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Test-retest reliability and gender differences in the Sexual Discounting Task among cocaine-dependent individuals

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Abstract

The Sexual Discounting Task uses the delay discounting framework to examine sexual HIV risk behavior. Previous research showed task performance to be significantly correlated with self-reported HIV risk behavior in cocaine dependence. Test-retest reliability and gender differences had remained unexamined. The present study examined the test-retest reliability of the Sexual Discounting Task. Cocaine-dependent individuals (18 men, 13 women) completed the task in two laboratory visits ~7 days apart. Participants selected photographs of individuals with whom they were willing to have casual sex. Among these, participants identified the individual most (and least) likely to have a sexually transmitted infection (STI), and the individual with whom he/she most (and least) wanted to have sex. In reference to these individuals, participants rated their likelihood of having unprotected sex vs. waiting to have sex with a condom, at various delays. A money delay discounting task was also completed at the first visit. Significant differences in discounting among partner conditions were shown. Differential stability was demonstrated by significant, positive correlations between test and retest for all four partner conditions. Absolutely stability was demonstrated by statistical equivalence tests between test and retest, and also supported by a lack of significant differences between test and retest. Men generally discounted significantly more than women for sexual outcomes but not money. Results suggest the Sexual Discounting Task to be a reliable measure in cocaine-dependent individuals, which supports its use as a repeated measure in clinical research, e.g., studies examining acute drug effects on sexual risk, and the effects of addiction treatment and HIV prevention interventions on sexual risk.

Keywords

cocaine; delay discounting; gender differences; HIV; reliability; sex characteristics; unsafe sex

Introduction

Substantial evidence shows cocaine abuse to be associated with increased rates of HIV sexual risk behavior and HIV infection (e.g., Booth et al., 1993; Edlin et al., 1994; Bux et al., 1995; Grella et al., 1995; Joe & Simpson, 1995; Hoffman et al., 2000; Edwards et al., 2006). This may in part be due to decision-making processes, such as delay discounting, in cocaine-dependent individuals. Delay discounting refers to the observed decrease in subjective value of a consequence due to a delay until receipt of that consequence (Rachlin & Green, 1972; Ainslie, 1975; Rachlin et al., 1991). Delay discounting may model a chronic choice in drug dependence; that is, choosing a smaller sooner reward (the immediate but

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short-lived effects of the drug) over a larger delayed reward (the arguably more valuable improvements in health and social functioning that come with sustained abstinence). However, studies typically examine choices between smaller immediate and larger later amounts of the same commodity (e.g., money or drugs of abuse) for methodological simplicity. It is well established that drug-abusing individuals typically prefer smaller sooner rewards over larger later rewards relative to control participants, across a wide variety of drugs including cocaine (Coffey et al., 2003; Kirby & Petry, 2004; Heil et al., 2006). In addition to decisions regarding drug abuse, delay discounting may also model choice related to risky sex. For example, individuals may be presented with a choice between immediate unprotected sex (ultimately less valuable given the increased risk of HIV and other health problems) versus waiting some length of time so that a condom can be obtained to have protected sex (ultimately more valuable given a healthier life).

There has been limited research investigating sexual decision-making from a delay discounting framework. One study presented college students with a choice between an immediate but shorter duration of preferred, unspecified sexual activity (e.g., 3 minutes now), and a delayed but longer duration of the same sexual activity (e.g., 10 minutes one week from now) (Lawyer et al., 2010). Lawyer et al. found that discounting of unspecified sexual outcomes conformed to a hyperbolic pattern characteristic of delay discounting. Using the same task, Lawyer and Schoepflin (in press) found that delay discounting for sexual outcomes, but not money outcomes, was significantly related to sexual excitability. Another study by Lawyer found that delay discounting for hypothetical erotic stimuli conformed to a hyperbolic function under some conditions (Lawyer, 2008). Together, these studies suggest that delay discounting is relevant to sexual decision making.

To increase relevance to HIV risk behavior, a recent study in our laboratory examined cocaine-dependent participants and framed delay discounting questions with clinical relevance to HIV sexual risk behavior (Johnson & Bruner, 2012). The Sexual Discounting Task presented participants with choices between immediate unprotected sex and delayed sex with a condom across four hypothetical partners: most (and least) likely to have a sexually transmitted infection (STI), and most (and least) sexually desirable. Sexual Discounting Task results were largely systematic and showed a strong effect of delay in decreasing choice to use a condom. Sexual discounting (preference for immediate unprotected sex) was significantly greater when making responses for partners judged least (compared to most) likely to have an STI, and for partners judged most (compared to least) desirable. Differences in sexual discounting were significant after controlling for differences in condom use (when immediately and readily available) between conditions. Greater discounting in three of the four Sexual Discounting Task conditions, but not in a money discounting task, was associated with significantly greater self-reported sexual risk behavior as measured by the HIV Risk-Taking Behavior Scale (Darke et al., 1991; Petry, 2001). A non-significant correlation in the expected direction was found in the fourth condition (the most sexually desirable condition). Even in a high-risk group of cocaine-dependent participants, delay had a dramatic effect on condom use in some conditions. Participants reported a high propensity to use a condom if one was readily available, but adding a relatively short delay of a few hours to sex greatly reduced condom use. This suggests that delay is a critical variable in choice to engage in sexually risky behavior, and the Sexual Discounting Task appears to provide a clinically meaningful assessment of this phenomenon. However, the task's test-retest reliability has been unknown.

Several studies have assessed test-retest reliability of delay discounting, typically for money reward outcomes. Test-retest reliability can be evaluated in terms of both differential and absolute stability. Differential stability refers to similarity of ordering of values at test and retest (i.e., correlations). Absolute stability refers to a lack of change between test and retest,

and in discounting studies has typically been judged by the lack of statistical difference between test and retest. Studies suggest money reward delay discounting test-retest reliability is generally high at a 1-week interval. A study in college students found a 1-week correlation of $r = .91$ for money rewards, with absolute stability suggested by a lack of statistical difference between sessions (Simpson & Vuchinich, 2000). In a study evaluating 1-week test-retest reliability of a wide variety of discounting conditions in heavy smokers and nonsmokers (Baker et al., 2003), heavy smokers had significant test-retest correlations ranging from $r = .71$ to $.78$ across a several money reward-magnitude and reward-reality (i.e., hypothetical vs. potentially real) conditions, while values for nonsmokers ranged from $r = .77$ to $.90$. Correlations for other outcomes including money losses, and health and cigarette rewards and losses ranged from $r = .44$ to $.89$. Absolute stability was not evaluated. An identically designed study found that light smokers had test-retest correlations ranging from $r = .55$ to $.87$ across money reward conditions (Johnson et al., 2007). Correlations for other outcomes including money losses, and health and cigarette rewards and losses ranged from $r = .48$ to $.90$. Absolute stability was not evaluated. Another study examined the 1-week reliability of a traditional money rewards delay discounting task and an operant task assessing choices between small immediate certain rewards and large delayed and uncertain rewards (Experiential Discounting Task; EDT) (Smits et al., in press). The traditional task showed a significant test-retest correlation of $r = .86$, and absolute stability was suggested by a lack of significant difference between test and retest. The EDT appeared less reliable, showing a nonsignificant test-retest correlation of Spearman's $\rho = .32$, but absolute stability was suggested by a lack of significant difference between test and retest.

Other studies have reported delay discounting reliability at longer intervals with a wider range of correlations strengths. A study of indigenous Bolivian rainforest inhabitants as found low but significant test-retest Pearson correlations (range, $r = .15-.46$) of discounting for both money and candy rewards among the second, third, and fourth of four 3-month intervals (Kirby et al., 2002). Correlations with the first assessment showed very low and nonsignificant correlations with other intervals, which the authors suggested resulted from a lack of trust or misunderstanding the task in the first assessment. Absolute stability of discounting was not reported. Another study found that in college students, test-retest Pearson correlations for money rewards delay discounting ranged from $r = .66$ to $.75$ across magnitudes over a 5-week interval, from $.59$ to $.71$ over a 1-year interval, and from $.57$ to $.61$ over a 57 week interval (Kirby, 2009). In terms of absolutely stability, delay discounting increased across time, although the authors suggested this result may have been confounded by the potentially-real rewards nature of the procedure. Ohmura et al. (2006) reported significant 3-month test-retest correlations of $r = .61$ and $.75$ for different metrics of money reward delay discounting in college students. The study also suggested absolute stability of discounting with a lack of statistical differences between test and retest. Takahashi et al. (2007) found low but significant correlations using alcohol-dependent individuals in money reward discounting collected at a 2-month interval across magnitudes (range, $r = .31-.47$), and no significant changes between test and retest. Another study tested 6-week test-retest reliability of money reward discounting in college students, and found significant correlations of $r = .64$ and $.70$ for different discounting metrics (Beck & Triplett, 2009). Absolute stability was suggested by the lack of statistical differences between test and retest. Weatherly et al. (2011) examined test-retest reliability of delay discounting for money rewards and other hypothetical outcomes at a 12-week interval in college students. Test-retest correlations were significant and ranged from $r = .42$ to $.69$ across different magnitudes of money rewards and different discounting metrics. Discounting significantly decreased over time in one money reward condition. A wider range of correlation coefficients were found for other (non-money reward) conditions, with a decrease in delay discounting for some conditions.

In addition to test-retest reliability, gender differences in the Sexual Discounting Task are also of interest because sexual behavior might be expected to differ by gender. Using a different delay discounting task assessing sexual outcomes in which college student chose between a shorter duration of unspecified sexual active now vs. increased duration of sexual activity later (e.g., 3 minutes now vs. 10 minutes in 1 week), Lawyer and Schoepflin (in press) found a nonsignificant trend for men to discount sexual outcomes more than women. The same trend was present for an analogous probability discounting task for sex (while delay discounting examines the effect of delay on reward value, probability discounting examines the effect of uncertainty on reward value). No gender based trend was present for money delay and probability discounting. For the discounting of money reward outcomes there has been no clear evidence for a gender effect across studies. Studies have found that men delay discount significantly more than women (Kirby and Marakovi, 1996), that women delay discount significantly more than men (Beck and Triplett, 2009), and that there is no significant difference between men and women (de Wit et al., 2007; Epstein et al., 2003; Heyman and Gibb, 2006; Mitchell, Fields, D'Esposito, & Boettiger, 2005; Wallace, 1979). Other studies provided complex results. Two experiments found that for nonsmokers, men and women did not differ in money reward delay discounting, whereas for smokers, men discounted money more than women (Jones et al., 2009; Mitchell and Wilson, 2012). However, in the second of two experiments within their report, Mitchell and Wilson (2012) found no gender effect or gender interaction with smoking. Mitchell (2003) found in a pooled analysis of previous studies that discounting was associated with drug use, but only for males and not females. Petry et al. (2002) found that women without a paternal history of alcohol dependence discounted less than men with or without a paternal history of alcohol dependence. Women with a paternal history of alcoholism were similar to both groups of men. Reynolds et al. (2004) reported a lack of gender interaction with potential diazepam effects on delay discounting, but did not report if there was a main effect of gender. Another study showed that while pictures of attractive women caused men to increase their delay discounting of money, pictures of attractive men had no effect on money delay discounting in women (Wilson and Daly, 2004).

To further investigate the clinical utility of the Sexual Discounting Task, the current study assessed the test-retest reliability of the sexual discounting at a 1-week interval. This was the first study to examine test-retest reliability for the discounting of sexual rewards. In addition to examining correlations and statistical tests of differences between test and retest, tests of equivalence for discounting across test and retest were examined. Tests of equivalence are a more stringent assessment of absolute stability than failure to find statistical differences between conditions (Luzar-Stiffler and Stiffler, 2002). Finding the Sexual Discounting Task to be reliable would support its future use as a repeated measure when investigating the effects of state changes on sexual discounting or the effects of clinical interventions. Because the sample consisted of both men and women, gender differences in the Sexual Discounting Task were also examined.

Methods

Participants

The participants were 31 cocaine-dependent individuals from the Baltimore, MD area. Thirteen participants were female. Twenty-nine of these participants were African-American and two were Caucasian. Inclusion criteria included being aged 18–65 years and reporting having engaged in sexual intercourse in the last 30 days. Participants met criteria for cocaine dependence but not other drugs (excluding caffeine and nicotine) as assessed by a Diagnostic and Statistical Manual of Mental Disorders (DSM) checklist (Hudziak et al., 1993) updated for DSM-IV. Urinalysis results were positive for cocaine on at least one of two laboratory visits. Psychiatric treatment in the past six months was an exclusion criterion.

Twenty-seven participants identified themselves as heterosexual, one as a gay man, two as bisexual men, and one as a bisexual woman. Other relevant demographics for these participants are listed in Table 1. Volunteers were monetarily compensated for their participation in this study. During the session, participants worked in a quiet experimental room.

Procedure

Participants were interviewed over the telephone to collect demographic information and screen out psychiatric disorders or abstinence from sexual intercourse in the last 30 days. If they initially qualified for the study, they were invited to participate in an in-person screening, where they provided informed consent, gave a urine sample to test for drugs of abuse, completed the Quick Test, a test of verbal intelligence (Ammons & Ammons, 1962), and provided demographic and drug use history information. All procedures were approved by the Johns Hopkins Medicine Institutional Review Boards. If participants qualified upon the in-person screening, they were invited to take part in the two-session study. Immediately after screening, participants began the first session. Approximately one week later (mean=6.9 days, SD=1.0 days), the second session took place. Cigarette smokers were given a 10-min break every two hours (between tasks) during screening and sessions to smoke, to minimize the effects of nicotine withdrawal on outcome measures. Tasks were not completed until at least 20 min after smoking to avoid peak nicotine plasma concentrations (Benowitz et al., 1988). Participants also completed other tasks not immediately relevant to the current analyses and not described here.

Sexual Discounting Task

In this task, delay discounting for sexual rewards was assessed in reference to specific photographed hypothetical sexual partners. Participants were initially trained to make ratings using visual analog scales (VAS). Participants were asked to imagine that for all decisions during the task there was no chance of pregnancy. A research assistant then spread 60 color photographs of clothed people (30 male, 30 female), each printed on a 21.59 × 27.94 cm sheet of paper, on the floor in front of the participant. During the first session (week 1), the participant was asked to select the photographs of all people with whom he or she would be willing to have casual sex based on physical appearance alone.

Of all photographed individuals who were selected, the participant was asked to identify the person: (1) most likely to have a sexually transmitted infection (STI), (2) least likely to have an STI, (3) he or she most wants to have sex with, and (4) he or she least wants to have sex with. One photograph was allowed to serve for multiple categories. For each of the four categories (presented in randomized order), participants were presented with a paper questionnaire with eight VAS (100-mm lines), with the photograph corresponding with that category in sight next to the questionnaire. The first VAS was a 0-delay trial to rate the likelihood (0–100%) of using an immediately available condom. The VAS ranged from “I will definitely have sex with this person now without a condom” to “I will definitely have sex with this person now with a condom.”

For the next seven VAS (delay trials), the participant was asked to rate his or her likelihood of waiting a specified period of time for protected sex when no condom was immediately available. The VAS ranged from “I will definitely have sex with this person now without a condom” to “I will definitely wait [delay] to have sex with this person with a condom.” This question was repeated with the delay changed to assess seven total delays in ascending order: 1 hour, 3 hours, 6 hours, 1 day, 1 week, 1 month, and 3 months.

On the second session (week 2), participants viewed the photographs they had chosen at week 1 for each category and provided responses on the VAS again. We considered allowing participants to choose photographs of people to serve in each category again at week 2, but wanted to avoid the potential confound of assessing test-retest reliability across qualitatively different rewards if different photographs were chosen across weeks. Therefore, we tested the reliability of their VAS ratings rather than their partner selections.

Potentially real money rewards delay discounting task

Delay discounting for a \$10 reward was examined in the first session, but not the session ~7 days later, with a task used in several previous studies (Baker et al., 2003; Johnson and Bickel, 2002; Johnson and Bruner, 2012; Johnson et al., 2007). The task evaluated delays that ranged from 1 day to 6 months. As instructed to participants before beginning the task, one choice trial from the task was randomly selected after task completion, and the reward chosen on that trial was delivered at the end of the session or at the designated delay. The procedure is described in greater detail elsewhere (Johnson and Bickel, 2002).

Data analysis

Raw delay-discounting data for the Sexual Discounting Task consisted of four sets of data points (one for each partner condition) for each participant. Data points were defined as a proportion of the VAS line marked for the Sexual Discounting Task. Area Under the Curve (AUC) was determined for each set of data points (Myerson et al., 2001). Lower AUC values indicate greater delay discounting, or relative preference for smaller, sooner rewards (immediate unprotected sex). In addition, data points were analyzed with nonlinear regression using the hyperbolic decay model (Mazur 1987): $V = 1/(1+kd)$. V represents subjective value, expressed as a proportion of the larger, later reward. The d variable was delay to delivery of the larger reward. Parameter k was a free parameter and served as an index for rate of discounting. The time unit of hours was used for the delay variable in all regression analyses. Therefore, all k estimates carry the reciprocal of hours (i.e., hours⁻¹) as units. Larger values of k show relative preference for smaller immediate rewards. A log₁₀ transformation was applied to the k values before parametric analyses to reduce skew in the distribution of values. Data from the money discounting task were also analyzed with the AUC and hyperbolic delay model methods described above.

To assess the orderliness of Sexual Discounting Task data, a previously published algorithm was used (Johnson & Bickel, 2008). Specifically, sexual discounting functions were identified as nonsystematic if any delay's rating was at least 0.2 greater than the rating on the delay preceding it, starting with the second shortest delay. Pearson correlations were used to compare AUC and log₁₀ k metrics of discounting for each week of all four sexual partner conditions.

To assess differential stability between the two sessions, Pearson correlations examined the relationship between sexual discounting in weeks 1 and 2 for each condition, for both AUC and log₁₀ k values. In order to assess absolute stability, two approaches were taken. First, to test if the discounting was similar across test and retest, tests of statistical equivalence were conducted for AUC using the general guidelines laid out by Lizar-Stiffler and Stiffler (2002). We only used AUC, and not k , for these analyses because with AUC the absolute scale is clear, as it is bounded by 0 (complete discounting even at the first delay) and 1 (no discounting at all), allowing for the designation of a meaningful tolerance threshold (i.e., an acceptable range of variability). For each of the four conditions, difference scores were calculated between test and retest (week 1 – week 2), and 90% confidence intervals were calculated for these difference scores. The two test times were considered equivalent if 1) the 90% confidence interval surrounded 0, and 2) the lower and upper confidence intervals

were within the tolerance threshold of ± 0.2 (i.e., within 20% of the total scale) of 0. As a second assessment of absolute stability which is more comparable to previous reliability studies of delay discounting (which have tested absolute stability by testing for differences rather than testing for equivalence), and in order to assess partner condition differences, a repeated measures ANOVA was conducted using the within-subject variables of time (week 1 and week 2) and partner condition (“least want to have sex with”, “most want to have sex with”, “least likely to have an STI”, “most likely to have an STI”). To further examine selected differences between partner conditions, planned comparisons were conducted using paired t-tests to detect differences between (1) the “least want to have sex with” and “most want to have sex with” conditions separately at weeks 1 and 2, and (2) the “least likely to have an STI” and “most likely to have an STI” conditions separately at weeks 1 and 2.

To examine the effects of gender, and the interaction of gender with time (week 1 vs. week 2), on sexual discounting, a mixed model ANOVA with time as a repeated measure and gender (men vs. women) as a between-subjects factor was conducted for each of the four partner conditions and for each metric of discounting (AUC and $\log_{10} k$). Independent t-tests were used to compare delay discounting for money (using both AUC and $\log_{10} k$) between men and women.

To compare delay discounting for money and sexual outcomes, Pearson correlations were conducted between money discounting and each partner condition of the Sexual Discounting Task, using both AUC and $\log_{10} k$.

Results

Orderliness of Sexual Discounting Task data

Overall, 6.0%, or 15 out of 248 discounting functions (i.e., 31 participants X 4 conditions X 2 weeks) were flagged as nonsystematic (11 from week 1 and 4 from week 2). The majority (13 out of 15) of these flagged discounting functions were cases in which only 1 data point (i.e. the data point at a single delay) was nonsystematic. Visual inspection of the discounting functions for these cases showed these functions to be sufficiently systematic to provide confidence in the resulting AUC and $\log_{10} k$ values. We therefore retained these data for analyses. There were 2 discounting functions that had 2 data points each that were flagged as nonsystematic. Both of these functions were from a single participant (a woman), and were across two different partner conditions. Visual inspection provided less confidence in these data. Therefore, all discounting data from that single participant were omitted from analyses resulting in $n=30$ (18 men, 12 women). AUC and $\log_{10} k$ values during each condition at each assessment period were significantly correlated (Table 2).

Differential stability

Table 3 shows mean AUC for each Sexual Discounting Task condition at week 1 and week 2, as well as corresponding Pearson’s r values and p values for each partner condition. Table 4 shows the analogous data for the $\log_{10} k$ metric of discounting. Test and retest discounting values (using both metrics of discounting) were moderately to highly correlated, with positive and significant correlations.

Absolute stability

Figure 1 shows mean ($\pm$ SEM) AUC at week 1 and week 2 for each of the four partner conditions. Figure 2 shows the analogous data using the $\log_{10} k$ metric of discounting. For both metrics, discounting was relatively stable across the two weeks, particularly in comparison to the large differences in discounting observed across the four partner conditions (see *differences between sexual partner conditions* section below). The tests of

statistical equivalence showed that all four conditions met the two criteria for statistical equivalence (i.e. confidence intervals of difference scores surrounded 0 and were within ± 0.2 of 0). The bounds for the 90% confidence intervals were -0.066 and 0.118 for the “least want to have sex with” condition, -0.149 and 0.011 for the “most want to have sex with” condition, -0.131 and 0.050 for the “least likely to have STI” condition, and -0.083 and 0.050 for the “most likely to have STI” condition.

Using AUC as the metric of discounting, the time X partner ANOVA revealed no main effect of test time on sexual discounting, $f(1, 29) = .54, p = .47$. Likewise, using $\log_{10} k$ as the metric of discounting, ANOVA revealed no main effect of test time on sexual discounting, $f(1, 29) = .037, p = .85$.

Differences between sexual partner conditions

Using AUC as the metric of discounting, the time X partner ANOVA showed a main effect of sexual partner condition on sexual discounting, $f(3, 87) = 9.98, p < .0001$, and no significant interaction between time and partner condition, $f(3, 87) = 1.01, p = .39$. Similarly, using $\log_{10} k$ values, ANOVA showed a main effect of sexual partner condition on sexual discounting, $f(3, 87) = 10.92, p < .0001$, and no significant interaction between time and partner condition $f(3, 87) = .62, p = .60$. Planned comparisons with paired t-tests further explored differences for each week. At week 1, the “least want to have sex with” condition showed significantly greater AUC (i.e., had a greater likelihood of waiting until a condom was available) than the “most want to have sex with” condition, $t(29) = 2.61, p = .01$. At week 1 the “most likely to have an STI” condition showed significantly greater AUC than the “least likely to have an STI” condition, $t(29) = 4.02, p < .001$. Similar results were found at week 2. The “least want to have sex with” condition showed greater AUC than the “most want to have sex with” condition, however, this did not reach significance, $t(29) = 1.92, p = .07$. The “most likely to have an STI” condition had significantly greater AUC than the “least likely to have an STI” condition, $t(29) = 3.70, p = .001$. Similar results were observed with $\log_{10} k$. At week 1, the “least want to have sex with” condition showed significantly lower $\log_{10} k$ than the “most want to have sex with” condition, $t(29) = 2.59, p = .02$. The “most likely to have an STI” condition showed significantly lower $\log_{10} k$ than the “least likely to have an STI” condition, $t(29) = 4.06, p < .001$. At week 2, the “least want to have sex with” condition showed significantly lower $\log_{10} k$ than the “most want to have sex with” condition, $t(29) = 2.13, p = .04$. The “most likely to have an STI” condition showed significantly lower $\log_{10} k$ than the “least likely to have an STI” condition, $t(29) = 3.76, p = .001$.

Gender Differences

Results of the gender analyses for the Sexual Discounting Task are shown in Table 5 (AUC values) and Table 6 ($\log_{10} k$ values). Using the AUC metric of discounting, men showed statistically greater discounting (lower AUC) than women in three of four conditions, with a trend level nonsignificant difference in the “most likely to have STI” condition. For AUC, no significant interactions between gender and time were observed. Using the $\log_{10} k$ metric, men were found to discount statistically more than women in all four sexual partner conditions. In the “least want to have sex with” condition there was a significant gender interaction with time, with larger differences between the genders in week 2 than week 1. Simple effects were explored using independent samples t-test, showing men to have significantly lower AUC values than women in week 2 ($t=4.10, df=28, p=.0003$) but not week 1 ($t=1.76, df=28, p=.09$). A trend toward a significant interaction was present for the “least likely to have STI” condition, corresponding to a trend for larger difference between genders in week 2 than week 1.

For money reward delay discounting AUC, men showed a mean value of .376 (SEM=.055) and women showed a mean value of .431 (SEM=.089). For money discounting $\log_{10} k$ (using hours^{-1} as units for k), men showed a mean value of .509 (SEM=.292) and women showed a mean value of .388 (SEM=.443). Discounting did not statistically differ between men and women using either AUC ($t=.55$, $df=28$, $p=.59$) or $\log_{10} k$ ($t=.24$, $df=28$, $p=.81$).

Relation between money and sexual discounting

Using AUC, money discounting task performance was not significantly correlated with any of the four Sexual Discounting Task partner conditions at week 1 and week 2 (r values ranging from $-.25$ to $.05$; p values ranging from $.17$ to $.89$). Similar results were obtained with $\log_{10} k$ (r values ranging from $-.25$ to $.06$; p values ranging from $.19$ to 1.0).

Discussion

This study resulted in several findings. First, Sexual Discounting Task data were orderly. Second, significant differences were detected among the different conditions involving different categories of sexual partners. Third, differential stability of the task was supported. Fourth, absolute stability was supported by multiple methods, including tests of statistical equivalence. Fifth, gender differences were found with men generally showing increased discounting of sexual outcomes compared to women across multiple conditions. These findings will be discussed in turn.

The data resulting from the Sexual Discounting Task were orderly. The large majority of individual functions at both test and retest were determined to be systematic using an objective algorithm developed by Johnson and Bickel (2008) for detecting nonsystematic discounting data. Among the remaining functions, the majority were largely systematic with only a single data point deviating from the expectation of stable or monotonically decreasing data points with increasing delay. These results are similar to the results of a previous study in cocaine dependent individuals showing Sexual Discounting Task data to be largely systematic (Johnson & Bruner, 2012). Also suggesting order in the data, the AUC and $\log_{10} k$ metrics were highly and significantly, positively correlated for all four partner conditions at both week 1 and week 2.

Differences between partner conditions were also similar to the results of Johnson and Bruner (2012). Participants showed greater discounting (relative preference for immediate unprotected sex) for partners they judged least likely to have an STI compared to those they judged most likely to have an STI. This effect was significant at both week 1 and week 2, for both metrics of discounting (AUC and $\log_{10} k$). Participants also showed greater discounting for partners they found most sexually desirable compared to those they found least sexually desirable. This effect was significant for both week 1 and week 2 using the $\log_{10} k$ metric, and for the AUC metric at week 1. However, for week 2 the effect was at a nonsignificant trend level when using the AUC metric. Failure to find a significant difference in this case would appear to be a power issue given that the previous study found the effect with a great number of participants.

Differential stability of Sexual Discounting Task performance was supported. Discounting in week 1 and week 2 were moderately to highly, positively and significantly correlated for the four partner conditions, using both metrics of discounting (AUC and $\log_{10} k$). These correlation strengths are similar to the range of correlation strengths at 1-week test-retest found for money rewards and other consequences reviewed in the introduction.

Absolute stability of Sexual Discounting Task performance was also supported. This was suggested by the lack of significant differences across test and retest for all of the sexual

partner conditions, the standard that has been used to judge absolute stability of test-retest performance in previous studies of delay discounting. However, because, the lack of significant difference may result not only from stable responding, but also from a lack of sufficient statistical power to detect differences, tests of statistical equivalence were applied to performance across week 1 and week 2. These tests showed that rest and retest performance were equivalent within a relatively narrow tolerance threshold (20% of the possible range of AUC values). The absolute stability of Sexual Discounting Task performance is particularly convincing given the differences that were detected between partner conditions. That is, it is apparent in Figure 1 and Figure 2 that the differences between the different sexual partner conditions overshadow any differences apparent across weeks within each condition. Although differential and absolute stability appear good, it should be noted that the relatively short test-retest period of 1 week is a limitation, and lower levels of reliability may be found at longer intervals. Another limitation is the hypothetical nature of the task. However, data with the delay discounting of money rewards suggests that hypothetical rewards provide a reasonable proxy for real rewards (e.g., Baker et al., 2003; Johnson & Bickel, 2002; Johnson et al., 2007).

Genders differences were detected for the Sexual Discounting Task. Although a few differences between the AUC and $\log_{10} k$ metrics of discounting added complexity to the results, both measures agreed in showing men to discount significantly more (i.e., prefer immediate unprotected sex) than women (without an interaction across time) for the “least likely to have STI” and “most want to have sex with” conditions, which were the two conditions in which men showed the highest discounting. Using AUC, men also showed significantly greater discounting than women in the “least want to have sex with” condition (without an interaction across time). Using $\log_{10} k$, men discounted significantly more than women for this condition in week 2 but not week 1. There is no apparent explanation for the interaction across time. The gender differences on the Sexual Discounting Task stand in contrast to the results for money delay discounting, which did not significantly differ between men and women, similar to results of Lawyer and Schoepflin (in press), and suggesting domain specificity. That is, the discounting of sexual outcomes but not money outcomes differs by gender. It is intriguing that the two conditions in which men unambiguously chose to take the most risk by forgoing delayed condom use in favor of immediate unprotected sex (the “least likely to have STI” and “most want to have sex with” conditions) are associated with the least perceived risk and the greatest motivation for sexual activity, respectively. Perhaps these gender differences relate to the hypothesis that men devote more effort to short term mating strategies (i.e., prefer a greater number of short term partners), relative to women, because the evolutionary success of men necessitates relatively less parental investment (Buss and Schmitt, 1993).

In summary, the Sexual Discounting Task showed good test-retest reliability in terms of both differential and absolute stability of performance across a 1-week interval in all four partner conditions. Men were found to discount more than women in multiple conditions. The reliability findings support the value of the Sexual Discounting Task as a tool for examining changes in sexual-risk behavioral processes. For example, the task may be used to determine the effects of interventions such as drug dependence treatment and HIV prevention programs on these processes (although many interventions are longer than the 1-week interval examined in this study). The task may also be used to examine state changes in sexual-risk behavioral processes, including the acute effects of drugs associated with sexual risk behavior (e.g., cocaine, methamphetamine, and alcohol).

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Figure 1.

Mean AUC at week 1 and week 2 for each of the four partner conditions ($n=30$). The top panel shows data from the “least likely to have an STI” and “most likely to have an STI” conditions. The bottom panel shows data from the “least want to have sex with” and “most want to have sex with” conditions. Error bars represent standard error of the mean (*SEM*).

Figure 2.

Mean log₁₀ k at week 1 and week 2 for each of the four partner conditions ($n=30$). The top panel shows data from the “least likely to have an STI” and “most likely to have an STI” conditions. The bottom panel shows data from the “least want to have sex with” and “most want to have sex with” conditions. Error bars represent standard error of the mean (SEM).

Table 1

Demographic and drug use characteristics of participants (N=31)

Demographic	Mean (SD)
Age (years)	48.5 (8.4)
Education (years)	12.4 (1.3)
Monthly income (US \$)	657 (704)
Quick Test intelligence score ^a	37.2 (4.8)
Cigarettes smoked per day	6.7 (5.4)
Days since last cocaine use	1.5 (1.4)
Money spent on cocaine per week (US \$)	229 (196)
Marital status (married count)	4 (12%)

^a max=50; adult norms: M=41.4, SD=6.0 (Ammons & Ammons, 1962)

Table 2

Pearson correlations between Area Under the Curve (AUC) and $\log_{10}$ k values partner conditions at week 1 and week 2 (n=30)

Sexual Discounting Condition	Pearson <i>r</i>	<i>p</i>
Least likely to have STI - week 1	-.899	<.0001
Least likely to have STI - week 2	-.926	<.0001
Most likely to have STI - week 1	-.841	<.0001
Most likely to have STI - week 2	-.814	<.0001
Least want to have sex with - week 1	-.866	<.0001
Least want to have sex with - week 2	-.880	<.0001
Most want to have sex with - week 1	-.864	<.0001
Most want to have sex with - week 2	-.883	<.0001

Table 3

Mean (SEM) Area Under the Curve (AUC) for week 1 and week 2 and corresponding Pearson correlations and p values (n=30)

Sexual Discounting Condition	Week 1 AUC	Week 2 AUC	Pearson <i>r</i>	<i>p</i>
Least likely to have STI	0.587 (0.085)	0.627 (0.083)	0.801	<.0001
Most likely to have STI	0.898 (0.046)	0.914 (0.044)	0.624	.0002
Least want to have sex with	0.808 (0.065)	0.782 (0.064)	0.650	.0001
Most want to have sex with	0.565 (0.079)	0.634 (0.079)	0.820	<.0001

Table 4

Mean (SEM) $\log_{10} k$ values for week 1 and week 2 and corresponding Pearson correlations and p values ($n=30$)

Sexual Discounting Condition	Week 1 $\log_{10} k$	Week 2 $\log_{10} k$	Pearson r	p
Least likely to have STI	−4.48 (1.44)	−5.09 (1.33)	0.719	<.0001
Most likely to have STI	−9.54 (0.88)	−9.64 (0.85)	0.476	.008
Least want to have sex with	−7.92 (1.05)	−7.34 (1.10)	0.610	.0003
Most want to have sex with	−4.16 (1.35)	−4.57 (1.35)	0.846	<.0001

$n=30$

Table 5

Mean (SEM) Area Under the Curve (AUC) for Sexual Discounting in Men and Women (n=30)

Sexual Discounting Condition	Men AUC	Women AUC	<i>f</i> gender (<i>p</i>)	<i>f</i> gender X time (<i>p</i>)
Least likely to have STI - week 1	0.440 (0.111)	0.807 (0.109)		
Least likely to have STI - week 2	0.437 (0.107)	0.911 (0.081)	8.39 (.007)	.97 (.33)
Most likely to have STI - week 1	0.831 (0.074)	0.998 (0.002)		
Most likely to have STI - week 2	0.859 (0.071)	0.997 (0.003)	3.69 (.07)	.132 (.72)
Least want to have sex with - week 1	0.710 (0.100)	0.955 (0.039)		
Least want to have sex with - week 2	0.638 (0.093)	0.997 (0.003)	7.81 (.009)	1.01 (.31)
Most want to have sex with - week 1	0.394 (0.099)	0.820 (0.090)		
Most want to have sex with - week 2	0.486 (0.106)	0.855 (0.086)	8.45 (.007)	.35 (.56)

f and *p* values for the main effect of gender (df=1, 28) and the gender X time interaction (df=1, 28) are based on a mixed model ANOVA (n= 30) for each partner condition with time and gender as factors.

Table 6

Mean (SEM) Log10 k Values for Sexual Discounting in Men and Women (n=30)

Sexual Discounting Condition	Men log ₁₀ k	Women log ₁₀ k	f gender (p)	f gender X time (p)
Least likely to have STI - week 1	-2.24 (1.62)	-7.83 (2.43)		
Least likely to have STI - week 2	-1.27 (1.50)	-10.81 (1.17)	11.32 (.002)	3.79 (.06)
Most likely to have STI - week 1	-8.05 (1.29)	-11.78 (0.68)		
Most likely to have STI - week 2	-8.21 (1.25)	-11.79 (0.67)	7.03 (.01)	.01 (.93)
Least want to have sex with - week 1	-6.46 (1.48)	-10.11 (1.23)		
Least want to have sex with - week 2	-4.38 (1.40)	-11.79 (.669)	10.44 (.003)	4.15 (.05)
Most want to have sex with - week 1	-0.91 (1.65)	-9.03 (1.48)		
Most want to have sex with - week 2	-1.49 (1.70)	-9.20 (1.42)	12.45 (.001)	.07 (.80)

f and p values for the main effect of gender (df=1, 28) and the gender X time interaction (df=1, 28) are based on a mixed model ANOVA for each partner condition with time and gender as factors.