives as least likely to have a STI. AUCs are presented for the full study population, including participants who did not discount condom-protected sex, and for the subset of participants who did discount condom-protected sex

	Mean	Median	Min	Max	Proportion not discounting
MCQ (ln*k*)	−4.53	−4.63	−8.74	−1.39	4.4
MOSTSEX %AUC	0.66	0.83	2.3×10^{-4}	1.00	29.4
MOSTSEX %AUC[A]	0.44	0.45	2.3×10^{-4}	1.00[B]	N/A
LEASTSEX %AUC	0.84	1.00	2.3×10^{-4}	1.00	48.1
LEASTSEX %AUC[A]	0.63	0.70	2.3×10^{-4}	1.00[B]	N/A
MOSTSTI %AUC	0.89	1.00	2.3×10^{-4}	1.00	56.4
MOSTSTI %AUC[A]	0.69	0.79	2.3×10^{-4}	1.00[B]	N/A
LEASTSTI %AUC	0.75	0.99	2.3×10^{-4}	1.00	37.8
LEASTSTI %AUC[A]	0.52	0.55	2.3×10^{-4}	1.00[B]	–

[A] Excluding participants who did not discount condom-protected sex;

[B] Rounded up to 1.00.

Table 4

Change in mean ln*k* associated with increases in sexual discounting for each condition of the Sexual Delay Discounting Task (SDT) for categorised and rank-transformed AUC

AUC, Area under the curve; CI, confidence interval; ref, Reference; MOSTSEX, Condition representing the man the participant would most like to have sex with; LEASTSEX, Condition representing the man the participant would least like to have sex with (among those men identified as sexually desirable); MOSTSTI, Condition representing the man the participant perceives as most likely to have a STI; LEASTSTI, Condition representing the man the participant perceives as least likely to have a STI.

	MOSTSEX		**LEASTSEX**		**MOSTSTI**		**LEASTSTI**	
Categorised AUC	Δln*k* (95% CI)	*P*-value	Δln*k* (95% CI)	*P*-value	Δln*k* (95% CI)	*P*-value	Δln*k* (95% CI)	*P*-value
0.0 ≤ %AUC ≤ 25.0	0.29 (−0.11, 0.69)	0.15	0.49 (−0.07, 1.04)	0.09	0.10 (−0.54, 0.75)	0.76	0.16 (−0.29, 0.61)	0.49
25.0 < %AUC ≤ 50.0	0.56 (0.02, 1.09)	0.04	0.11 (−0.53, 0.76)	0.73	0.65 (−0.11, 1.40)	0.09	0.50 (−0.03, 1.03)	0.06
50.0 < %AUC ≤ 75.0	0.45 (−0.02, 0.93)	0.06	0.15 (−0.33, 0.63)	0.54	0.04 (−0.48, 0.55)	0.89	−0.23 (−0.72, 0.26)	0.35
75.0 < %AUC < 1.0	0.10 (−0.34, 0.54)	0.64	0.16 (−0.20, 0.52)	0.38	−0.04 (−0.37, 0.29)	0.81	0.15 (−0.24, 0.54)	0.44
%AUC = 1.0	ref		ref		ref		ref	
Rank-transformed AUC	Δln*k* (95% CI)	*P*-value	Δln*k* (95% CI)	*P*-value	Δln*k* (95% CI)	*P*-value	Δln*k* (95% CI)	*P*-value
100-Unit decrease in rank[A]	0.09 (0.00, 0.18)	0.05	0.06 (−0.02, 0.14)	0.16	0.01 (−0.06, 0.09)	0.73	0.03 (−0.05, 0.12)	0.43

[A] Decrease in rank indicates an increase in sexual delay discounting.

Table 5

χ^2 tests examining the concordance between no versus any delay discounting on the MCQ and SDT

MCQ, Monetary Choice Questionnaire; SDT, Sexual Delay Discounting task; DD, delay discounting. MOSTSEX; LEASTSEX; MOSTSTI; LEASTSTI

	Monetary discounting		
SDT condition	**No DD (*n*)**	**Any DD (*n*)**	***P*-value**
MOSTSEX			
No DD	14	191	0.03
Any DD	10	338	
LEASTSEX			
No DD	16	304	0.38
Any DD	10	273	
MOSTSTI			
No DD	21	386	0.26
Any DD	9	261	
LEASTSTI			
No DD	14	241	0.09
Any DD	9	318	