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Devaluation of Safe Sex by Delay or Uncertainty: A Within-Subjects Study of Mechanisms Underlying Sexual Risk Behavior

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Abstract The value of safe sex may be discounted based on contextual factors associated with an opportunity for sex. College students in a within-subjects study selected hypothetical sexual partners from a set of pictures and classified them based on attractiveness and estimated chance of having an sexually transmitted infection (STI). In the Sexual Delay Discounting (SDD) task, participants rated their likelihood (0–100 %) of waiting for some period of time (e.g., 3 h) to have protected sex with their selected partners, when they could have immediate sex without protection. In the Sexual Probability Discounting (SPD) task, participants rated their likelihood of having protected sex if the opportunity was uncertain (e.g., 50 %), when they could have unprotected sex for sure (100 %). All participants included in the final analyses were aware of and had a positive attitude towards protection against STIs as they were likely to have immediate (or certain) protected sex. Results from 432 delay data in the SDD task and 488 probability data in the SPD task showed that participants' preference for safe sex systematically decreased as the delay to and odds against having safe sex increased. However, this preference was altered by the participants' perception of their partner's attractiveness and STI risk.

Keywords Sexual risk behavior · STI · HIV/AIDS · Attractiveness · Delay discounting · Probability discounting

Introduction

Although sexually transmitted infections (STIs) are a major public health problem worldwide, having unsafe sex remains common practices. This is in part because risky choices occur in less than optimal circumstances. For example, risky sexual encounters most likely occur with unfamiliar partners when the opportunity for sex presents itself. Individuals who might otherwise choose to have safe sex may, in the heat of the moment, take great risk rather than wait or miss a seemingly good opportunity. Therefore, given that having the right attitude and knowledge of STIs may not be sufficient to prevent infection, it is important to understand how such risky decisions are influenced by people's personal characteristics, and by the circumstances surrounding the opportunity for sex.

Common sexual risk reduction strategies include abstinence and safer sex education, condom distribution, self-efficacy promotion, increasing HIV/AIDS risk perception and attitude change. Although many intervention programs employing these strategies have been proven effective (Chin et al., 2012; Kirby et al., 1994; Mize, Robinson, Bockting, & Scheltema, 2002; Wingood & DiClemente, 2000), a considerable number of people still engage in sexual risk behavior (Halkitis & Parsons, 2003; Liau, Millett, & Marks, 2006; Thamotharan, Grabowski, Stefano, & Fields, 2015). Furthermore, most sexual risk reduction interventions usually target populations at higher risk for STIs such as drug users and men who have sex with men (e.g., Heil, Sigmon, Mongeon, & Higgins, 2005; Rosser et al., 2010) because these populations are known to engage in sexual risk behavior without much regard for a specific situation or characteristics of their sexual partners. Less attention has been directed to populations at lower risk for STIs. However, to implement even more effective education or intervention programs, it is also important to understand sexual risk decision making in those who

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indicate the general intention to have safe sex but still engage in sexual risk behavior in some situations.

Delay discounting (DD) and *probability discounting* (PD) rates have been implicated in a number of problems of impulse control such as sexual risk behavior (Johnson & Bruner, 2012; Johnson, Johnson, Herrmann, & Sweeney, 2015), drug use (Kirby, Petry, & Bickel, 1999), and cigarette smoking (Bickel, Odum, & Madden, 1999; Reynolds, Karraker, Horn, & Richards, 2003). DD refers to the decrease in the subjective value of a reward (e.g., money, drugs, sex) as the delay to receiving the reward increases. For example, to most people $100 now is better than $100 tomorrow, and $100 tomorrow is better that $100 in 1 month. In turn, PD is the decrease in the subjective value of a reward as the probability of receiving it decreases. In delay discounting studies, participants are often asked to choose between a smaller but immediate reward and a larger but delayed reward (e.g., $10 now vs. $100 in 1 year). In probability discounting studies, participants are often asked to choose between a smaller but certain reward and a larger but uncertain reward (e.g., $10 for sure vs. $100 with a 25 % chance). For a given reward, on average, individuals prefer an immediate reward to a delayed reward (in a delay discounting task) and a certain reward to a probabilistic reward (in a probability discounting task). Thus, in general, the subjective value assigned to a reward (outcome) is discounted as a function of the delay until or odds against receiving that reward (Green, Fristoe, & Myerson, 1994; Rachlin, Raineri, & Cross, 1991).

Johnson and Bruner (2012) first assessed the effect of delaying a desired sexual encounter on condom use. In their sexual discounting task, cocaine-dependent participants were asked to rate their likelihood (0–100 %) of waiting a specified period of time (e.g., 1 month) for protected sex when no condom was immediately available. They also examined individual preference for delayed protected sex with four different types of hypothetical sexual partners (i.e., most vs. least desirable and most vs. least likely to have an STI). Their results showed that individuals discounted the value of protected sex when it was contingent on waiting until a condom was available. It was also found that participants discounted the use of a condom in delayed trials much more steeply for partners considered most desirable and those considered least likely to have an STI, showing that the preference for immediate unprotected sex was influenced by characteristics of a sexual partner. Their sexual discounting task had good test–retest reliability (Johnson & Bruner, 2013); and those results were replicated in other studies (Herrmann, Hand, Johnson, Badger, & Heil, 2014; Johnson et al., 2015). Moreover, steeper discounting of delayed sexual activity was found to be significantly related to higher rates of sexual sensation seeking, self-reported sexual risk behavior, and impulsive personality (Herrmann et al., 2014; Johnson & Bruner, 2012; Lawyer & Schoepflin, 2013). Taken together, these findings support to some degree the external validity of the Sexual Delay Discounting task in situations where protected sex may not be immediately possible.

While probability discounting of erotica and sexual activity was studied previously (Lawyer & Schoepflin, 2013; Lawyer, Williams, Prihodova, Rollins, & Lester, 2010), it was Johnson et al. (2015) who investigated the relationship between the probability of contracting an STI and devaluation of protected sex. In that study (Johnson et al., 2015), cocaine-dependent and non-drug-dependent participants rated their own likelihood of having protected sex with a 0 % chance of contracting an STI from a selected partner when they could have unprotected sex with some chance (e.g., 33 % chance) of contracting an STI from the partner. It was found that the participants' likelihood of having protected sex appropriately decreased when the chance of contracting an STI decreased for both cocaine-dependent and control groups. In addition to the decreased probability of contracting an STI, risky choice may be hastened if the opportunity for protected sex is uncertain compared to having an assured opportunity for unprotected sex. To the best of our knowledge, the study reported here is the first to explore the effect of uncertain sexual opportunity on preference for safe sex.

Delay discounting of protected sex exemplifies situations in which individuals choose to engage in unprotected sex because they do not want to wait for protected sex (e.g., when a condom is not immediately available). In turn, probability discounting of protected sex exemplifies situations in which individuals choose unprotected sex because they do not want to miss an opportunity to have sex with a desirable partner, such as when the potential partner does not want to use a condom. In this study, we examined people's preference for protected sex when the opportunity to have protected sex was delayed or uncertain.

The experiment included two tasks: a Sexual Delay Discounting (SDD) task and a Sexual Probability Discounting (SPD) task. In the SDD task, participants were asked to rate, on a visual analogue scale (VAS), their likelihood (0–100 %) of waiting for some period of time (e.g., 6 h) to have protected sex. In the SPD task, participants were asked to rate their likelihood (0–100 %) of having protected sex when the chance to do so was uncertain (e.g., with a 25 % chance). In the SDD task, delay discounting of protected sex occurred if participants were less willing to have protected sex when they needed to wait longer for it. In the SPD task, probability discounting of protected sex occurred if participants were less willing to have protected sex when protected sex decreased their chance to have sex.

From a set of pictures provided, participants were asked to select hypothetical sexual partners based on their judgment of the partners' attractiveness and likelihood they might have an STI. In previous sexual discounting studies, four partner conditions generated two pairs of comparisons: (1) most vs. least desirable and (2) most vs. least likely to have an STI. To obtain more information about the effect of a partner's characteristics on sexual risk behavior, we asked participants to estimate levels of STI risk for the most and least desirable partners, and for the partners with whom they would want to have sex even if the partners were not their most or least desir-

able ones. Thus, this study is the first to include all comparisons across main effects and combinations of a partner's desirability and STI risk.

In addition to the number of partner conditions, this study also differs from the previous studies in the inclusion of picture ratings. Because sexual discounting studies in the past did not measure a partner's levels of attractiveness, it is not possible to determine the relationship between participants' sexual risk behavior and their partner's attractiveness; this is because the reported desirability of a partner may or may not be positively related to their reported attractiveness, as a relatively less attractive person may be more desirable than a more attractive one (White, 1980). Moreover, partners' perceived STI risk might not be different from each other as participants might have randomly selected partners who were most and least likely to have an STI when they were, in fact, perceived as having equal risk. Therefore, a picture of a potential sexual partner might not depict what it was expected to depict. In this study, participants rated the selected pictures in terms of attractiveness and STI risk in randomized order, after completing the tasks, to maximize the likelihood that there would be differences between potential sexual partners. Furthermore, with only a few exceptions (Dariotis & Johnson, 2015; Herrmann et al., 2014; Johnson et al., 2015), most sexual discounting studies in the past included only drug users as a target population. Therefore, not enough information exists on delay or probability discounting of protected sex in a normal population. Thus, one of the purposes of this study is to see whether the past results could be replicated in a sample comprising college students.

To isolate the effect of delay (or probability) from general preferences for protection against STIs, delay and probability data for a given participant were normalized based on his or her preference for immediate (or certain) protected sex, and the data were omitted if a participant would definitely have unprotected sex even when protected sex was immediately available or certain. In other words, this study included only individuals who were likely to have safe sex in general; and participants who preferred unsafe sex across *all* situations were excluded.

It could be argued that participants' sexual decision making in this study is likely to be deliberate or rational rather than spontaneous or reactive, as they might be carefully weighing risks (contracting an STI) and benefits (immediate or certain sexual opportunity) when they rated their likelihood of having sex with protection. Traditional models of deliberative decision making (e.g., the health belief model) suggest that people process information and make decisions by evaluating the value of each option (Reyna & Farley, 2006; Reyna & Rivers, 2008). According to these models, both risk taking and risk avoidance can be rational as long as they lead to some important goals (e.g., enhancing sexual pleasure vs. being sexually healthy). However, these models do not account for spontaneous decision making which relies on intuition and holistic approaches rather than logical thinking. Existing literature shows that sexual decision making is usually unplanned and spontaneous, especially when a person is under the influence of alcohol or substance use or in the heat of passion (Ariely & Loewenstein, 2006; Flack et al., 2007; Klein, Geaghan, & MacDonald, 2007; Norris et al., 2009; Poulin & Graham, 2001).

However, this does not imply that a rational decision making framework cannot be useful in sexual risk-taking research. People, including adolescents and young adults, are capable of rational decision making (Reyna & Farley, 2006), and sexual risk reduction interventions using this framework have successfully reduced sexual risk behaviors in the past (El-Bassel et al., 2005; Jemmott, Jemmott, & Fong, 1998; Jemmott, Jem-mott, Fong, & Morales, 2010). One of the major concerns, on the other hand, is its strong emphasis on risk perception. According to this framework, increasing people's perception of sexual risk should decrease their willingness to engage in sexual risk behavior. However, in contrast with conventional belief, young adults usually overestimate important health-related risks (Millstein & Halpern–Felsher, 2002) and those who engage in unsafe sex realize that they are at higher risk than those who do not (Johnson, McCaul, & Klein, 2002). Therefore, intervention programs emphasizing attitude change may be less effective for people who are normally aware of STI risk but still have unsafe sex in some situations with some sexual partners. This may explain why STIs are still a major public health concern despite increasing success in our ability to improve people's awareness and knowledge of STI risk in recent years. This study, therefore, aimed to examine mechanisms underlying decisions to have unsafe sex despite awareness of STI risk.

Many studies to date (Bancroft, Carnes, & Janssen, 2005; Bancroft, Janssen, Carnes, Goodrich, & Strong, 2004; Cooper, Shapiro, & Powers, 1998; Nguyen et al., 2012) have relied on self-report measures to examine sexual risk decision making and behavior. Although self-report questionnaires are among the most effective measures of sexual risk-taking, their accuracy can be greatly affected by memory errors. Previous studies found that longer reporting intervals lead to decline in accuracy, and that people usually over-report low-frequency sexual behaviors, and underreport high-frequency sexual behaviors (Napper, Fisher, Reynolds, & Johnson, 2010; Schroder, Carey, & Vanable, 2003). Behavioral measures such as delay and probability discounting tasks, in contrast, do not rely on the human memory as they measure choice and decision making at that moment and, therefore, can capture sexual risk behavior with specific partners in specific situations. To be sure, this does not mean behavioral measures are more reliable than self-report questionnaires. Rather, as sexual risk-taking tends to be multidimensional, using alternative approaches that directly measure people's choice in a laboratory setting can shed light on a less researched aspect of sexual risk behavior.

We hypothesized that (1) in the SDD task, the value of protected sex would decrease as waiting time to have protected sex

increased; (2) in the SPD task, the value of protected sex would decrease as the odds against having protected sex increased; (3) delay and probability discounting functions would be influenced by an individual's perception of a sexual partner's attractiveness and risk of having an STI.

Method

Participants

The participants were male and female college students ($n = 78$) who received course credits by enrolling through the departmental research participation system. Inclusion criteria were (1) being 18–40 years old, (2) not being opposed to premarital or casual sex, and (3) being sexually active or having an interest in sex. Data from three participants were excluded from the analyses because they provided nonsystematic delay and probability discounting data in more than half of the eight sexual partner conditions (see the data analysis section for more details). Of the remaining 75 participants, 53 (70.7 %) were females. The age ranged from 18 to 38 years with a mean of 22.39 years ($SD = 4.09$). Forty-two (56 %) were European/White Americans. Other ethnicities included 17 (22.7 %) Hispanic/Latino Americans, 6 (8 %) Asian/Asian-Americans, 3 (4 %) African-Americans, 2 (2.7 %) Native/Indian-Americans, and 5 (6.7 %) others whose ethnicity was unspecified. Sixty participants (80 %) identified themselves as heterosexual, 2 (2.7 %) as homosexual, and 13 (17.3 %) as bisexual. Forty-two participants (56 %) were currently in an intimate relationship. Sixty-five participants (86.7 %) reported having experience in sexual intercourse.

After data normalization (see the data analysis section for more details), of the remaining 54 participants in the Sexual Delay Discounting (SDD) task, 39 (72.2 %) were females. The age ranged from 18 to 38 years with a mean of 22.93 years ($SD = 4.53$). The sample in this task consisted of 30 (55.6 %) European/White Americans, 11 (20.4 %) Hispanic/Latino Americans, 5 (9.3 %) Asian/Asian-Americans, 2 (3.7 %) African-Americans, 2 (3.7 %) Native/Indian-Americans, and 4 (7.4 %) others whose ethnicity was unspecified. Forty-three participants (79.6 %) identified themselves as heterosexual, 2 (3.7 %) as homosexual, and 9 (16.7 %) as bisexual. Thirty-one participants (57.4 %) were currently in an intimate relationship. Forty-eight participants (88.9 %) reported having experience in sexual intercourse. Similar to the SDD task, the sample's demographics in the Sexual Probability Discounting (SPD) task did not change drastically after normalization. Of the remaining 61 participants, 45 (73.8 %) were females. The age ranged from 18 to 38 years with a mean of 22.34 years ($SD = 4.13$). The sample in this task consisted of 34 (55.7 %) European/White Americans, 14 (23 %) Hispanic/Latino Americans, 4 (6.6 %) Asian/Asian-Americans, 3 (4.9 %) African-Americans, 2 (3.3 %) Native/Indian-Americans, and 4 (6.6 %) others whose ethnicity was unspecified. Forty-nine participants (80.3 %) identified themselves as heterosexual, 2 (3.3 %) as homosexual, and 10 (16.4 %) as bisexual. Thirty-three participants (54 %) were currently in an intimate relationship. Fifty-three participants (86.9 %) reported having experience in sexual intercourse.

Measures and Procedure

The SDD and SPD tasks were completed on a computer in a private experimental room without an investigator's presence. To counterbalance the task order, participants were randomized into two groups. In one group, the SDD task was followed by the SPD task, and the reverse was true for the other group. Before the tasks began, participants were instructed on how to make ratings using a VAS on the computer screen.

At the beginning of the session, the computer program asked participants to choose the gender they usually felt attracted to or aroused by. Three options were available: "*women*," "*men*," and "*both*." Participants choosing *women* were presented with 40 pictures of adult females. Participants choosing *men* were presented with 40 pictures of adult males. Participants choosing *both* were presented with both picture sets. As the purpose of the pictures used in this study was to depict credible hypothetical sexual partners, the pictures included in this experiment were selected to maximize diversity of physical features such as age, race, dress style, and so on.

Participants were asked, based on appearance alone, to exclude pictures of the people with whom they would never want to have sex under any circumstance. They were also asked to be sure that the remaining pictures (the ones participants did not exclude) depicted people with whom they might want to have sex at least in some situations. There was no limit set to the number of pictures that could be excluded at this stage. If participants agreed to have sex with all of the people depicted, they would reject none of the pictures, and proceed to the next step. However, unknown to the participants, the experiment ended immediately if there were less than eight pictures left in the set, as it was the minimum number of stimuli necessary for the full assessment (no such case occurred in this study). Participants were asked to imagine being single and available throughout the experiment if they were currently in an intimate relationship. In addition,the instructions used the word "STD" instead of "STI" as we believed that the former is more familiar to college-aged participants. An STD was defined in the tasks as "sexually transmitted disease: a disease passed from person to another person through intimate sexual contact. HIV, syphilis, and gonorrhea are all examples of STDs. STD can be used interchangeably with STI (sexually transmitted infection)."

From the remaining pictures, based on appearance alone, participants were asked to select *three* pictures of the people they *most wanted* to have sex with (MW) and *three* pictures of the ones they *least wanted* to have sex with (LW). From the three most-wanted pictures selected, participants chose one person who was perceived as *most likely to have an STI* (MSTI) and another person who was perceived as *least likely to have an STI*

(LSTI). Thus, the only one remaining picture in the set is the person identified as having neither the most or least STI risk (i.e., only most-wanted). This process was repeated for the three pictures considered least-wanted. Finally, from the rest of the unselected pictures in the picture pool, participants were asked to identify one person who was most likely to have an STI (i.e., only most-STI) and another person who was least likely to have an STI (i.e., only least-STI). Figure 1 depicts the resulting eight categories of potential sexual partners which include (1) most-wanted AND most-likely-to have-an-STI (MW/MSTI), (2) most-wanted (MW), (3) most-wanted AND least-likely-to have-an-STI (MW/LSTI), (4) least-wanted AND most-likely-to have-an-STI (LW/MSTI), (5) least-wanted (LW), (6) least-wanted AND least-likely-to have-an-STI (LW/LSTI), (7) most-likely-to have-an-STI (MSTI), and (8) least-likely-to have-an-STI (LSTI).

Participants were asked to imagine a scenario where they met the person in the picture at a social event and that both of them were in the mood for sex. The instructions asked participants to rate their own likelihood of having protected sex with the hypothetical sexual partner when the use of protection was either unavailable or uncertain; and "protection" meant the protection against STIs. Thus, use of birth control without protection against STIs (such as contraceptive pills) was not an option. In addition, participants were asked to assume that for purposes of the study there was no chance of pregnancy, even without protection. Then, participants were asked to complete the SDD and SPD tasks in the assigned order. After completing both discounting tasks, participants rated on a 10-point scale the attractiveness and perceived STI risk of all individuals in the pictures previously seen.

Sexual Delay Discounting Task

The eight selected pictures were presented in a randomized order along with the instruction asking participants to rate how likely they were to wait to have protected sex with that person. The VAS line ranged from 0 to 100 % where 0 % = "*I would definitely have sex without protection*" and 100 % = "*I would definitely have sex with protection.*" For each partner, the first trial was the zero-delay trial where both protected and unprotected sex were immediately available. The next six trials presented six different delay intervals for protected sex in ascending order (3 h, 6 h, 1 day, 1 week, 1 month, 3 months), along with the option to have unprotected sex "right now." The same set of trials was repeated for all eight partners. Figure 2 is a screenshot taken from one of the delay trials displayed on a computer.

Sexual Probability Discounting Task

The SPD task was similar to the SDD task except that it asked participants to rate how likely they were to have protected sex when the opportunity to do so was uncertain. For each hypothetical sexual partner, the chance of having unprotected and protected sex in the first trial was 100 %. The next six trials presented six different probabilities for protected sex, in descending order (90, 75, 50, 25, 15, 5 %), while the chance for unprotected sex remained at 100 %. The same set of trials was repeated for all eight partners. The odds against having sex was defined as $[1/p] - 1$, where p is the probability of having sex (Rachlin et al., 1991). Figure 3 is a screenshot taken from one of the probability trials displayed on a computer.

Data Analysis

After Johnson and Bickel (2008), discounting values were identified as nonsystematic if any delay or probability rating was 0.2 or higher than the rating on the preceding delay or probability value, starting with the second shortest delay or highest probability.

The subjective values of protected sex used in the data analysis were the percentages marked on the VAS. Each participant's delay and probability discounting data consisted of eight sets of value points, one for each sexual partner condition. As the objective of this study was to examine delay or probability discounting of safe sex, it was necessary to ensure that any decrease in participants' ratings is an accurate reflection of their devaluation of delayed (or uncertain) safe sex. Because we could not assume that all participants preferred sex with protection when it was immediate or certain, each delay or probability value was normalized based on the rating on the first trial of each set (when there was no difference in delay or probability between protected and unprotected sex). In other words, all delay and probability data were normalized to prevent the effect of participants' general preference for protected sex regardless of delay or probability. Normalization was accomplished by dividing each VAS value in delay or probability trials by the VAS value in the zero-delay or 100 % trial. Any data set was undefined and excluded from analysis if the VAS value in the first trial from both tasks was equal to zero, as there was no devaluation of protected sex in those cases (i.e., the participants had no preference for protected sex in all circumstances).

Area under the discounting curve (AUC) was determined for each data set using the method proposed by Myerson, Green, and Warusawitharana (2001). AUC has been successfully used to assess the magnitude of delay and probability discounting functions in previous studies; it is the area under the empirical discounting function (i.e., actual data points) that is theoretically neutral and not tied to a particular mathematical discounting model (Jarmolowicz, Lemley, Asmussen, & Reed, 2015; Lawyer et al., 2010; Myerson et al., 2001). Smaller AUC indicates greater delay (or probability) discounting of protected sex, or relative preference for immediate (or certain) unprotected sex.

A one-way repeated measures ANOVA with Greenhouse-Geisser correction was used to compare mean AUC values across eight sexual partner conditions. In addition, a paired

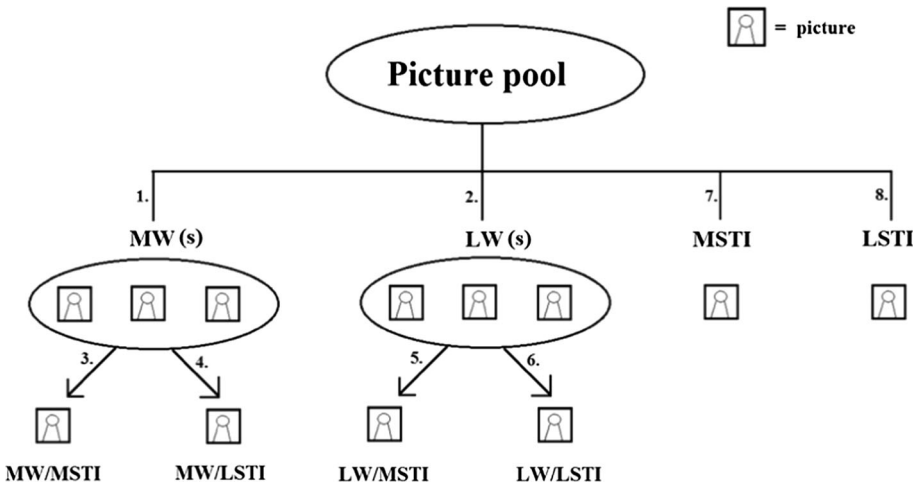

Fig. 1 Participants assigned their hypothetical sexual partners to eight conditions. MW = most-wanted-to have-sex-with, LW = least-wanted-to have-sex-with, MSTI = most-likely-to have-an-STI, and LSTI = least-likely-to have-an-STI. The number on each *line* indicates the order of the selection process. Note that among the three most-wanted pictures, one person was not selected to be most or least likely to have an STI, and thus was only labeled as MW. Similarly, among the three least-wanted pictures, one person was not selected to be most or least likely to have an STI, and thus was only labeled as LW

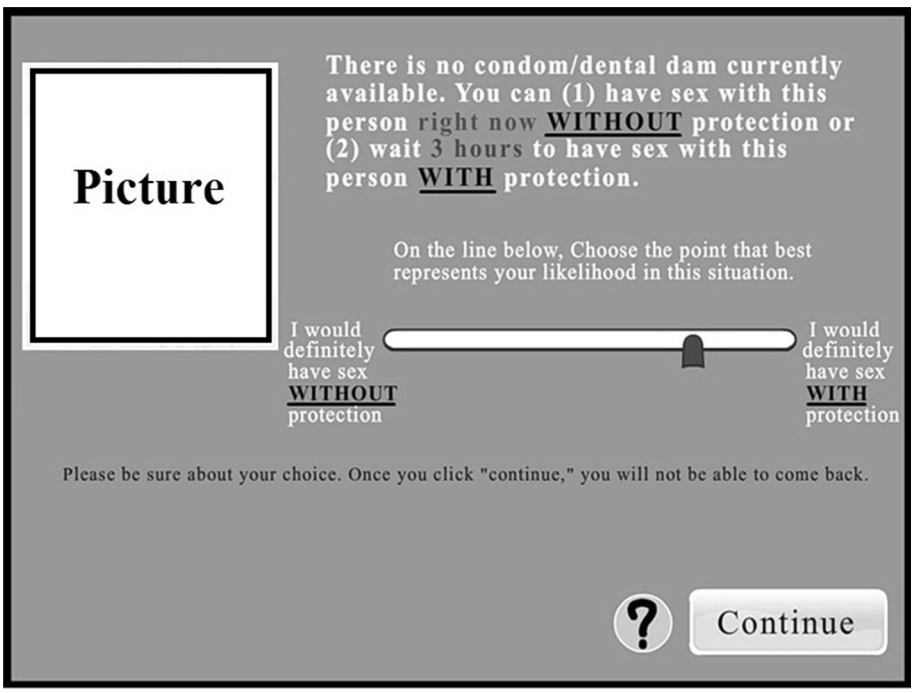

Fig. 2 One of the delay trials shown on a computer screen

sample *t* test was used to compare overall mean AUC between the SDD and SPD tasks. Finally, multiple regression was used to assess whether a partner's attractiveness and likelihood of having an STI predicted overall mean AUC; and a one-way repeated measures ANOVA was used to compare (1) attractiveness ratings and (2) risk of STI ratings across eight partners.

Results

Identifying Nonsystematic Data

Data from three participants were found to be entirely nonsystematic and were excluded from the analyses.

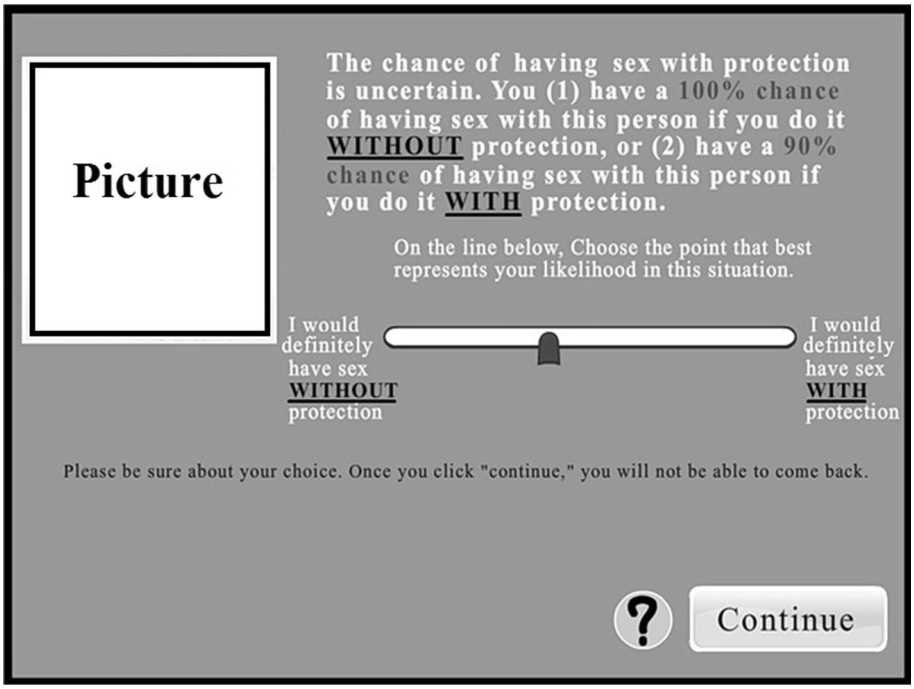

Fig. 3 One of the probability trials shown on a computer screen

In the SDD task, of the 600 discounting data sets across eight partner conditions, 36 (6 %) were nonsystematic; of those, 13 were retained for analysis because they were cases in which only a single point out of the seven data points (one zero-delay and six delay values) was nonsystematic, and previous research has shown that these functions provided reliable AUC calculations (Johnson & Bruner, 2012, 2013). One participant's delay (but not probability) discounting data were excluded entirely from analyses because there were at least two nonsystematic points in five of the eight partner conditions. In the SPD task, of the 14 (2.33 %) nonsystematic data sets, three were excluded as there were more than one nonsystematic point in each set.

Analyses of Zero-Delay and 100 % Trials

For the SDD task, the mean likelihood to have immediate safe sex was high in all partner conditions, ranging from $M = .86$ ($SD = .32$) in the MW condition to $M = .98$ ($SD = .08$) in the LW/MSTI condition. However, there were no significant differences in mean VAS ratings in the zero-delay trial across all partner conditions. For the SPD task, the mean likelihood to have safe sex for sure was also high in all partner conditions, ranging from $M = .85$ ($SD = .34$) in the MW/LSTI condition to $M = .98$ ($SD = .08$) in the LW/MSTI condition. Results from a one-way repeated measures ANOVA showed that mean VAS ratings across partner conditions were significantly different, even though the effect size is small, $F(3.3, 244.87) = 5.43$, $p = .001$, $\eta_p^2 = .07$. The Bonferroni post hoc comparisons revealed that the mean rating in the MW/LSTI condition was significantly lower than those in the LW/MSTI and MSTI ($M = .98$, $SD = .09$) conditions.

Comparisons Across Partner Conditions

Sexual Delay Discounting (SDD) Task

After exclusion of nonsystematic and undefined data, 432 data from 54 participants allowed for the within-subjects comparisons across all sexual partners. Figure 4 illustrates mean normalized VAS ratings in each partner condition for the SDD task. Results showed that mean AUC across partner conditions was significantly different, $F(4.81, 254.68) = 30.27$, $p < .001$, $\eta_p^2 = .36$. Table 1 shows results from the Bonferroni post hoc comparisons across eight sexual partners.

Sexual Probability Discounting (SPD) Task

After exclusion of nonsystematic and undefined data, 488 data from 61 participants allowed for the within-subjects comparisons across all sexual partners. Figure 5 illustrates mean normalized VAS ratings in each partner condition for the SPD task. Results showed that mean AUC across partner conditions was significantly different, $F(4.47, 268.05) = 33.71$, $p < .001$, $\eta_p^2 = .36$. Table 2 shows results from the Bonferroni post hoc comparisons across eight sexual partners.

Comparison Between SDD and SPD

Although we found similar discounting patterns in the SDD and SPD tasks, the overall mean AUC in the SDD task ($M = .63$, $SD = .40$) was significantly lower than that in the SPD task ($M = .70$, $SD = .36$), $t(543) = -6.72$, $p < .001$.

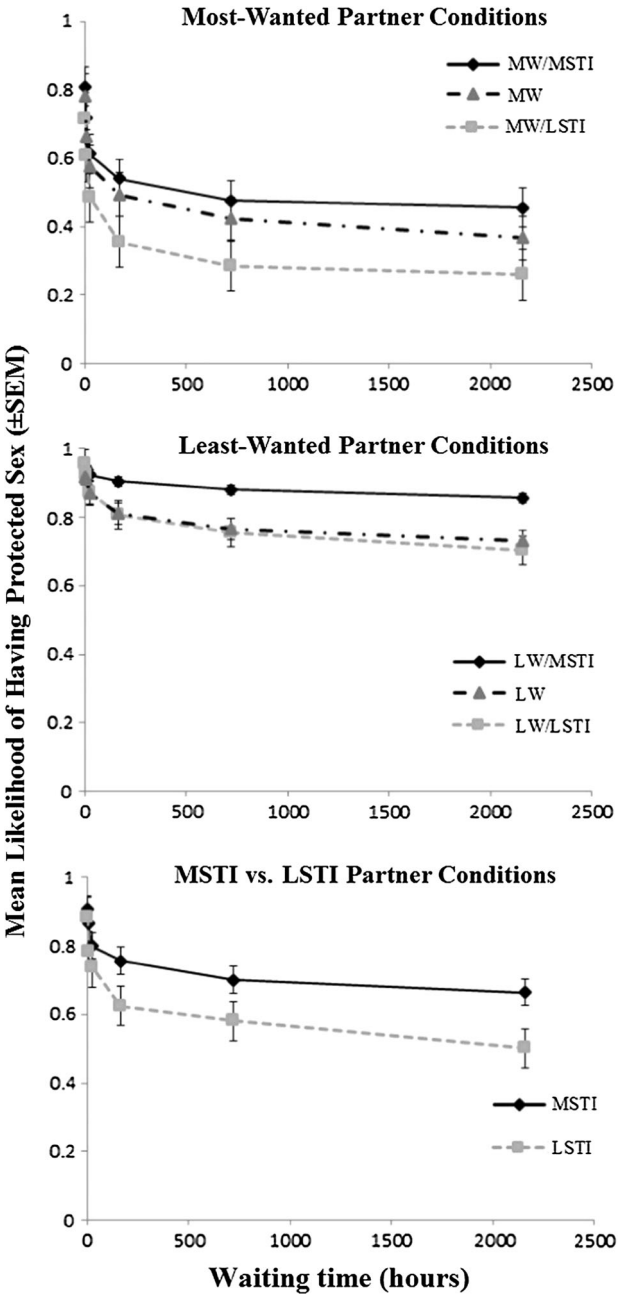

Fig. 4 Mean normalized VAS ratings (likelihood of having protected sex) in each partner condition for the SDD task. A steeper discounting curve indicates smaller AUC and greater preference for immediate, unprotected sex. *Error bars* represent ± SEM

Comparisons Across Partner Ratings

A partner's attractiveness and perceived STI risk accounted for a significant proportion of the variance in overall mean AUC, $R^2 = .18$, $F(2, 571) = 61.21$, $p < .001$. Furthermore, both attractiveness ($\beta = -.35$, $p < .001$) and STI risk ($\beta = .23$, $p < .001$) were significant independent predictors of overall mean AUC.

Attractiveness Ratings

Mean attractiveness ratings across the eight sexual partners were significantly different, $F(3.90, 288.68) = 104.68$, $p < .001$, $\eta_p^2 = .59$. The Bonferroni post hoc comparisons revealed, as expected, that all three most-wanted partners were significantly more attractive than all three least-wanted partners and the MSTI one ($p < .001$). The MW/LSTI partner ($M = 9.19$, $SD = .87$) was rated as the most attractive ($p < .01$). No difference in ratings of attractiveness was observed among all least-wanted partners ($M = 4.71$, $SD = 1.81$ for the LW/MSTI partner, $M = 5.05$, $SD = 1.86$ for the LW/LSTI partner, $M = 4.59$, $SD = 1.79$ for the LW partner). The LW/MSTI and LW partners were rated as signif icantly less attractive than the MSTI partner ($p < .01$). Finally, the LSTI partner ($M = 7.12$, $SD = 1.58$) was rated as significantly less attractive than the MW/MSTI ($M = 8.69$, $SD = 1.00$, $p < .001$) and MW/LSTI partners ($p < .001$), but more attractive than the three least-wanted partners ($p < .001$) and the MSTI one ($M = 6.03$, $SD = 2.14$, $p = .018$).

Risk of STI Ratings

The mean ratings of STI risk were significantly different across sexual partners, $F(5.32, 393.48) = 104.68$, $p < .001$, $\eta_p^2 = .45$. The Bonferroni post hoc comparisons revealed that the MW/MSTI partner ($M = 6.48$, $SD = 2.15$) was rated as being significantly more likely to have an STI than all partners ($p < .001$) except the LW/MSTI ($M = 6.69$, $SD = 1.85$) and MSTI partners ($M = 6.40$, $SD = 2.06$) who were rated as having the same STI risk. The MW/LSTI partner ($M = 3.61$, $SD = 2.32$) was rated as being significantly less likely to have an STI than all partners ($p < .02$) except the LW/LSTI ($M = 3.20$, $SD = 1.65$) and LSTI partners ($M = 3.05$, $SD = 1.73$) who were rated as having the same STI risk. The MW partner ($M = 4.35$, $SD = 1.75$) was rated as being less likely to have an STI than the LW/MSTI and MSTI partners but more likely to have an STI than the LW/LSTI and LSTI partners ($p < .001$). Similarly, the LW partner ($M = 4.92$, $SD = 1.95$) was rated as being less likely to have an STI than the LW/MSTI and MSTI partners but more likely to have an STI than the LW/LSTI and LSTI partners ($p < .001$).

Discussion

The results from this study supported our hypothesis that the value of protected sex was discounted when it was delayed or uncertain. In the SDD task, consistent with the findings from previous studies, participants' preference for protected sex decreased as waiting time to have protected sex increased; and immediate, unprotected sex was preferred over delayed, protected sex. In our novel SPD task, preference for protected

Table 1 Mean AUC comparisons across eight partner conditions in the Sexual Delay Discounting (SDD) task

Condition (I)	*M* (*SD*)	Condition (II)	*M* diff (I–II)	*p*
MW/MSTI	.51 (.42)	MW/LSTI	.16**	.003
		MW	.07	ns
		LW/MSTI	−.35**	<.001
		LW/LSTI	−.23**	<.001
		LW	−.27**	<.001
		MSTI	−.23**	<.001
		LSTI	−.09	ns
MW/LSTI	.35 (.37)	MW	−.08	ns
		LW/MSTI	−.50**	<.001
		LW/LSTI	−.39**	<.001
		LW	−.43**	<.001
		MSTI	−.38**	<.001
		LSTI	−.25 **	<.001
MW	.44 (.39)	LW/MSTI	−.42**	<.001
		LW/LSTI	−.30**	<.001
		LW	−.34**	<.001
		MSTI	−.30**	<.001
		LSTI	−.16	ns
LW/MSTI	.85 (.26)	LW/LSTI	.11	.068
		LW	.08	ns
		MSTI	.12	ns
		LSTI	.26**	<.001
LW/LSTI	.74 (.33)	LW	−.04	ns
		MSTI	.01	ns
		LSTI	.14	.084
LW	.78 (.33)	MSTI	.04	ns
		LSTI	.18*	.016
MSTI	.73 (.35)	LSTI	.14*	.035
LSTI	.60 (.38)	–	–	–

Smaller AUC indicates greater sexual risk-taking. The column labeled "M diff I-II" represents mean difference between each partner condition in the first column (Condition I) and the third column (Condition II)

* $p < .05$; ** $p < .01$

sex decreased as the odds against having protected sex increased; and certain, unprotected sex was preferred over uncertain, protected sex. The results also supported our hypothesis that the devaluation of protected sex was influenced by a partner's characteristics as there was greater relative preference for having immediate (or certain) unprotected sex with some sexual partners but not others.

The results showed that the partner's attractiveness ratings in all most-wanted conditions were significantly higher than those in all least-wanted conditions. Thus, at least in this study, a partner's desirability indicated his or her attractiveness. There was also a significant difference in the risk of STI ratings between the partners who were most likely to have an STI and those who were least likely to have an STI (including the combined conditions such as MW/MSTI and MW/LSTI). Therefore, it is likely that the observed difference in the AUC was actually due to a partner's attractiveness and perceived STI risk.

Overall, mean VAS ratings (likelihood to have safe sex) in the zero-delay and 100 % trials were high, indicating that participants in this study, on average, were likely to have immediate (or certain) safe sex. In addition, a partner's characteristics had no impact on general preferences for protected sex in the zero-delay trial as the mean ratings were the same in all partner conditions. For the 100 % trial, a partner's characteristics had an impact only when a partner was the most desirable and least likely to have an STI (MW/LSTI) as the mean rating in this condition was lower than those in the LW/MSTI and MSTI conditions. After data normalization, the SDD and SPD tasks generated similar discounting functions of the value of protected sex. Consistent with the previous findings, participants were less likely to have

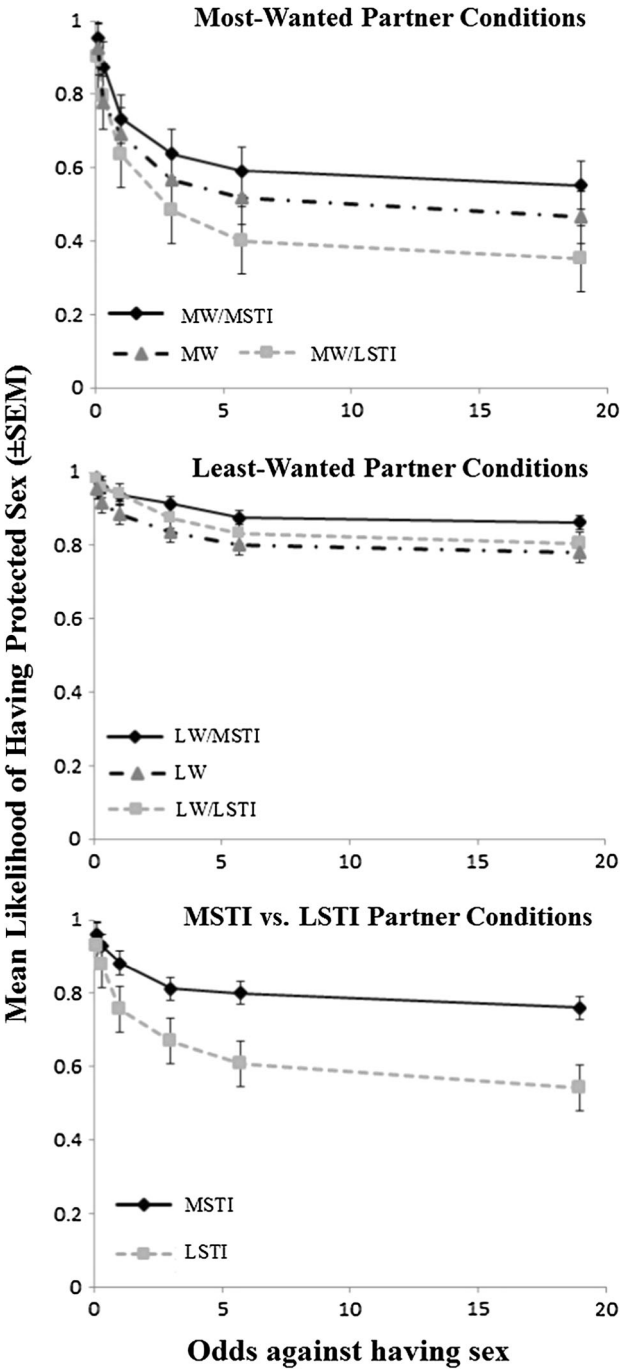

Fig. 5 Mean normalized VAS ratings (likelihood of having protected sex) in each partner condition for the SPD task. A steeper discounting curve indicates smaller AUC and greater preference for certain, unprotected sex. *Error bars* represent ± SEM

delayed (or uncertain) safe sex with the most-wanted (MW) partner compared to the least-wanted (LW) one. They were also more sexually impulsive with the most-STI (MSTI) partner compared to the least-STI (LSTI) partner. Looking at both main and combined effects of the partner conditions, we found that discounting of protected sex was prominent only in the three most-wanted conditions and the least-STI condition, while there was almost no discounting in the three least-wanted conditions and the most-STI condition. Moreover, participants reported being more likely to engage in sexual risk behavior (had smaller AUC) with the most attractive partners than they were with the least attractive ones, regardless of the partners' perceived STI risk. Please note that, as the participants had excluded the ones with whom they would never want to have sex in the beginning of the tasks, all partners, even the least attractive ones, were still their potential sexual partners. In other words, it is unlikely that the participants' low discounting rates in some partner conditions might have meant they did not want to have sex with those partners in the first place.

It was not surprising that participants reported being more likely to have delayed (or uncertain) safe sex with the most desirable partner who had the highest chance of having an STI (MW/MSTI) compared to another most desirable partner with the lowest STI risk (MW/LSTI). However, contrary to our expectation, there were no differences between the most desirable partner with the highest STI risk (MW/MSTI) and another most desirable partner who was neither most or least likely to have an STI (MW). This may be because both partners were perceived as highly attractive even though one of them was also perceived as highly likely to have an STI.

Also, we expected to see differences in AUC between the least-wanted partner conditions. However, the results indicated that, regardless of partners' perceived STI risk, participants were willing to wait (in the SDD task) or sacrifice their chance (in the SPD task) to have safe sex with the least attractive partners. Moreover, preferences for delayed (or uncertain) safe sex in all three least-wanted partners (even the one with the least STI risk or LW/LSTI) were equal to that of the most-STI one (MSTI).

In addition, the results showed that the ratings of attractiveness and STI risk were a significant predictor of overall mean AUC. More specifically, attractiveness was negatively related to overall mean AUC, and STI risk was positively related to overall mean AUC. We also found consistency between picture ratings and AUC comparisons across sexual partner conditions, especially for the attractiveness rating. Among the three most-wanted conditions, when there was no significant difference in levels of attractiveness; participants discounted delayed (or uncertain) protected sex equally for the most desirable ones, regardless of the partners' STI risk. Among the three least-wanted conditions, as there were no differences in levels of attractiveness, participants preferred delayed (or uncertain) protected sex with all these partners, regardless of the partners' STI risk. One of the most striking findings is that the most desirable partner with the highest STI risk (MW/MSTI) was not rated differently from the LW/MSTI and MSTI partners in terms of perceived STI risk. Moreover, the MW/MSTI partner was even perceived as riskier than the other two least-wanted partners (LW/LSTI and LW). However, mean AUC in this partner condition was significantly lower than those in all of the aforementioned conditions. Thus,

Table 2 Mean AUC comparisons across eight partner conditions in the Sexual Probability Discounting (SPD) task

Condition (I)	*M* (*SD*)	Condition (II)	M diff (I–II)	*p*
MW/MSTI	.65 (.37)	MW/LSTI	.20**	<.001
		MW	.07	ns
		LW/MSTI	−.25**	<.001
		LW/LSTI	−.20**	<.001
		LW	−.19**	.002
		MSTI	−.23**	<.001
		LSTI	−.001	ns
MW/LSTI	.45 (.37)	MW	−.13*	.015
		LW/MSTI	−.45**	<.001
		LW/LSTI	−.40**	<.001
		LW	−.40**	<.001
		MSTI	−.43**	<.001
		LSTI	−.20**	<.001
MW	.58 (.38)	LW/MSTI	−.32**	<.001
		LW/LSTI	−.27**	<.001
		LW	−.27**	<.001
		MSTI	−.30**	<.001
		LSTI	−.07	ns
LW/MSTI	.90 (.21)	LW/LSTI	.05	ns
		LW	.06	ns
		MSTI	.02	ns
		LSTI	.25**	<.001
LW/LSTI	.85 (.25)	LW	.01	ns
		MSTI	−.03	ns
		LSTI	.20**	<.001
LW	.84 (.27)	MSTI	−.04	ns
		LSTI	.19**	<.001
MSTI	.88 (.20)	LSTI	.23**	<.001
LSTI	.65 (.35)	–	–	–

Smaller AUC indicates greater sexual risk-taking. The column labeled "M diff I-II" represents mean difference between each partner condition in the first column (Condition I) and the third column (Condition II)

* $p < .05$; ** $p < .01$

as the MW/MSTI partner was rated as more attractive compared to those four partners, participants were more willing to take a sexual risk with this partner despite his or her high likelihood of having an STI.

Together, these findings suggest that a person may be willing to wait for safe sex and perhaps forgo unsafe sex with a relatively less desirable partners or the one who had an estimated higher chance of having an STI, but preferred to have immediate (or certain) unsafe sex with a more desirable partners or the one who had an estimated lower chance of having an STI. Moreover, although both partner's attractiveness and STI risk predicted overall preference for protected sex, a partner's attractiveness seems to have more weight given that they preferred immediate (or certain) unsafe sex with the most attractive partners compared to the least attractive ones, regardless of their perceived STI risk.

Our data showed very similar patterns of delay and probability discounting. Such similarity may be taken as indication that delay and probability discounting of protected sex depend on the same underlying processes, given that choosing to wait for delayed protected sex also introduces some degree of uncertainty of a sexual opportunity with that partner (e.g., the partner may become bored and lose interest in them after some period of time). Consistent with our findings, although using a different SPD task, Johnson et al. (2015) also found positive relationships between delay and probability discounting of condom-protected sex. In recent years, there has been conflicting evidence regarding the independence of the processes underlying delay and probability discounting (Green, Myerson, & Ostaszewski, 1999; Prelec & Loewenstein, 1991). However, those studies investigated discounting of monetary rewards. Because, compared to sexual activity (as investigated here), money has a nominal value

independent of the subject, and does not involve social consent or physical contact, it is not clear that discounting of money and sex depend on precisely the same variables. To date, the degree of independence between delay and probability discounting of protected sex remains to be resolved.

In this study, overall preference (mean AUC) for delayed but safe sex was significantly lower than preference for uncertain but safe sex, meaning that participants were less willing to wait for safe sex than they were to sacrifice their chance of having sex for safety reasons. However, it may be too early to say whether participants' preference for having protected sex was actually more affected by delay than uncertainty. Another factor potentially contributing to that difference is the dissimilarity in the framing of the instructions in the SDD and SPD tasks. In the SDD task, it was clear why participants needed to wait for protected sex (i.e., no condom/dental dam was available). In the SPD task, however, it was not as clear why they had a lower chance for protected sex as participants were only told that their possibility to have protected sex was uncertain. Thus, participants might have been more willing to have probabilistic protected sex in some partner conditions because the task did not depict a scenario as vividly as the one in the SDD task. Another possible explanation is that participants' grasp of the concept of *percentage* in the SPD task might not be as good as their understanding of time in the SDD task. That is, it might have been more difficult for participants to imagine a 75 % chance of having protected sex than a 6-h delay until they can have protected sex. Future research should control for these factors when addressing differences between delay and probability discounting of protected sex.

These findings contribute to a growing literature on integration of discounting procedures into research on sexual risk behavior. One of the major implications from this study is that even people who indicate intention to have safe sex may change their mind based on circumstances and a partner's characteristics. Therefore, policy makers, educators and clinicians should be aware that even those who are capable of rational thinking may still be at high risk for STIs. Moreover, it may be difficult to implement effective risk-reduction interventions for people with good knowledge and attitude toward protected sex because they may have little insight into the factors that cause them to engage in sexual risk behavior. For instance, if a person generally prefers sex with protection, he or she may not be well prepared for situations that can affect his or her willingness to have safe sex when condoms are not immediately available in the heat of the moment or when a partner shows reluctance to have sex with protection.

This study also contributes to the existing literature on the effect of attractiveness on risk taking and impulsivity (Ronay & von Hippel, 2010) by showing that, although participants realized protection against STIs was important, the benefits of having sex with a partner possessing desirable traits outweighed the risk of contracting an STI. In addition, participants in this study were less likely to have delayed (or uncertain) safe sex with a partner with relatively low estimated STI risk, suggesting that future intervention programs might be designed to discourage people from relying on their subjective perception of STI risk. For example, educators may emphasize the fact that a person appearing innocent or "clean" may still have an STI.

One limitation of this study, which may affect the generalizability of the results, is that all participants were college students and, consistent with the local student population, the majority were females. Moreover, unlike most delay and probability discounting studies measuring devaluation of monetary rewards, the value of sexual activity as presented in this study is entirely subjective; that is, in the case of sex there is no independent normative value to compare to, as there is with cash. Another limitation is that some delay values in the SDD task may not well represent real-life situations. For example, it seems unlikely that one might need to wait more than a few hours for a condom. However, our results and those obtained earlier (e.g., Johnson & Bruner, 2012; Lawyer et al., 2010) depict systematic changes in delay discounting of sexual outcomes over longer periods that are consistent with the more realistic shorter values. In addition, delay discounting functions of erotica across different sets of delay values (e.g., 1 min – 60 min vs. 1 day – 365 days) were well described by a hyperbolic discounting model (Lawyer, 2008), suggesting that differences in the specific delay values used may not be critical to how people discount a sex-related outcome. Future research studies may include shorter delay intervals (e.g., 30 min – 180 min) to depict more realistic waiting times until a condom or other uses of protection become available. Another limitation of this study is that the reward (i.e., a sexual activity) is hypothetical. Thus, it could be argued that participants may choose differently when a real opportunity for sex is available. Although no study to date has compared real versus hypothetical sexual activities, participants in an earlier study showed similar neurobiological response to real and hypothetical rewards (Bickel, Pitcock, Yi, & Angtuaco, 2009), and a number of studies have found equivalent results when using hypothetical and real monetary rewards (Hinvest & Anderson, 2010; Johnson & Bickel, 2002; Madden, Begotka, Raiff, & Kastern, 2003). Finally, this study did not account for other situational factors that can facilitate spontaneous and irrational sexual decision making, such as sexual arousal, alcohol and drug use. In addition, the effect of social interactions on sexual decision making was not investigated in our present study. In certain social contexts, such as parties or nightclubs, adolescents and young adults may make decisions based on social norms or heuristics (Metzler, Noell, Biglan, Ary, & Smolkowski, 1994; Reyna & Farley, 2006; Romer et al., 1994; Sampson, Morenoff, & Gannon-Rowley, 2002), which have been shown to have an impact on sexual decision making to some extent. Therefore, the findings from this study may not fully account for behavior in some real-life sexual encounters.

Conclusion

In this study, participants were likely to have protected sex when it was immediate or certain. However, preference for protected sex decreased systematically as delay to or odds against having protected sex increased. In addition, the results suggested that an individual's choice was affected by perception of a sexual partner's appearance and perceived sexual risk. Even a person who would otherwise prefer to have protected sex may be less willing to wait or miss an opportunity to have sex with an attractive partner or the one perceived as unlikely to have an STI. One important implication is that an individual's knowledge and attitude towards protected sex may not translate to actual behavior under certain circumstances. This brings up substantial complexity to research on sexual risk-taking, and highlights the importance of interventions that directly target impulse control.

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