# Delay and Probability Discounting as Determinants of Sexual Risk Behavior:

# The Effects of Delay, Uncertainty, and Partner's Characteristics

by

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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 (n = 75) 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 STI. In the sexual delay discounting (SDD) task, participants rated their likelihood (0 – 100%) of waiting for some period of time (e.g., 3 hours) 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 indicated preference for immediate (or certain) protected sex. Results show that participants' willingness to have safe sex systematically decreased as the delay to and odds against having safe sex increased. However, these discounting patterns were observed only in some partner conditions but not others, showing that preference for delayed (or uncertain) safe sex was altered by perceived attractiveness and STI risk of sexual partners. Moreover, the hyperbolic discounting model provided good to acceptable fit to the delay and probability discounting data in most-wanted and least-STI conditions. Gender differences in devaluation of safe sex were also found.

# DEDICATION

For my loving parents and grandmother who gave me support and pushed me through the best education possible. Also for my best friend, Pair, who gave me strength, unending support and helpful suggestions throughout the entire project. I would not have been able to get to this stage without them.

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# CHAPTER 1

## INTRODUCTION

Sexually transmitted infections (STI), such as gonorrhea, chlamydia and HIV/AIDS, can have negative health effects, infertility or even death. Many STIs cause no noticeable symptoms for a long time, ranging from several weeks to several years. Therefore, an infected person may transmit a disease to his or her partner unknowingly, making STIs one of the most silent threats to society. In the United States alone, there are nearly 20 million cases of new infections each year, and approximately 10 million new cases occur among individuals aged 15 – 24 even when they represent just 25% of the sexually experienced population. (Centers for Disease Control [CDC], 2012).

Although STIs are a major public health problem, unsafe sex remains a common practice. 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 indicate the general intention to have safe sex but still engage in sexual risk behavior in some situations.

**Delay and Probability Discounting Approaches to Impulsive Behavior**

*Delay discounting* (DD) refers to the decrease in the subjective value of an outcome as the delay to receiving it increases. For example, to most people $100 now is better than $100 tomorrow, and $100 tomorrow is better that $100 in one month. 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 delivered in one year). In turn, *probability discounting* (PD) is the decrease in the subjective value of an outcome as the probability of receiving it decreases. 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 magnitude, 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). Unsurprisingly, DD and PD rates have been implicated in a number of problems of impulse control such as pathological gambling (Dixon, Marley, & Jacobs, 2003; Holt, Green, & Myerson, 2003), drug use (Kirby, Petry, & Bickel, 1999) and cigarette smoking (Bickel, Odum, & Madden, 1999; Reynolds, Karraker, Horn, & Richards, 2003).

Delay discounting data can be described using a hyperbolic function (Mazur, 1987):

$$V = \frac{A}{1 + kD} \quad (1)$$

where $V$ represents the subjective value of a delayed outcome, $A$ represents the actual value of a delayed outcome, $k$ represents a parameter indicating the rate of decrease in value, and $D$ represents the delay to receiving that outcome.

Probability discounting data can also be described using a hyperbolic function (Rachlin et al., 1991):

$$V = \frac{A}{1 + h\odot} \quad (2)$$

where $V$ represents the subjective value of a probabilistic outcome, $A$ represents the actual value of a probabilistic outcome, $h$ represents a parameter analogous to k in Equation 1, and $\odot$ represents the odds against receiving a probabilistic outcome (defined as [1/p] – 1, where p is the probability of receiving an outcome).

Behavior economists used the term “hyperbolic discounting” because the best fitting mathematical equation is the generalized function for a hyperbola. With hyperbolic discounting, the rate of discounting increases very rapidly for small delays or high probabilities, but then decreases as the delay interval increases or the probability becomes lower (Green & Myerson, 2004). For instance, many people prefer $100 now to $110 in a day, but may not prefer $100 in one year to $110 in one year and a day. Those who exhibit such preferences are described as showing "present-biased" (Thaler, 1981). Similarly, many people prefer $100 with a 100% chance to $110 with a 95% chance but may not prefer $100 with a 20% chance to $110 with a 15% chance. Therefore, while people can be patient in the long run or when the probability of reward is low, they may still act impulsively in the short run or when the probability of reward is high. Compared with the traditional exponential model (where the value of a reward is discounted by a factor that increases with the amount of the delay or odds against), hyperbolic discounting devalues a reward more than exponential discounting for short delays or high probabilities but less than exponential discounting for long delays or low probabilities (Green & Myerson, 2004).

**Delay and Probability Discounting Approaches to Sexual Risk Behavior**

In typical delay and probability discounting procedures, researchers often use hypothetical monetary outcomes in the assessment of impulsive decision-making (e.g., Green et al., 1994). Monetary outcomes are usually preferred by many researchers because money is universally reinforcing and easily quantifiable. However, monetary rewards might not be enough to measure more dynamic decision-making in which discounting patterns may vary based on characteristics of an outcome. Existing literature

shows that non-monetary outcomes, such as food, can be well described by discounting patterns (Holt, Newquist, Smits, & Tiry, 2014; Rasmussen, Lawyer, & Reilly, 2010). In fact, several studies found commodity effects in discounting rates. For example, cocaine users may devalue delayed cocaine rewards at a higher rate than delayed monetary rewards (Coffey, Gudleski, Saladin, & Brady, 2003).

Lawyer et al. (Lawyer, 2008; Lawyer, Williams, Prihodova, Rollins, & Lester, 2010) proposed a new procedure using sex-related outcomes to examine delay and probability discounting patterns. In his 2008 study, Lawyer examined delay and probability discounting of erotica, and found the orderly patterns of responding elicited by the erotica discounting tasks. Consistent with the previous study, Lawyer et al. (2010) found similar patterns of delay and probability discounting of sexual activity as those of money. These findings support the applicability of discounting tasks to research on sexual choice and decision-making in a laboratory context.

While delay discounting of erotica and sexual activity was studied previously by Lawyer and colleagues, it was Johnson and Bruner (2012) who 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 show that individuals discounted the value of protected sex when it was contingent on waiting until a condom was available. The authors 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, Johnson, Herrmann, & Sweeney, 2015). Moreover, steeper discounting of delayed sexual activity was found to be significantly related to higher rates of lifetime risky sexual partners, sexual sensation seeking, self-reported sexual risk behavior, and impulsive personality (Dariotis & Johnson, 2015; 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.

In addition to the effect of delay on willingness to have safe sex, Johnson et al. (2015) investigated the relationship between the probability of contracting an STI and devaluation of safe sex. In that study, 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. The authors found that the participants' likelihood of having protected sex 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. However, before the current study, the effect of uncertainty of a sexual opportunity on preference for safe sex remained uninvestigated.

**Risky Sexual Decision-Making: Deliberate vs. Spontaneous**

It could be argued that participants' sexual decision-making in a study using discounting procedures is likely to be deliberate or rational rather than spontaneous or reactive, as they might be carefully weighing risks (contracting an STI) and benefits (having sex with a selected partner) when they rate 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. The existing literature shows that sexual decision-making is usually unplanned and spontaneous, especially when a person is under the influence of alcohol or other substance 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,

Jemmott, 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. The current study, therefore, aims to examine mechanisms underlying decisions to have unsafe sex despite awareness of STI risk.

**Gender Differences in Sexual Risk-Taking**

Previous studies have shown that, while both genders have accurate knowledge about HIV/AIDS, men engage in sexual risk behaviors more than women do (Lewis & Watters, 1991; Poppen, 1995). Men also tend to have unsafe sex in unplanned and spontaneous situations while women tend to feel more comfortable practicing abstinence and safer sex. (Jadack, Hyde, & Keller, 1995).

Furthermore, men discount protected sex or other sex-related outcomes more than women do (Jarmolowicz et al., 2014; Jarmolowicz, Lemley, Asmussen, & Reed, 2015; Johnson & Bruner 2013; Lawyer & Schoepflin, 2013). These findings are inconsistent with previous studies that reported no gender differences in delay discounting of

monetary rewards (Cross, Copping, & Campbell, 2011; Epstein et al., 2003), showing that men may be more willing to take a sexual risk, but not a monetary risk, than women are. Moreover, despite differences in the magnitude of discounting rates between men and women, the value of delayed safe sex was discounted in a similar fashion by both sexes (Dariotis & Johnson, 2015). That is, although men are more sexually impulsive compared to women, both men and women prefer immediate unsafe sex to delayed safe sex. However, to my knowledge, no study to date has explored gender differences in probability discounting of safe sex. Therefore, this study explores whether gender differences also exist in the devaluation of safe sex by uncertainty.

**Current Study**

This study examined people's preference for safe sex when the opportunity to have safe 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 hours) 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). The VAS is an instrument consisting of a line that ranges from one extreme to the other extreme of the phenomenon being measured (0 – 100% in this study). Unlike other instruments using dichotomous or discrete techniques (e.g., Likert scale), the VAS measures a characteristic that is believed to be continuous, and thus can estimate the magnitude of subjective phenomena (e.g., pain). Traditional delay and probability discounting procedures usually ask dichotomous questions in which participants need to

choose between a smaller, sooner reward and a larger, longer reward. However, recent research has been successfully incorporated the use of VAS in studies of discounting (Johnson & Bruner, 2012; Kaplan, Reed, & McKerchar, 2014).

Delay discounting of protected sex occurs if participants are less willing to have protected sex when they needed to wait longer for it. Discounting rates in this task exemplify 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). Probability discounting of protected sex occurs if participants are less willing to have protected sex when protected sex decreased their chance to have sex. Discounting rates in this task exemplify 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 partner does not want to use a condom.

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 desirable. Thus, this study is the first to include all comparisons across main effects and combinations of a partner's desirability and STI risk. I anticipated that people might not be sexually impulsive with all partners. Although some people with impulsive personality can be

impulsive regardless of a partner's characteristics, many people, even non-risk takers, may choose to have causal sex without protection depending on the characteristics of sexual partners.

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 was 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 his or her reported attractiveness, as a person judged as relatively less attractive may be more desirable than a more attractive one (White, 1980). Moreover, levels of perceived STI risk might not be different among sexual partners 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 an 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 of 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 from analysis if a participant would 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 to have unsafe sex across *all* situations were excluded.

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, the attitude towards safe sex measured by these questionnaires may not always reflect actual behavior under certain circumstances. Moreover, the accuracy of self-report questionnaires 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. Nonetheless, 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.

*Hypotheses*

1. Hyperbolic discounting functions provide a good fit to delay and probability discounting data in all partner conditions (Equation 1 for DD and Equation 2 for PD).

2. In the SDD task, the value of protected sex decreases as waiting time to have protected sex increases.

3. In the SPD task, the value of protected sex decreases as the odds against having protected sex increases.

4. Delay and probability discounting rates are influenced by an individual's perception of a sexual partner's attractiveness and risk of having an STI.

5. Gender differences in the devaluation of safe sex are expected in both tasks with men being less likely to have delayed (or uncertain) safe sex across all partner conditions.

# CHAPTER 2

# METHOD

## Participants

*Sample Characteristics Before Data Normalization*

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 18-38 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. Twenty-four participants (32%) were affiliated with a religion. 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.

*Sample Characteristics After Data Normalization*

After normalization (see the data analysis section for more details), the remaining 54 participants in the sexual delay discounting (SDD) task included 39 (72.2%) females.

The age ranged from 18-38 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. Nineteen participants (35%) were affiliated with a religion. 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 18-38 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. Eighteen participants (30%) were affiliated with a religion. 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.

**Procedure**

The sexual delay discounting (SDD) and sexual probability discounting (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 (see Appendix A for the VAS practice given before the actual tasks).

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 female adults. Participants choosing *men* were presented with 40 pictures of male adults. 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 fewer 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 I 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 labeled as MW). 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 labeled as MSTI) and another person who was least likely to have an STI (i.e., only labeled as LSTI). Therefore, there were eight categories of potential sexual partners as follows (see Appendix B for a simulation of the picture selection process):

1. Most-wanted AND most-likely-to have-an-STI (MW/MSTI)
2. Most-wanted AND least-likely-to have-an-STI (MW/LSTI)
3. Most-wanted (MW)
4. Least-wanted AND most-likely-to have-an-STI (LW/MSTI)

5. Least-wanted AND least-likely-to have-an-STI (LW/LSTI)

6. Least-wanted (LW)

7. Most-likely-to have-an-STI (MSTI)

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. Below is the scenario given to participants.

> *You are having a good time at a social event (e.g., birthday party, beach party, concert, nightclub, bar, during vacation, business dinner, etc.) You meet the person in the photograph and chat throughout the event. It is obvious that there is chemistry between the two of you.*
>
> *Please imagine that you are in the mood for sex (being tipsy, for example), and there is a chance that you can have sex with this person (keep in mind that in this scenario you are single and completely available!). Similar to a real world situation, you don't know if it will be just a "one-night-stand" or a long lasting, committed relationship.*

The instructions asked participants to rate their own likelihood of having protected sex with a selected 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. Participants also completed a post-task questionnaire for a manipulation check.

*Sexual Delay Discounting (SDD) 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 hours, 6 hours, 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. Below is the instruction seen in the delay trials (see Appendix C for a screenshot taken from one of the delay trials displayed on a computer).

> *There is no condom/dental dam currently available. You can (1) have sex with this person right now WITHOUT protection or (2) wait [delay] to have sex with this person WITH protection.*"

*Sexual Probability Discounting (SPD) 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. Below is the instruction seen in the probability trials (see Appendix D for a screenshot taken from one of the probability trials displayed on a computer).

> *The chance of having sex with protection is uncertain. You (1) have a 100% chance of having sex with this person if you do it WITHOUT protection, or (2) have a [percentage] chance of having sex with this person if you do it WITH protection.*

**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 and 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 it cannot be assumed 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 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).

Nonlinear regression was used to determine fit to hyperbolic discounting functions. To compare discounting across partner conditions, area under the discounting curve (AUC) was determined for each data set using the method proposed by Myerson, Green & 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 curve (i.e., actual data points) that is theoretically neutral and not tied to a particular mathematical discounting model (Jarmolowicz et al, 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.

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 sample t-test was used to compare overall mean AUC between the SDD and SPD tasks. To assess gender differences, an independent sample t-test was used to compare mean AUC in women and men for each partner condition. Finally, multiple regression was used to assess whether a partner's attractiveness and STI risk predicted overall mean

AUC; and one-way repeated measures ANOVA was used to compare (1) attractiveness ratings and (2) risk of STI ratings across eight partners.

# CHAPTER 3

# RESULTS

## Manipulation Check

The mean ratings of whether participants could *not* be honest with their answers on the SDD and SPD tasks is 1.87 (SD = 1.27; where 1 = strongly disagree and 5 = strong agree). The mean ratings of whether sexual partners in the tasks were the ones participants wanted to have sex with in reality is 4.47 (SD = .83; where 1 = strongly disagree and 5 = strong agree). The mean ratings of whether the SDD and SPD tasks reflected participants' sexual behavior in real-life situations is 3.84 (SD = 1.21; where 1 = strongly disagree and 5 = strong agree). Of the 42 participants who were currently in an intimate relationship, the mean ratings of whether their current relationship affected their choice and decision-making in the SDD and SPD tasks is 1.48 (SD = .74; where 1 = strongly disagree and 5 = strong agree).

## 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 significantly 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 ($p < .001$).

**Identifying Nonsystematic Data**

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

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; Johnson & Bruner, 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 of having 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. There was no difference in mean VAS ratings in the zero-delay trial across all partner conditions. Results from an independent sample t-test show that men (M = .74, SD = .41) were less willing to have immediate safe sex than women were (M = .91, SD = .27) in the MW condition, $t(72) = -2.09$, $p = .04$. Men (M = .75, SD = .42) were also less willing to have immediate safe sex than women were (M = .92, SD = .24) in the LSTI condition, $t(72) = -2.13$, $p = .037$.

For the SPD task, the mean likelihood of having 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 show 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 reveal 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. In addition, men (M = .75, SD = .41) were less willing to have safe sex for sure than women were (M = .93, SD = .22) only in the LSTI condition, $t(73) = -2.47$, $p = .016$.

**Fit to the Hyperbolic Discounting Model**

*Sexual Delay Discounting (SDD) Task*

Results from a nonlinear regression show that, with exception of the LW/MSTI and LW conditions, the hyperbolic discounting model provided a good to acceptable fit to delay data in all conditions. Figure 1 shows median VAS ratings from the three most-wanted conditions and the least-STI condition. Figure 2 shows median VAS ratings from the three least-wanted conditions and the most-STI condition.

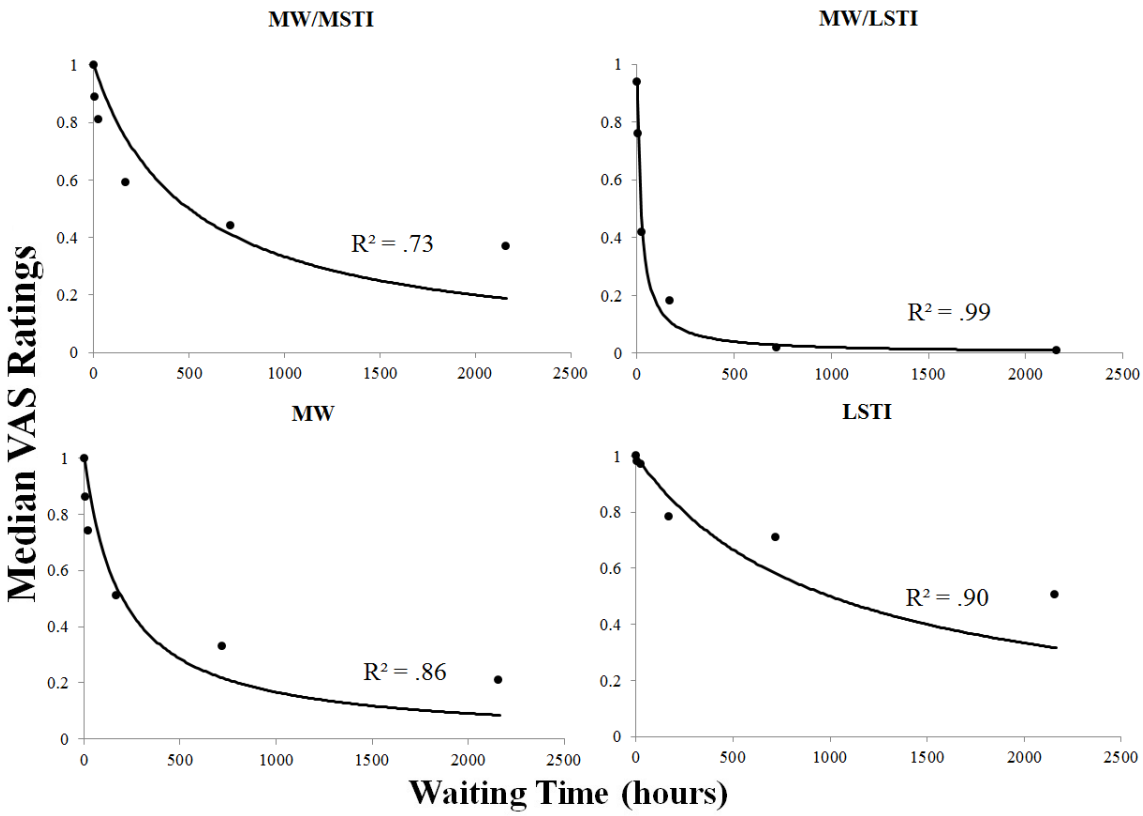


*Fig 1.* Mean VAS ratings (likelihood of having protected sex) of MW and LSTI conditions in the SDD task. MW = most-wanted-to have-sex-with, MSTI = most-likely-to have-an-STI, and LSTI = least-likely-to have-an-STI. Lines represent fit of the hyperbolic discounting function.

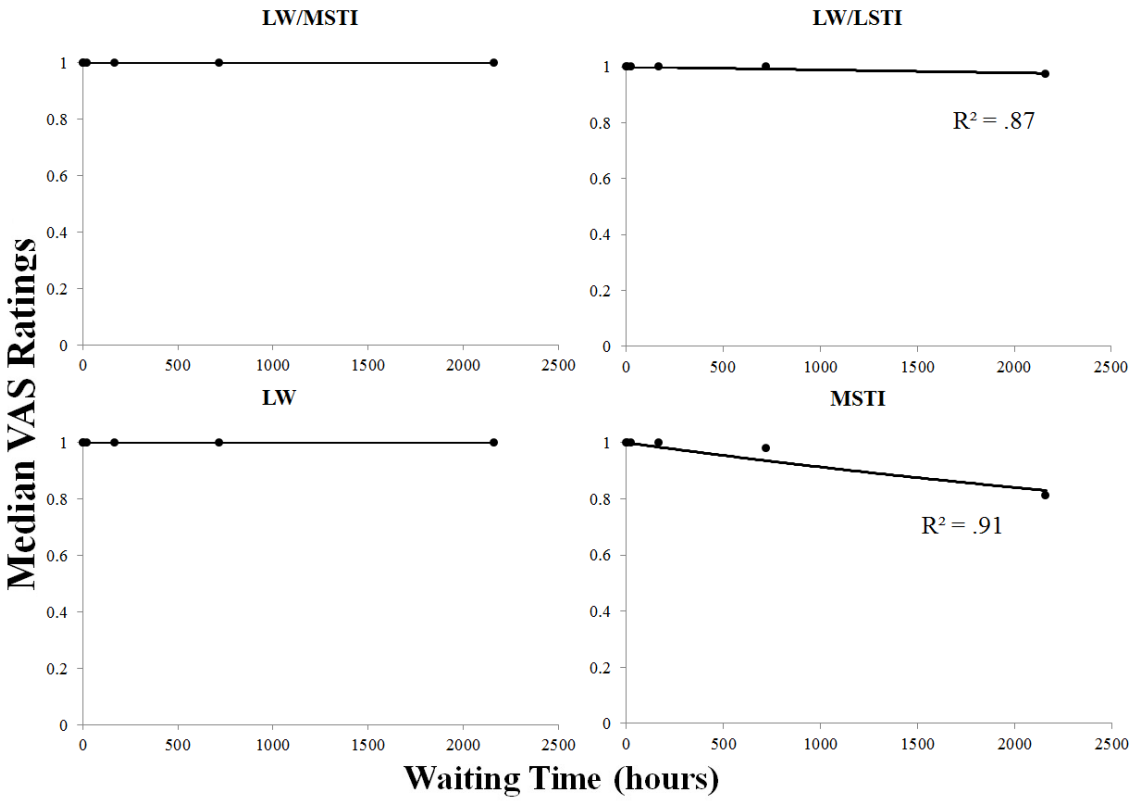


*Fig 2.* Mean VAS ratings (likelihood of having protected sex) of LW and MSTI conditions in the SDD task. LW = least-wanted-to have-sex-with, MSTI = most-likely-to have-an-STI, and LSTI = least-likely-to have-an-STI. Lines represent fit of the hyperbolic discounting function. Value for proportion of explained variance is not available in the conditions where there was no discounting of protected sex.

*Sexual Probability Discounting (SPD) Task*

Results from a nonlinear regression show that, with exception of the three least-wanted conditions and the MSTI condition, the hyperbolic discounting model provided a good to acceptable fit to probability data in all conditions. Figure 3 shows median VAS ratings from the three most-wanted conditions and the least-STI condition. Figure 4 shows median VAS ratings from the three least-wanted conditions and the most-STI condition.

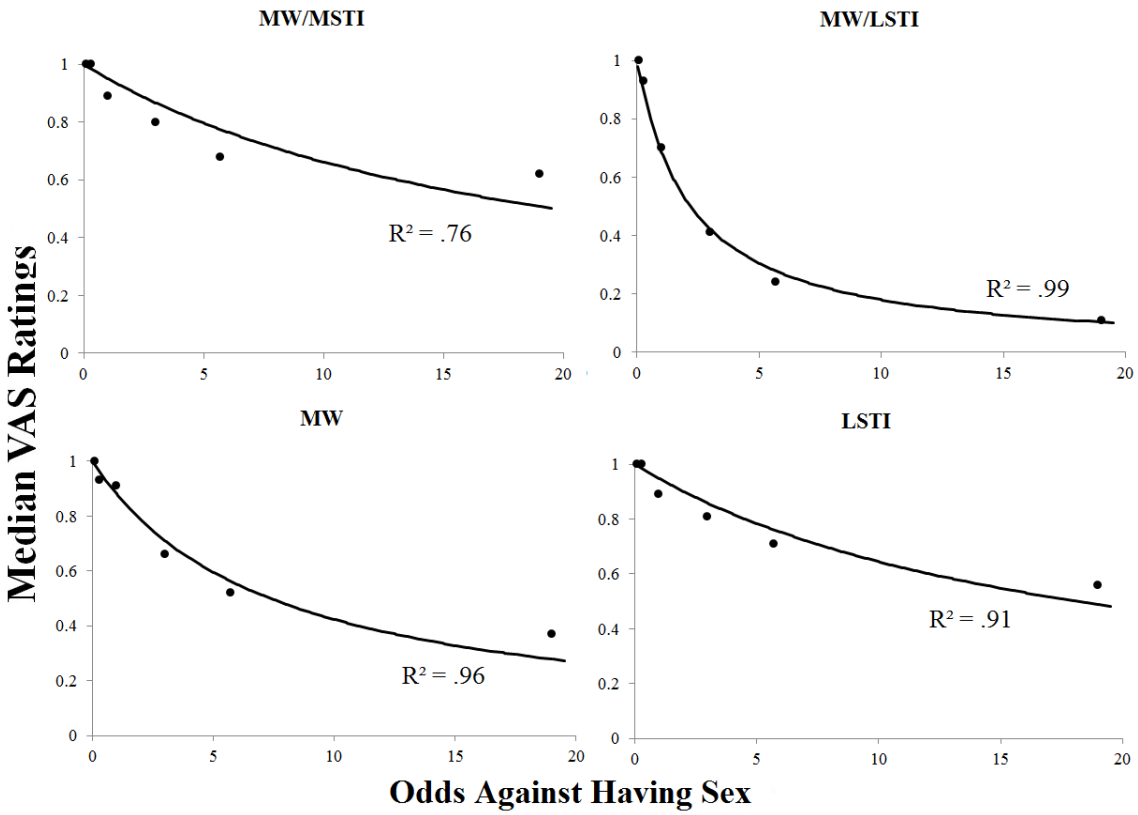


*Fig 3.* Mean VAS ratings (likelihood of having protected sex) of MW and LSTI conditions in the SPD task. MW = most-wanted-to have-sex-with, MSTI = most-likely-to have-an-STI, and LSTI = least-likely-to have-an-STI. Lines represent fit of the hyperbolic discounting function.

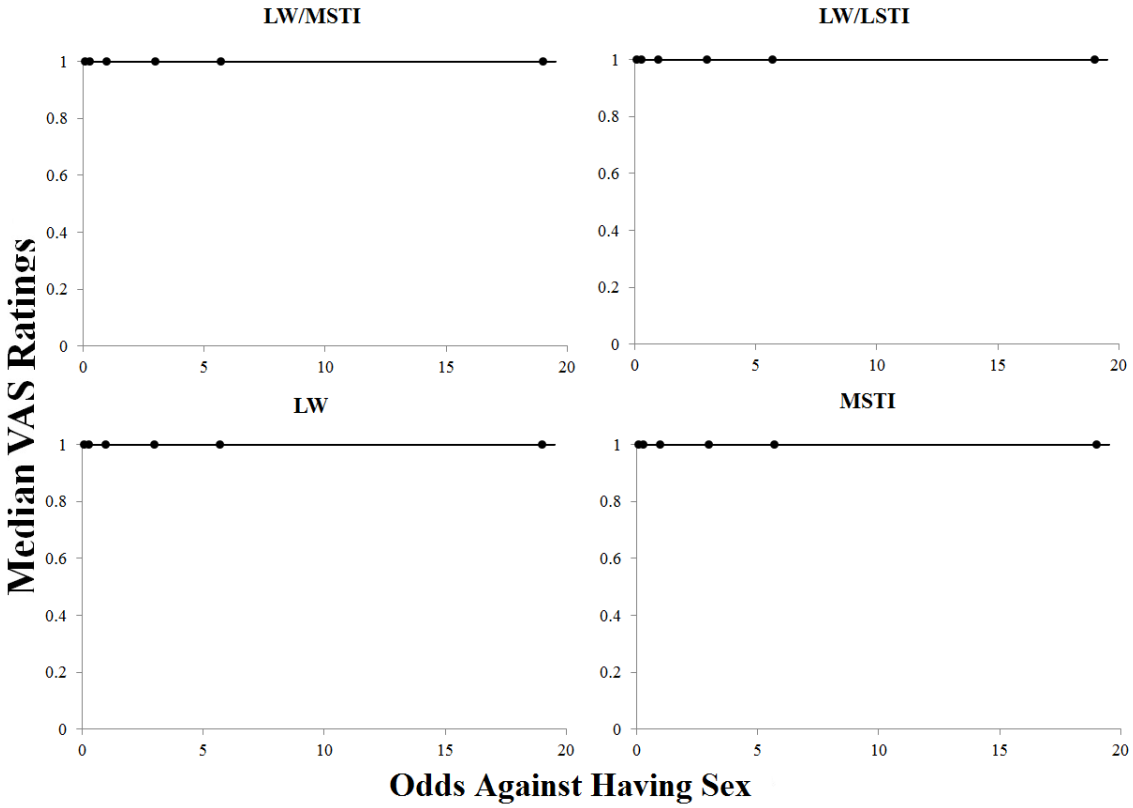


*Fig 4.* Mean VAS ratings (likelihood of having protected sex) of LW and MSTI conditions in the SPD task. LW = least-wanted-to have-sex-with, MSTI = most-likely-to have-an-STI, and LSTI = least-likely-to have-an-STI. Lines represent fit of the hyperbolic discounting function. Value for proportion of explained variance is not available in the conditions where there was no discounting of protected sex.

## Comparisons across Partner Conditions

*Sexual Delay Discounting (SDD) Task*

After excluding nonsystematic and undefined data, 432 data from 54 participants allowed for the within-subjects comparisons across all sexual partners. Results show 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.

Table 1

*Mean AUC Comparisons across Eight Partner Conditions in the SDD Task*

| Condition (I) | M (*SD*) | Condition (II) | M diff (I-II) | Sig. |
|---|---|---|---|---|
| MW/MSTI | .51 (.42) | MW/LSTI | .16** | .003 |
| | | MW | .07 | 1.000 |
| | | LW/MSTI | -.35** | <.001 |
| | | LW/LSTI | -.23** | <.001 |
| | | LW | -.27** | <.001 |
| | | MSTI | -.23** | <.001 |
| | | LSTI | -.09 | 1.000 |
| MW/LSTI | .35 (.37) | MW | -.08 | .349 |
| | | 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 | .110 |
| LW/MSTI | .85 (.26) | LW/LSTI | .11 | .068 |
| | | LW | .08 | 1.000 |
| | | MSTI | .12 | .167 |
| | | LSTI | .26** | <.001 |
| LW/LSTI | .74 (.33) | LW | -.04 | 1.000 |
| | | MSTI | .01 | 1.000 |
| | | LSTI | .14 | .084 |
| LW | .78 (.33) | MSTI | .04 | 1.000 |
| | | LSTI | .18* | .016 |
| MSTI | .73 (.35) | LSTI | .14* | .035 |
| LSTI | .60 (.38) | - | - | - |

Note. 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). *$p < .05$. **$p < .01$.

*Sexual Probability Discounting (SPD) Task*

After excluding nonsystematic and undefined data, 488 data from 61 participants allowed for the within-subjects comparisons across all sexual partners. Results show 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.

Table 2

*Mean AUC Comparisons across Eight Partner Conditions in the SPD Task*

| Condition (I) | M (*SD*) | Condition (II) | M diff (I-II) | Sig. |
|---|---|---|---|---|
| MW/MSTI | .65 (.37) | MW/LSTI | .20** | <.001 |
| | | MW | .07 | 1.000 |
| | | LW/MSTI | -.25** | <.001 |
| | | LW/LSTI | -.20** | <.001 |
| | | LW | -.19** | .002 |
| | | MSTI | -.23** | <.001 |
| | | LSTI | -.001 | 1.000 |
| 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 | 1.000 |
| LW/MSTI | .90 (.21) | LW/LSTI | .05 | 1.000 |
| | | LW | .06 | 1.000 |
| | | MSTI | .02 | 1.000 |
| | | LSTI | .25** | <.001 |
| LW/LSTI | .85 (.25) | LW | .01 | 1.000 |
| | | MSTI | -.03 | 1.000 |
| | | LSTI | .20** | <.001 |
| LW | .84 (.27) | MSTI | -.04 | 1.000 |
| | | LSTI | .19** | <.001 |
| MSTI | .88 (.20) | LSTI | .23** | <.001 |
| LSTI | .65 (.35) | - | - | - |

Note. 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). *$p < .05$. **$p < .01$.

**Comparison between the SDD and SPD Tasks**

Although similar discounting patterns in the SDD and SPD tasks were found, 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), $t(543) = -6.72$, $p < .001$.

**Comparison between Genders**

Figure 5 shows men's and women's mean AUC in each partner conditions. In the SDD task, men's mean AUC was significantly lower than women's in the "LW/LSTI", $t(70) = -2.98$, $p = .004$, "LW", $t(70) = -2.91$, $p = .005$, and "MSTI" conditions, $t(70) = -2.13$, $p = .036$. In the SPD task, men's mean AUC was significantly lower than women's in "MW/MSTI", $t(68) = -2.29$, $p = .025$, "MW/LSTI", $t(65) = -3.10$, $p = .003$, "MW", $t(67) = -2.98$, $p = .004$, "LW/LSTI", $t(72) = -2.07$, $p = .042$, "LW", $t(73) = -4.34$, $p < .001$, and "MSTI" conditions, $t(73) = -2.14$, $p = .036$.

In the SDD task, although there was a significant main effect of gender on the overall mean AUC, $F(1, 542) = 27.70$, $p < .001$, $\eta_p^2 = .05$, there was no significant interaction between gender and partner conditions. The similar phenomenon was observed in the SPD task. That is, although a main effect of gender on the overall mean AUC was significant, $F(1, 558) = 48.67$, $p < .001$, $\eta_p^2 = .08$, there was no interaction between gender and partner conditions.

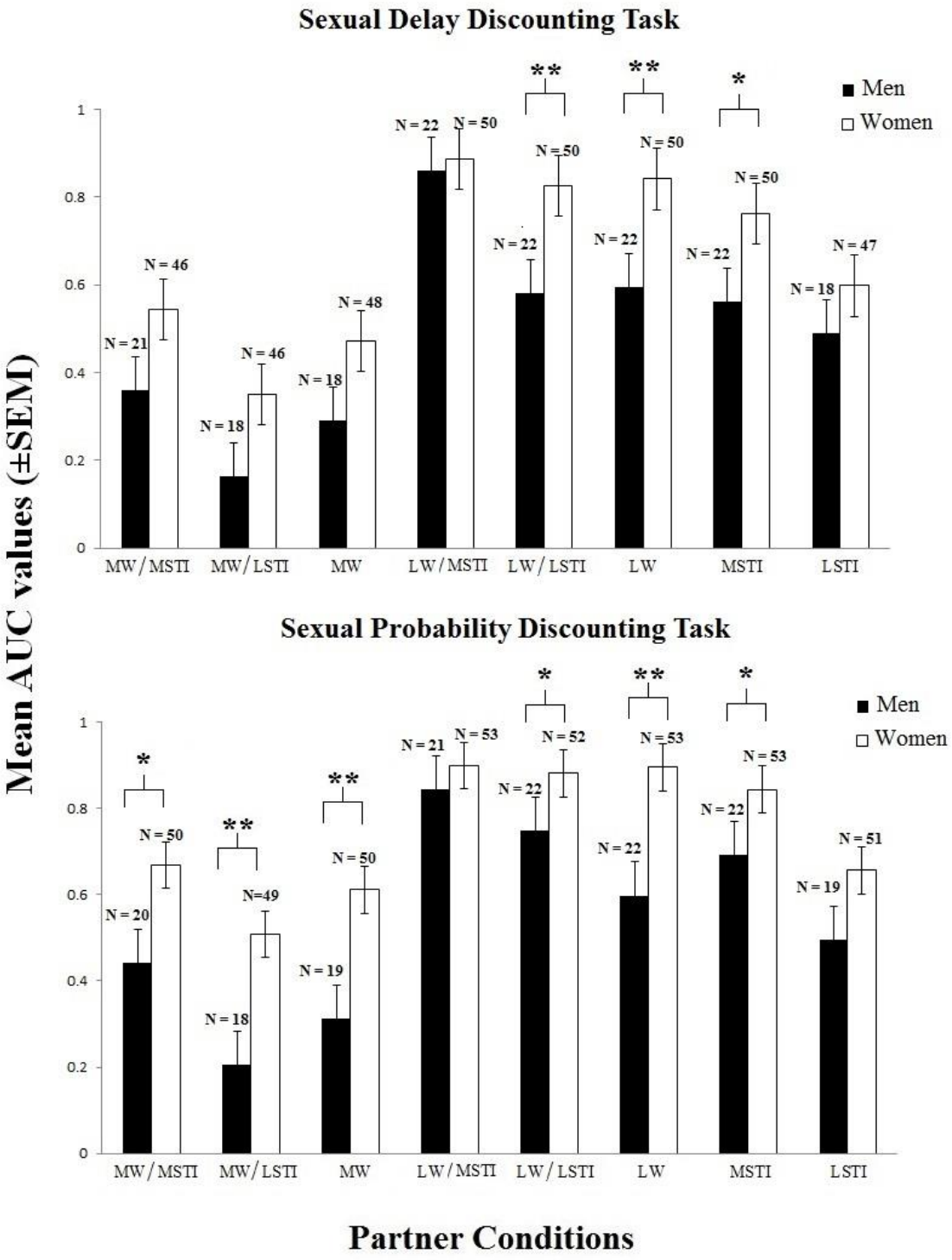


*Fig 5*. Mean area under the curve (AUC) of men and women across the eight partner conditions. The top panel shows results from the SDD task and the bottom panel shows results from the SPD task. Error bars represent ±SEM. *N* indicates number of participants in each group. $p^* < .05$. $p^{**} < .01$.

# CHAPTER 4

# DISCUSSION

The findings of this study contribute to a growing literature on the applicability of the discounting approaches to sexual risk behavior and decision-making, and suggest that the discounting estimation procedures may be useful in the study of mechanisms that underlie sexual or other health-related risk behaviors.

The results from this study supported the 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 this novel SPD task, preference for protected sex decreased as the odds against having protected sex increased; and certain, unprotected sex was preferred over uncertain, protected sex. The results also supported the 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. In addition, gender differences in discounting of delayed (or uncertain) safe sex were observed; however, the hypothesis that men were sexually impulsive than women across all conditions was only partially supported. In both tasks, men were less likely to have delayed (or uncertain) safe sex than women were, but not in all partner conditions.

In addition, 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 AUC was actually due to a partner's attractiveness and perceived STI risk. Furthermore, on average, participants reported being honest with their choices and believed the tasks reflected their sexual behavior in real-life situations. Therefore, the findings from the SDD and SPD tasks may, to some extent, reflect participants' real behavior even the choices are just hypothetical.

Overall, mean VAS ratings (likelihood of having 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 the 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. Gender differences in the preference for immediate (or certain) safe sex were found, but only in a few conditions (MW and LSTI in the SDD task and LSTI in the SPD task). This may imply that men are not necessarily more sexually impulsive than women at least when the protection against STIs is immediately available or does not decrease their chance of having sex. Moreover, when safe sex and unsafe sex are both immediately available or completely possible, men may rely more on their perception of a partner's STI risk as they were more willing to have unsafe sex with a partner who was least likely to have an STI (LSTI).

After data normalization, the SDD and SPD tasks generated similar discounting functions of the value of safe sex. Consistent with previous findings, participants were less likely to have delayed (or uncertain) safe sex with the most-wanted (MW) partner compared to the least-wanted (LW). 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, I found that discounting of protected sex was prominent only in the three most-wanted conditions and the least-STI condition, while there was little to no discounting in the least-wanted conditions and the most-STI condition. In the SDD task, except the two least-wanted conditions (LW/MSTI and LW) where there was no discounting of delayed safe sex, the data in the remaining conditions were well described by the hyperbolic discounting function. In the SPD task, except the three least-wanted conditions (LW/MSTI, LW/LSTI, LW) and most-STI condition (MSTI) where there was no discounting of uncertain safe sex, the data in all of the rest conditions were also well described by the hyperbolic discounting function. For the SDD task, the findings describe the phenomenon when people heavily discount the value of sexual health as they focus on the instant pleasure of sex with some certain partners. Moreover, the discounting rates of safe sex over a long length of delay (1 month vs. 3 months) are not as high as the discounting rates of safe sex over a short length of delay (now vs. 3 hours). For the SPD task, the findings describe the phenomenon when people heavily discount the value of sexual health as they focus on the pleasure of sure sex. Moreover, the discounting rates of safe sex when an opportunity for sex is low (25% vs. 15%) are not as high as the discounting rates of safe sex when an opportunity for sex is high (100% vs. 90%).

Additionally, 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 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. In fact, participants, on average, reported that they would have sex with their hypothetical sexual partners if they met them in reality.

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 my 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, I expected to see differences in AUC between the least-wanted partner conditions. However, the results indicate that, regardless of partners' perceived STI risk, participants were willing to wait long (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 show 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. I 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 (MW/MSTI and MW), 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 was no difference in levels of attractiveness, participants preferred to have 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 that in all of the aforementioned conditions. Thus, 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.

These data show 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 my findings, although using a different SPD task, Johnson et al. (2015) 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 (Prelec & Loewenstein, 1991; Green, Myerson, & Ostaszewski, 1999a). 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-hour 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.

Consistent with my expectation, men and women had similar discounting patterns in both SDD and SPD tasks. Moreover, men were less willing to have delayed (or uncertain) safe sex than were women. However, the differences were found only in some partner conditions. In the SDD task, AUC was smaller for men than women only in the LW/LSTI, LW and MSTI conditions. This means that men and women are equally impulsive with the most-wanted and least-STI partners. For the three least-wanted partners and the most-STI partner, men are as cautious as women only with the least desirable partner whose chance of having an STI was also very high (LW/MSTI) but are more willing to have immediate (or certain) unsafe sex with another least desirable

partners who had relatively lower chance of having an STI (LW/LSTI and LW), and the one who was most likely to have an STI but still not the least attractive (MSTI). More research is needed to understand why men are not as concerned as women about their sexual health at least when they have sex with these partners. The SPD task yields similar results except for the three most-wanted partner conditions where men were less willing to have uncertain safe sex than women were, showing that men and women are equally impulsive with the most-wanted partners when they need to wait for protected sex but not when the protected sex is uncertain.

**Implications for Future STI Prevention and Risk Reduction Intervention**

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 towards 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; Wilson & Daly, 2004) 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.

**Limitations of the Current Study**

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 vs. hypothetical sexual activities, participants in an earlier study showed similar neurobiological response to real and hypothetical rewards (Bickel et al., 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 environmental factors that can facilitate spontaneous and irrational sexual decision making, such as sexual arousal or alcohol and drug use. In addition, the effect of social interactions on sexual decision-making was not investigated in the current study. In certain social contexts, such as parties or nightclubs, adolescents and young adults may make decisions based on social norms or heuristics (Metzler et al., 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 be applicable to some real-life sexual encounters.

# CHAPTER 5

# CONCLUSION

In this study, participants preferred to have safe sex when it was immediate or certain. However, preference for safe sex decreased systematically as delay to or odds against having safe sex increased. In addition, these results suggest 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. Furthermore, men are more sexually impulsive than women as they tend to prefer immediate (or certain) unsafe sex at least with the less attractive partners who have lower STI risk and the partner with higher STI risk but not as low in terms of attractiveness. 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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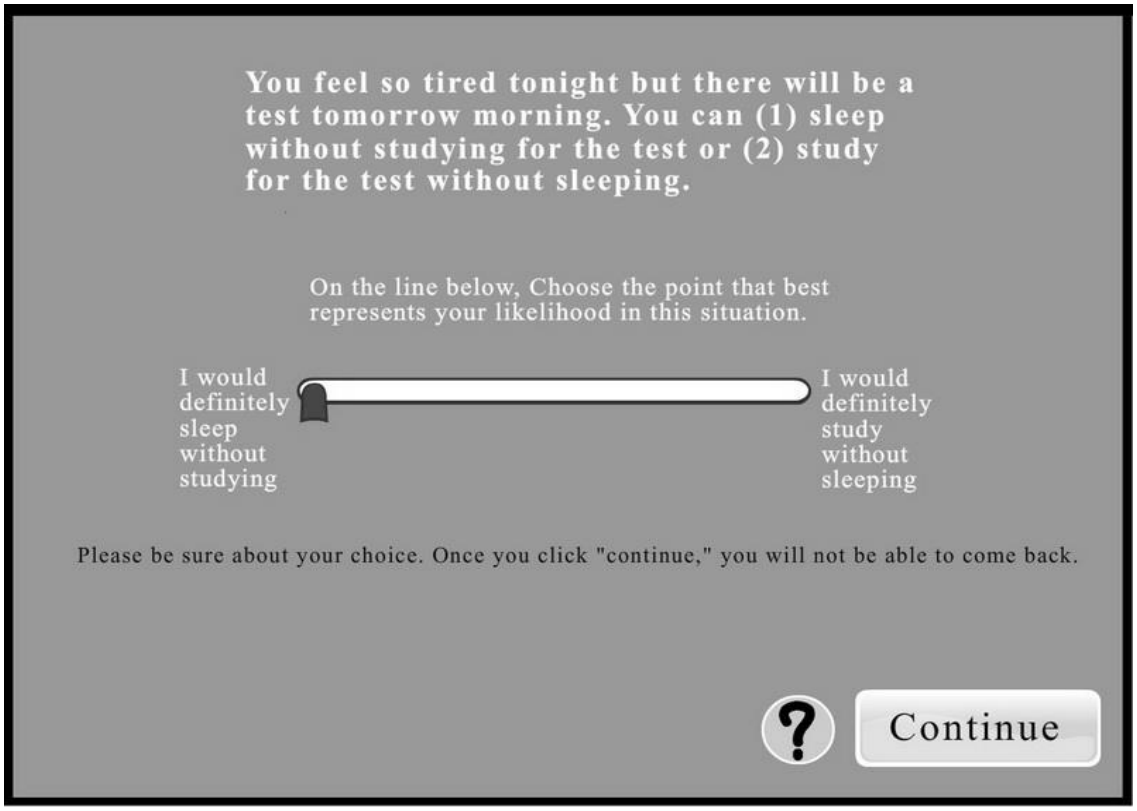
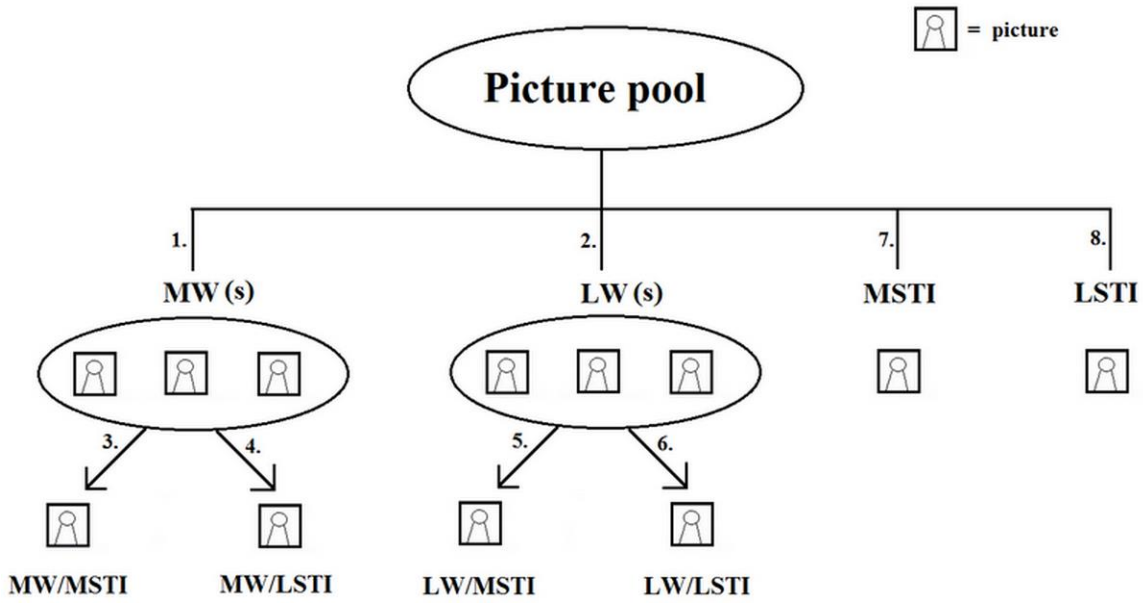
# APPENDIX A

## PRACTICE FOR VISUAL ANALOUGE SCALE (VAS)


You feel so tired tonight but there will be a test tomorrow morning. You can (1) sleep without studying for the test or (2) study for the test without sleeping.
On the line below, Choose the point that best represents your likelihood in this situation.
I would definitely sleep without studying
I would definitely study without sleeping
Please be sure about your choice. Once you click "continue," you will not be able to come back.
Continue

# APPENDIX B

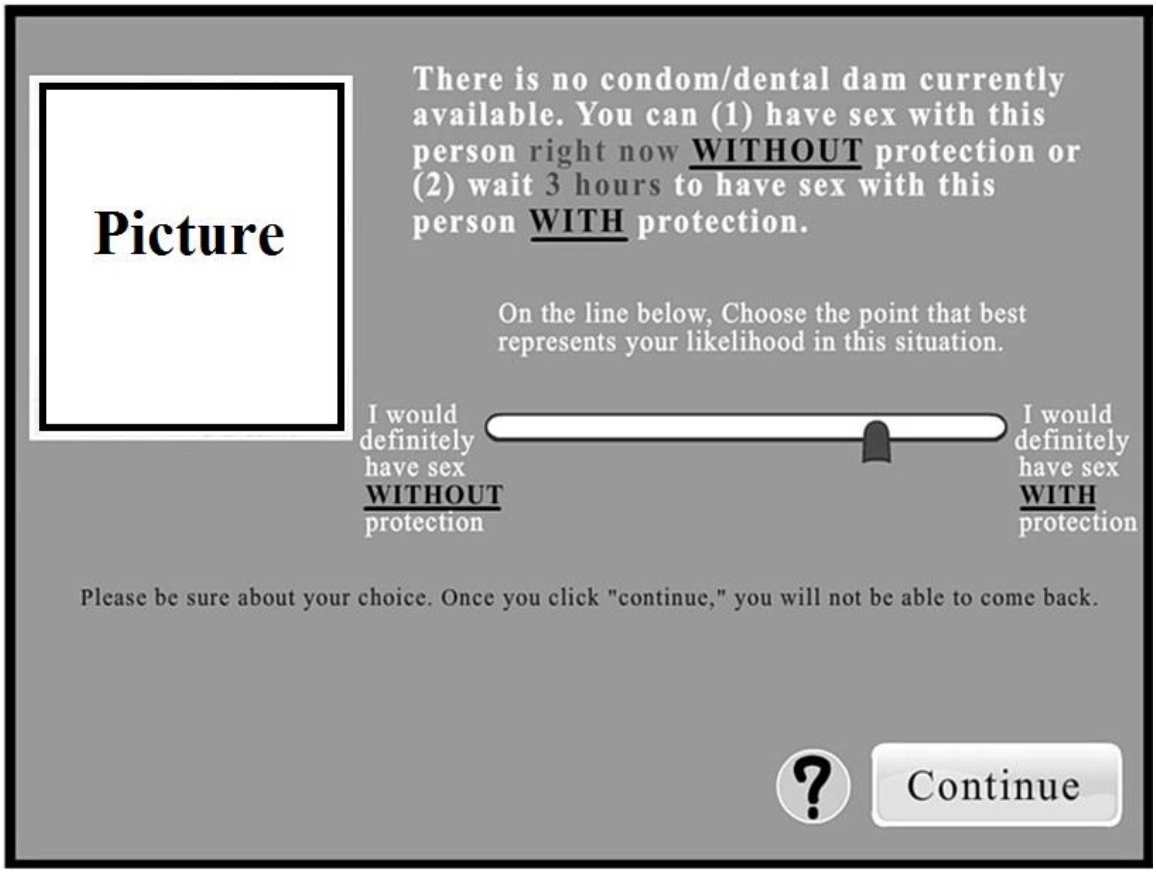
## PICTURE SELECTION PROCESS




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 assigned 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 assgined as LW.

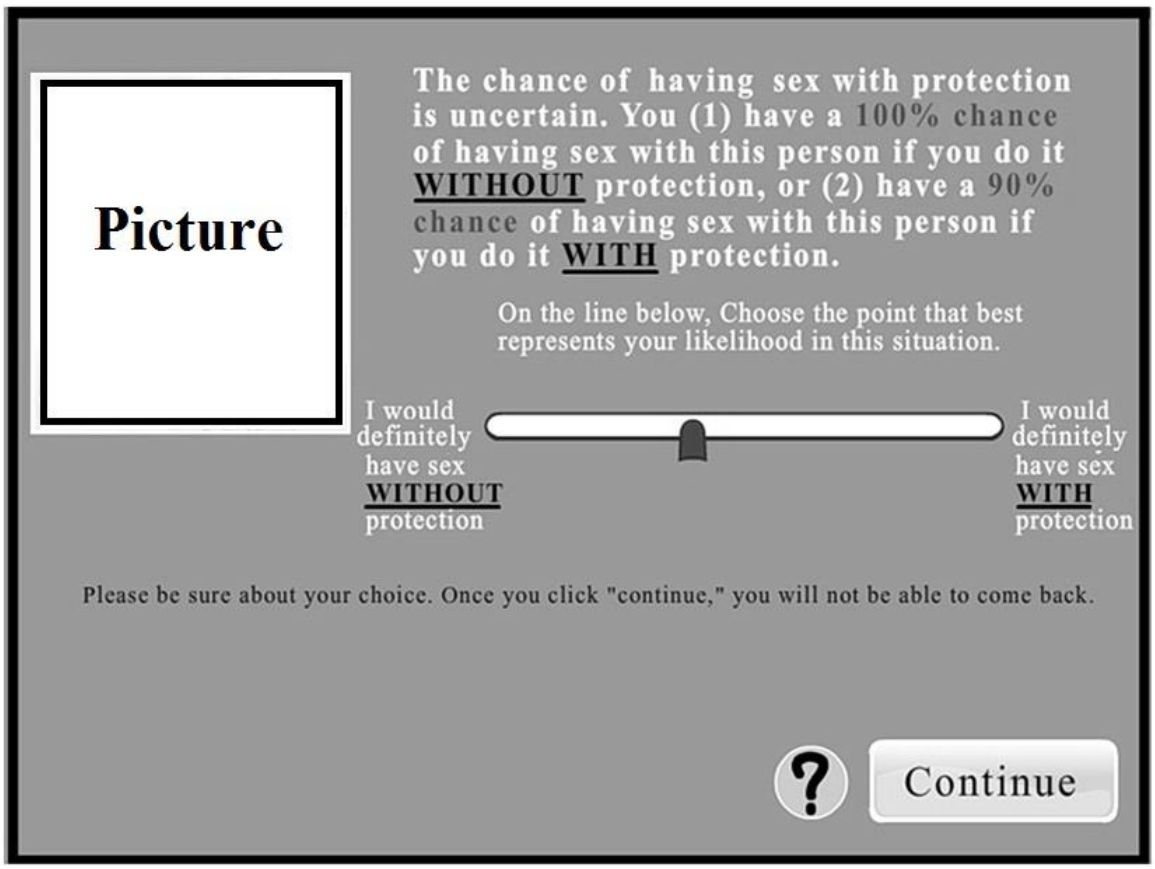
# APPENDIX C

## SCREEN SHOT FROM SEXUAL DELAY DISCOUNTING TASK


Picture
There is no condom/dental dam currently available. You can (1) have sex with this person right now WITHOUT protection or (2) wait 3 hours to have sex with this person WITH protection.
On the line below, Choose the point that best represents your likelihood in this situation.
I would definitely have sex WITHOUT protection
I would definitely have sex WITH protection
Please be sure about your choice. Once you click "continue," you will not be able to come back.
Continue

# APPENDIX D

## SCREEN SHOT FROM SEXUAL PROBABILITY DISCOUNTING TASK


Picture
The chance of having sex with protection is uncertain. You (1) have a 100% chance of having sex with this person if you do it WITHOUT protection, or (2) have a 90% chance of having sex with this person if you do it WITH protection.
On the line below, Choose the point that best represents your likelihood in this situation.
I would definitely have sex WITHOUT protection
I would definitely have sex WITH protection
Please be sure about your choice. Once you click "continue," you will not be able to come back.
Continue

# APPENDIX E

## APPROVAL FROM INSTITUSIONTAL REVIEW BOARD (IRB)

ASU Knowledge Enterprise Development

EXEMPTION GRANTED

Elias Robles-Sotelo
Social and Behavioral Sciences, School of
602/543-4515
Elias.Robles@asu.edu

Dear Elias Robles-Sotelo:

On 11/13/2014 the ASU IRB reviewed the following protocol:

| | |
|---|---|
| Type of Review: | Initial Study |
| Title: | The Subjective Value of Protected Sex |
| Investigator: | Elias Robles-Sotelo |
| IRB ID: | STUDY00001833 |
| Funding: | None |
| Grant Title: | None |
| Grant ID: | None |
| Documents Reviewed: | • Sexual Discounting Consent Form 11-03-14 Revised.pdf, Category: Consent Form;<br>• Sexual Discounting Protocol, Category: IRB Protocol;<br>• Demographic.pdf, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions);<br>• Screen 6.pdf, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions);<br>• Screen 1.pdf, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions);<br>• Screen 2.pdf, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions);<br>• Screen 3.pdf, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions);<br>• Sample screen shot from computerized task- 4, |

| | |
|---|---|
| | Category: Measures (Survey questions/Interview questions /interview guides/focus group questions);<br>• Sample screen shot from computerized task -5, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions);<br>• Debrief.pdf, Category: Other (to reflect anything not captured above);<br>• Recruiting Material, Category: Recruitment Materials; |

The IRB determined that the protocol is considered exempt pursuant to Federal Regulations 45CFR46 (2) Tests, surveys, interviews, or observation on 11/13/2014.

In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

Sincerely,

IRB Administrator

cc:
Sineenuch Wongsomboon