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Behavioral processes underlying sexual behavior are important for understanding normal human functioning and risk behavior leading to sexually transmitted infections (STIs). This systematic review examines delay and probability discounting in human sexual behavior through synthesis of 50 peer-reviewed, original research articles. Sixteen studies focusing exclusively on monetary delay discounting found small effect size positive correlations with sexual risk behaviors. Eleven studies examined delay or probability discounting of sexual behavior itself using tasks that varied duration, frequency, or quality of sex to determine value. Results show delay and uncertainty of sex causes systematic decreases in value. These studies also show consistent medium effect size relationships between sexual discounting measures and sexual health and substance use, supporting utility above and beyond monetary discounting. Twenty-three studies have modeled clinically relevant decision-making, examining effects of delay until condom availability and STI contraction probability on condom use. Observational and experimental designs found condom-use discounting is elevated in high-risk substance use populations, is sensitive to context (e.g., partner desirability), and is more robustly related to sexual risk compared with monetary discounting or condom use decisions when no delay/uncertainty was involved. Administering cocaine, alcohol, and, for some participants, methamphetamine increased condom-use discounting with minimal effect on monetary discounting or condom use when no delay/uncertainty was involved. Reviewed studies robustly support that sexual behavior is highly dependent on delay and probability discounting, and that these processes strongly contribute to sexual risk. Future research should exploit these systematic relationships to design behavioral and pharmacological approaches to decrease sexual risk behavior.

Public Health Significance
This systematic review provides a summary of research evaluating the experimental study of how delay and probability impact sexual behavior. Reviewed studies robustly support the idea that sexual decisions are highly dependent on delay and probability and that delay and probability contribute to sexual risk in general as well as among substance-using populations. Delay and probability discounting processes can be used in the design of behavioral and pharmacological approaches to decrease sexual risk behavior.

Keywords: condom, decision-making, delay discounting, HIV, STI

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HIV and other sexually transmitted infections (STIs; e.g., herpes) can have lifelong deleterious health consequences. The American health care system spends roughly 16 billion dollars annually on the diagnosis and treatment of STIs, and HIV infection alone accounts for the majority of this cost (Centers for Disease Control and Prevention [CDC], 2013; Owusu-Edusei et al., 2013). The risk of contracting HIV is markedly higher in vulnerable subpopulations compared to the general public, including men who have sex with men (MSM), women, and Black individuals (CDC, 2020). Persons who use drugs or with substance use disorder are also at higher STI risk (Celentano, Latimore, & Mehta, 2008; Feaster et al., 2016; Khan et al., 2013).

HIV is predominantly spread through sexual risk behavior (CDC, 2020; e.g., unprotected sex, multiple unknown partners). Behavior is likely the largest driver of the association between substance use and STIs. Beyond sexual risk and substance use being cross-sectionally associated, there is evidence that risk behavior increases when individuals are intoxicated or under the influence of substances (e.g., episode-level associations following alcohol or cocaine administration; Berry & Johnson, 2018; Scott-Sheldon et al., 2016). Reducing the transmission of STIs, therefore, is in large part a challenge for behavioral science.

Unwanted pregnancies are another major problem associated with sexual risk behavior. Unwanted pregnancies have been associated with life-threatening complications (Gerdts, Dobkin, Foster, & Schwarz, 2016) and can have significant deleterious effects on the mental health of the mothers relative to parents of planned children (Ali, 2016; Bahk, Yun, Kim, & Khang, 2015). Furthermore, children from unwanted pregnancies are at greater risk of developmental delay, cognitive deficits, and food insecurity (de La Rochebrochard & Joshi, 2013; Foster, Raifman, Gipson, Rocca, & Biggs, 2019; Patel & Surkan, 2016).

Aside from understanding and preventing the major societal problems of STIs and unwanted pregnancies, understanding the mechanisms underlying sexual behavior is important in its own right. Sexual behavior and sexuality are core aspects of human life. Sexuality is a central component of human culture, and norms surrounding sexual behavior are major aspects of religious and other ethical guidelines for life. Sexual behavior, temptations surrounding it, and its consequences have played important roles throughout the arts and literature. Even more broadly, sexual behavior plays an essential role in human procreation, maternity and paternity, and evolution. Sexual behavior is not surprisingly the largest domain of phenotypic behavioral difference between males and females (e.g., Hyde, 2005; Oliver & Hyde, 1993). An understanding of sexual behavior is therefore critical to an understanding of human sex and gender differences. In sum, it would be difficult to imagine a domain of behavior more critical and central to humanity than sexual behavior.

Discounting Processes

There are two fundamental features determining choice behavior that have largely been ignored in traditional sexual behavior research. These behavioral mechanisms are broadly considered *discounting* processes because they refer to environmental properties that devalue (or discount) the value of an outcome. *Delay discounting* is the effect of outcome delay on outcome devaluation (Ainslie, 1975; Mazur, 1987). *Probability discounting* is the effect of outcome uncertainty on outcome devaluation (Rachlin, Raineri, & Cross, 1991). Choice procedures, in both humans and a variety of nonhuman species, and using a variety of outcomes (e.g., different commodities; rewarding and aversive consequences) have shown delay and probability to be two fundamental properties governing the present value of an outcome (Ainslie, 1975; Bickel, Johnson, Koffarnus, MacKillop, & Murphy, 2014; Chung & Herrnstein, 1967; Green, Myerson, & Ostaszewski, 1999; Mazur, 1987; Rachlin & Green, 1972; Rachlin et al., 1991). Although delay and probability discounting are often studied using similar methods, these two processes are well established as distinct behavioral processes. This distinction is most strongly demonstrated by the observation that varying the magnitude of the outcome under evaluation has the opposite effect on delay and probability discounting, with individuals showing stronger delay discounting for smaller rewards compared to larger rewards, and showing stronger probability discounting for larger rewards than smaller rewards (Green et al., 1999).

Discounting processes have proven relevant to an understanding of problematic human behavior and, in particular, problematic substance use. Studies examining these topics in humans have predominantly used hypothetical monetary outcomes (Rachlin et al., 1991), although nonhuman discounting studies have typically used food and other primary reinforcers (e.g., Ainslie, 1975; Evenden & Ryan, 1996). Many studies have compared groups reporting substance use compared with control groups without a substance use history in their delay discounting of hypothetical money. Individuals who frequently use substances or have a substance use disorder tend to show greater delay discounting of monetary rewards when compared with controls (i.e., devalue a delayed monetary reward to a greater extent). This is true among individuals who use nicotine/tobacco, cocaine, methamphetamine, opioids, and alcohol (e.g., Baker, Johnson, & Bickel, 2003; Heil, Johnson, Higgins, & Bickel, 2006; Herrmann, Hand, Johnson, Badger, & Heil, 2014; Hoffman et al., 2006; Johnson, 2012; Johnson, Bickel, & Baker, 2007; Johnson, Johnson, Herrmann, & Sweeney, 2015; Mitchell, Fields, D'Esposito, & Boettiger, 2005; Petry, 2001). Aside from substance use, delay discounting has been studied in relation to other behaviors considered maladaptive or unhealthy such as overeating and gambling (reviewed in Bickel, Jarmolowicz, Mueller, Koffarnus, & Gatchalian, 2012, 2014).

Discounting theory is particularly well-suited for modeling temptations and the competing motivations between short- and long-term rewards through the concept of preference reversals. A preference reversal, which is related to the hyperbola-like shape of typical discounting curves, describes a situation in which an individual initially prefers a larger-later reward when both the larger-later and smaller-sooner rewards are temporally distant, but switches to a smaller-sooner reward as both options become more temporally proximal (Ainslie, 1975). For example, one might plan to exercise after work but then opt to watch TV upon arriving home. The hyperbola-like form of discounting curves can be applied to temporally distant rewards to determine the point at which an individual will switch from preferring the larger-later to smaller-sooner reward (Ainslie, 1975; Green, Fristoe, & Myerson, 1994). This application of discounting curves to preference reversals has tremendous relevance to the field of addiction as relapse can be conceptualized as choosing the short-term reinforcement of substance use despite having maintained abstinence and aspiring

toward the long-term goal of sobriety. The concept of a preference reversal can be applied to many lifestyle-related decision-making processes characterized by competition between short-term and long-term outcomes from drug use to dieting to financial planning.

The Importance of Discounting Processes in Sexual Behavior

Emerging literature suggests that greater sensitivity to individual pathology has been detected when delay discounting is assessed in clinically meaningful scenarios. That is, recent evidence has found a stronger relationship between delay discounting and clinical behavior when the discounting task evaluates clinically relevant outcomes other than money. For example, when studying eating behavior, one can assess delay discounting of choices between smaller sooner amounts of food and larger later amounts of food rather than the typical human delay discounting method which offers choices between smaller sooner and larger later amounts of money. Using methods involving clinically meaningful scenarios, one study found that participant body fat was more strongly related to delay discounting for food than to delay discounting for money (Rasmussen, Lawyer, & Reilly, 2010; see also Appelhans et al., 2011; Dong et al., 2016). Another study found scores on a compulsive hand-washing measure were more strongly related to greater discounting on a novel handwashing delay discounting task than to monetary discounting (Ong et al., 2019). Taken together, these findings suggest that the relationship between delay discounting and clinical outcomes may be strengthened when evaluating the discounting of outcomes with more relevance to the underlying health behavior (e.g., food or handwashing in the above examples).

Given this backdrop, several models of delay and probability discounting of sexual behavior have emerged. Some have examined the discounting of the occurrence of sexual behavior by assessing choices between smaller sooner durations or amounts of sexual behavior versus larger later durations or amounts of sexual activity in the case of delay discounting or between a smaller certain duration of sexual behavioral versus a larger uncertain duration of sexual behavior in the case of probability discounting (e.g., Jarmolowicz, Bickel, & Gatchalian, 2013, 2014; Lawyer, Williams, Prihodova, Rollins, & Lester, 2010). Other tasks have applied similar methods to duration of sexual-related activity such as erotica viewing (Lawyer, 2008). Yet other methods have deviated from the assessment of discounting sexual behavior itself and been geared toward assessing more clinically targeted questions, such as assessing the effect of delay on the likelihood of choosing to have immediate unprotected sex versus waiting for some delay to have sex with a condom (Johnson & Bruner, 2012), or assessing how the probability of contracting an STI affects the likelihood of choosing unprotected sex versus sex with a condom (Johnson et al., 2015). Using such tasks, a variety of studies have assessed group differences in substance use and other health behaviors, relations to monetary discounting and clinically relevant variables, and the effects of substance administration via these related, but distinct, methods.

Recent relevant reviews have described work at the intersection of discounting theory and sexual health, including impulsivity as a general framework for understanding the association of substance use and sexual risk behaviors (Leeman, Rowland, Gebru, & Potenza, 2019), micro- and macroeconomic research on STI transmission (Chesson, 2012), and the impact of drug administration on sexual health decision-making (Berry & Johnson, 2018; Scott-Sheldon et al., 2016). The purpose of this review was to evaluate the state of the literature on methods that are used to assess discounting processes in sexual decision-making, including connections to psychopharmacology and substance use. This systematic review of discounting theory in sexual health decision-making was designed to critically evaluate this broad array of laboratory methods explicitly developed to determine the involvement of delay and/or probability discounting in sexual behavior. Assessment of these discounting methods and results provides a key overview of advances made in the fields of sexual health and psychopharmacology. This assessment also emphasizes remaining gaps that future work should address to fully exploit these systematic relationships to understand human sexual behavior and approaches to decrease sexual risk.

Method

General Search Strategy

For this review we conducted a focused search within the PubMed database through December, 2019. This search was conducted in line with the guidelines for systematic reviews outlined by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; Moher et al., 2009). We took a systematic review approach rather than a meta-analytic approach because the literature reviewed entails substantial diversity that does not allow for a credible meta-analysis. This diversity includes a range of different tasks, with several of these assessing distinct phenomena (e.g., value of delayed sex; value of delayed condom use within a sexual scenario), and a range of experimental questions (e.g., correlations with a variety of self-report measures; effects of drug administration). The search used systematic search vocabulary as keywords that appeared either in the title or abstract or both. Therefore, the following search terms were used:

- "Sexual discounting"
- "Sexual delay discounting"
- "Sexual probability discounting"
- "Delay discounting AND (sexual risk behavior OR HIV risk behavior)"
- "Probability discounting AND (sexual risk behavior OR HIV risk behavior)"
- "Delay discounting AND (sexual risk behavior OR HIV risk behavior)"
- "Intertemporal choice AND (sexual risk behavior OR HIV risk behavior)"
- "Impulsivity AND (sexual risk behavior OR HIV risk behavior)"

Inclusion Criteria

For studies to qualify, the published articles were required to (a) include a study abstract, (b) be published in English, (c) be a primary peer-reviewed article, and (d) present data on sexual delay or probability discounting and/or present data on monetary delay or probability discounting and relations to sexual behavior broadly or other measures of sexual risk behavior (e.g., reported

condom use, number of sexual partners, etc.). To conduct the most inclusive review possible under the aforementioned criteria, no restrictions were placed on the domain of sexual discounting measured (e.g., the likelihood of condom use with increased delay to condom availability, number of sex acts available immediately or after a delay or probabilistically) or participant characteristics, country, or population of the study.

The authors reviewed the titles and abstracts of studies to determine initial relevance to serve the objectives of this review. For some articles, the title and abstract did not provide sufficient information to establish inclusion/exclusion, and in these cases the authors jointly reviewed and compared the study content to the inclusion criteria. In addition, the authors reviewed reference lists of included articles and drew on their knowledge of this area of discounting research for additional references not captured by the search terms. To ensure an accurate representation of the originally presented research, the terms and concepts as published in the primary articles remain in this review to the extent possible. This was a systematic review of existing literature and therefore not considered human subjects research.

Results

Summary of Overall Results

The initial search yielded 913 articles (see Figure 1). There were 186 duplicate entries across searches, therefore yielding a total of 727 unique articles for review. Fifty articles met inclusion criteria and were included for synthesis in the current review. Sixteen articles (32%) focused exclusively on the relationship between monetary delay and/or probability discounting and sexual risk behaviors. Thirty-four articles (68%) evaluated delay and/or probability discounting of sexual outcomes (e.g., duration of sexual activity, condom use during sex). An overview of these different task types is presented in Table 1. The majority of these articles evaluating sexual discounting also evaluated delay and/or probability discounting for monetary outcomes (24 of 34, or 71%).

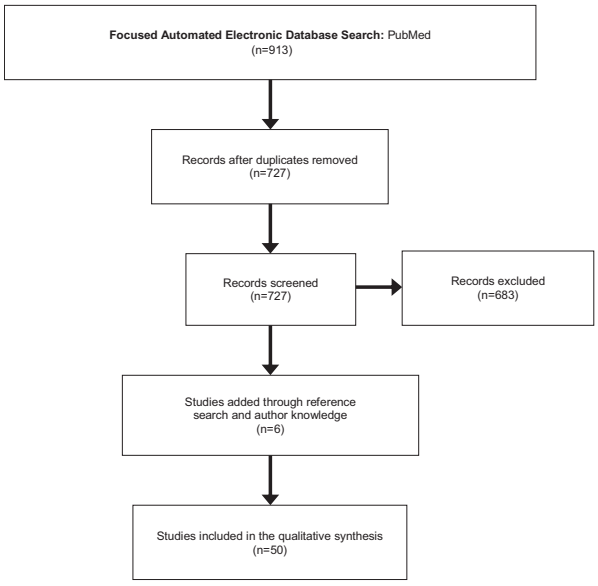

Figure 1. Flow diagram for systematic review detailing database searches, number of abstracts and full texts retrieved, number of articles excluded for failure to meet inclusion criteria, and the final number of articles included.

Monetary Discounting and Sexual Outcomes

Sixteen studies explored the association between sexual risk behavior and monetary discounting alone (see Table 2). At the broadest level, this research has evaluated whether delay or probability discounting of money is associated with measures of sexual behavior. These studies found significant associations between greater monetary delay discounting and risky sexual behaviors (e.g., early age of sexual debut, history of unprotected sex) in adolescents and young adults (Chesson et al., 2006; Kahn, Holmes, Farley, & Kim-Spoon, 2015; Khurana et al., 2012; Lawyer & Mahoney, 2018; Sparks, Isen, & Iacono, 2014). One study also found in participants recruited from a juvenile detention center that greater activation in brain regions relevant to reward during a monetary delay discounting was associated with lower levels of sexual risk behavior (Gardiner et al., 2018). A significant but small association ($r = .10$)[1] between greater delay discounting and risky sexual behaviors was also found in a very large study ($N > 40{,}000$) of the general adult population (Reimers, Maylor, Stewart, & Chater, 2009). A similar nonsignificant trend was observed in adults receiving substance abuse or other psychiatric treatment ($\beta = .19$; Black, Serowik, & Rosen, 2009). Such studies suggest a very small percentage of variance in sexual risk is accounted for by monetary delay discounting. Other studies have revealed significant relationships involving monetary delay discounting in more specialized or at-risk populations. Most notably, research in MSM has found that greater delay discounting of monetary outcomes is significantly associated with greater risky sexual behavior (e.g., $OR = 1.53$) for individuals higher on delay discounting reporting three or more past year unprotected anal intercourse partners, but that this association seems limited to young adults (18–24 years old) compared with older adults (Jones & Sullivan, 2015, 2016).

One of the few studies to evaluate both monetary reward delay and probability discounting found that while *greater* monetary delay discounting was significantly associated with more frequent sexual risk behaviors ($r = .18$), *lower* monetary probability discounting was significantly associated with more frequent sexual risk behaviors ($r = -.16$; Lawyer & Mahoney, 2018). An important clarification here is that the valences of *greater* and *lower* when comparing relationships between delay and probability discounting are superficial. These are distinct processes, and one should not assume correspondence between greater delay discounting and greater probability discounting due to the methodological term "greater discounting." Specifically, low probability discounting for a reward suggests risk taking, whereas high probability discounting for a reward suggests risk aversion. It should also be noted that lower monetary probability discounting is not

[1] Note that all correlations reported in this review have been coded such that a positive correlation represents relationships involving greater delay discounting. For example, correlations involving area under the curve have been reversed (e.g., $r = -.3$ changed to $r = .3$) reflecting that lower area under the curve values indicate greater discounting.

Table 1
Overview of Sexual Discounting Task Types

Task type	Discounted commodity	Response input	Value metric	Delayed/ Probabilistic outcome	Task manipulations[a]	Key references
			Delay discounting			
Erotica	Watching erotica	Discrete choice	Minutes watching preferred variety of erotica	Delayed longer viewing of erotica	N/A	Lawyer, 2008
Sexual duration	Preferred sexual activity	Discrete choice	Duration (minutes) of sexual activity	Delayed longer sexual activity	N/A	Lawyer, Williams, Prihodova, Rollins, & Lester, 2010
Sexual acts	Sex	Discrete choice	Number of sexual acts	Delayed greater number of sexual acts	N/A	Jarmolowicz, Bickel, & Gatchalian, 2013
Sexual quality (line)	Sex (intimate situation)	Discrete choice	Partner quality (line length)	Delayed higher quality sex	N/A	Holt, Newquist, Smits, & Tiry, 2014
Sexual quality (rank)	Sex	Discrete choice	Partner quality (rank preference)	Delayed better rank sexual partner	Condom Availability	Jarmolowicz, Lemley, Asmussen, & Reed, 2015
Condom use	Condom use in relation to casual sex	VAS	Likelihood of condom-protected sex	Delayed sex with a condom	Partner STI risk; Partner desirability	Johnson & Bruner, 2012
			Probability discounting			
Erotica	Watching erotica	Discrete choice	Minutes watching preferred variety of erotica	Probabilistic longer viewing of erotica	N/A	Lawyer, 2008
Sexual duration	Preferred sexual activity	Discrete choice	Duration (minutes) of sexual activity	Probabilistic longer sexual activity	N/A	Lawyer et al., 2010
Sexual acts	Sex	Discrete choice	Number of sexual acts	Probabilistic greater number of sexual acts	N/A	Jarmolowicz et al., 2013
Sexual quality (line)	Sex (intimate situation)	Discrete choice	Partner quality (line length)	Probabilistic higher quality sex	N/A	Holt et al., 2014
Condom use	Condom use in relation to casual sex	VAS	Likelihood of condom-protected sex	Probabilistic risk of STI	Partner STI risk; Partner desirability; STI type	Berry et al., 2019; Johnson, Johnson, Herrmann, & Sweeney, 2015

Note. VAS = visual analog scale; STI = sexually transmitted infection; N/A = not applicable.
[a] Task manipulations include manipulations, other than delay and probability manipulations, within the task itself. Other manipulations (e.g., group comparisons or drug administrations) are not included here.

Table 2
Summary of Studies Focusing on Monetary Discounting and Sexual Outcomes

Author/year	*N*	Population	Delay	Probability	Primary outcome(s)
Black, Serowik, & Rosen, 2009	51	Adults in outpatient community mental health treatment	Money	—	Trend towards an association between greater monetary delay discounting and higher sexual risk taking.
Celio et al., 2016	126	Emergency department patients	Money	—	Participants with greater monetary delay discounting showed a stronger correlation between alcohol expectancy variables (specifically, alcohol-induced sexual risk-taking and enhanced sexuality) and the percentage of recent unprotected sex events that co-occurred with alcohol use.
Cheng & Chiou, 2018	122/72	Undergraduates	Money	—	Exposure to attractive opposite-sex photos increased monetary delay discounting in male, but not female, participants. Changes in monetary delay discounting mediated increases in hypothetical cyber delinquent behavior following exposure to high valence sexual stimuli.
Chesson et al., 2006	1,042	Adolescents and young adults	Money	—	Monetary delay discounting was associated with early age of sexual debut and multiple sexual partners in the past 6 months.
Gardiner et al., 2018	177	Adolescents in a juvenile justice program	Money	—	Greater activation in brain regions relevant to reward during a monetary delay discounting was associated with lower levels of sexual risk behavior.
Jones & Sullivan, 2015	1,402	MSM	Money	—	Greater monetary delay discounting was associated with greater odds of reporting 3 or more unprotected anal intercourse partners in the past year.
Jones & Sullivan, 2016	1,332	MSM	Money	—	Greater monetary delay discounting was associated with unprotected anal intercourse, but only in men age 18–24 and not men 25 years old or older.
Kahn, Holmes, Farley, & Kim-Spoon, 2015	219	Adolescents	Money	—	Monetary delay discounting played a mediating role in the relationship between parent-adolescent relationships and risk sexual behavior for adolescents scoring low on a self-control measure.
Khurana et al., 2012	347	Adolescents	Money	—	Monetary delay discounting was associated with earlier age of sexual debut.
Lawyer & Mahoney, 2018	296	Young adults	Money	Money	Greater monetary delay discounting was associated with more frequent sexual risk behaviors, whereas lower monetary probability discounting was associated with more frequent sexual risk behaviors.
MacKillop et al., 2015	127	Emergency department patients	Money	Money	Greater monetary delay discounting was associated with a greater percentage of recent (past 90 days) unprotected sex co-occurring with alcohol use. Monetary probability discounting was not associated with unprotected sexual activity.
Negash, Sheppard, Lambert, & Fincham, 2016	123/37	Undergraduates	Money	—	Greater monetary delay discounting was significantly associated with more pornography viewing in the past 30 days. Abstinence from pornography use decreased monetary delay discounting.
Reimers, Maylor, Stewart, & Chater, 2009	42,863	Adults	Money	—	Greater monetary delay discounting was associated with earlier sexual debut.
Sparks, Isen, & Iacono, 2014	791	Adolescents	Money	—	Greater monetary delay discounting was associated with history of and past month casual sexual intercourse in adolescent sample.
Wilson & Daly, 2004	209	Undergraduates	Money	—	Viewing opposite-sex faces rated as attractive significantly increased monetary delay discounting in men, whereas a smaller and not significant increase was observed in women. No changes in monetary delay discounting were observed following viewing of opposite-sex unattractive faces.
Wray, Simons, & Maisto, 2015	113	Undergraduate (male)	Money	—	Monetary delay discounting was not significantly related to unprotected sex intentions under control conditions or following alcohol administration (target breath alcohol concentration of .08%) and autonomic arousal (recumbent bike exercise).

Note. MSM = men who have sex with men. Split sample sizes reflect sample sizes in different experiments in the reported study.

necessarily preferred clinically. For example, lower monetary probability discounting is associated with gambling including pathological gambling (Holt, Green, & Myerson, 2003; Madden, Petry, & Johnson, 2009), highlighting that lower probability discounting can imply that a person has insufficient sensitivity to risk (i.e., is a high risk-taker). That study also found that that response inhibition was not significantly associated with sexual risk-taking ($r = .04$; Lawyer & Mahoney, 2018). This outcome, combined with the distinct findings regarding delay and probability discounting, emphasizes broader concerns about the validity of an overarching construct of "impulsivity" subsuming these individual behavioral mechanisms (Strickland & Johnson, in press).

Effects of sexual arousal on monetary discounting. Three studies examined whether sexual arousal acutely affects monetary delay discounting. Wilson and Daly (2004) found that viewing opposite sex faces rated as attractive significantly increased monetary delay discounting in men (sexual orientation of participants not specified). A smaller increase in monetary delay discounting that did not reach statistical significance was observed for women. No changes were observed after viewing opposite sex faces rated as unattractive suggesting that these effects were specific to attractive (or arousing) stimuli. Negash and colleagues (2016) found that greater monetary delay discounting was significantly associated with more pornography viewing in the past 30 days ($\beta = .21$). A second experiment found that participants asked to abstain from pornography showed decreased delay discounting of monetary rewards relative to those in a control condition asked to abstain from their favorite food. Finally, Cheng and Chiou (2018) found that exposing heterosexual participants to "sexy" photos of the opposite gender led to greater monetary delay discounting in men (but not women) as well as increased rates of engaging in cyber delinquency (e.g., cyber fraud, illegal downloading, purchase counterfeit products) in a hypothetical decision-making task. This increase in cyber delinquent behavior was mediated by the delay discounting changes in men such that exposure to sexual stimuli rated as "highly sexy" increased delay discounting that then increased cyber delinquency. These data collectively suggest that stimuli associated with sexual situations and arousal may increase preferences for more immediate monetary outcomes and that these effects may be larger in men than women.

Relations between alcohol use, sex, and monetary discounting. Three studies examined the interplay of discounting processes, sexual risk behavior, and alcohol consumption. MacKillop and colleagues (2015) evaluated delay discounting, probability discounting, and sexual health in a sample of emergency department patients reporting risky alcohol use and risky sexual behaviors. This study identified a significant, small-to-moderate effect size correlation (Cohen, 1988) between monetary delay discounting and the percentage of recent (i.e., past 90 day) unprotected sex events that co-occurred with alcohol use ($r = .23$). The correlation between monetary delay discounting and absolute percentage of recent sexual events that were unprotected sex was smaller and not statistically significant ($r = .12$), and monetary probability discounting was not significantly correlated with either unprotected sex variable (r values $< .07$). Celio and colleagues (2016) evaluated this same sample, but determined the role of delay discounting in moderating the relationship between alcohol expectancy and alcohol-related condomless sex. Alcohol expectancy, which is the degree that a person believes alcohol will affect her/his sexual behavior, is significantly associated with drinking in sexual situations, and is significantly associated with engagement in sexual behavior after drinking (e.g., Bryan, Ray, & Cooper, 2007; Dermen, Cooper, & Agocha, 1998). Celio and colleagues (2016) found that individuals with greater monetary delay discounting showed a stronger correlation between alcohol expectancy variables (specifically, alcohol-induced sexual risk-taking and enhanced sexuality) and the percentage of recent unprotected sex events that co-occurred with alcohol use. Importantly, these effects were not observed when evaluating the absolute frequency of recent unprotected sex events that co-occurred with alcohol use, only the percentage of total events.

Finally, one study in undergraduate students found that monetary delay discounting was not significantly related to unprotected sex intentions under control conditions or following alcohol administration (target BAC of .08%) and autonomic arousal (recumbent bike exercise; Wray, Simons, & Maisto, 2015). This study, however, used the experiential discounting task (EDT; Reynolds & Schiffbauer, 2004; Reynolds, Richards, & de Wit, 2006), in which outcomes are both delayed and probabilistic as opposed to just delayed. Adding uncertainty to a delayed outcome can significantly impact delay discounting (e.g., Vanderveldt, Green, & Myerson, 2015), which may be why the results from Wray and colleagues (2015) differ from other studies reviewed above finding a role, albeit modest, for monetary delay discounting in general sexual intention and alcohol-relevant sexual intention.

Summary of studies on relations between monetary discounting and sexual outcomes. Research on monetary discounting processes and sexual outcomes has examined the relationship between monetary discounting outcomes and general sexual health, the impact of sexual arousal manipulations on discounting, and the specific role of alcohol use as it relates to monetary delay discounting. These studies have revealed a generally consistent but small effect size relationship for risky sexual behaviors with greater monetary delay discounting, in agreement with the broader literature evaluating monetary delay discounting and other health behaviors (Amlung, Vedelago, Acker, Balodis, & MacKillop, 2017; MacKillop et al., 2011). State-level changes in monetary delay discounting also appear sensitive to sexual arousal manipulations, perhaps more so for men than women. Notably, studies involving probability discounting have shown null effects (MacKillop et al., 2015) or associations between risky sexual behavior and decreased monetary probability discounting (Lawyer & Mahoney, 2018).

Discounting of "Pure" Sexual Outcomes

Discounting of delayed and probabilistic monetary rewards provides a useful behavioral index of decision-making as most people can easily relate to and conceptualize monetary outcomes. Further, money's divisibility provides an ecologically valid way to assess reductions in value (e.g., a delayed $100 can be compared with any smaller amount of immediate money). As such, determining relations between discounting of monetary outcomes and risky sexual behaviors can inform generalized trait-like decision-making processes that might underlie clinically relevant sexual risk behavior.

Although receipt of money is the most-common outcome examined with regard to discounting processes in humans, a growing body of literature indicates that discounting processes differ de-

pending on the outcome being discounted. For example, greater discounting of food, but not money, is significantly associated with greater percent body fat and body mass index (Hendrickson, Rasmussen, & Lawyer, 2015; Rasmussen et al., 2010; Schiff et al., 2016). Similarly, greater discounting of cannabis, but not money, is significantly associated with cannabis dependence severity (Strickland, Lile, et al., 2017). This specificity of discounting relationships with relevant outcomes is even evident with different forms of money, as shown in one study suggesting that delay discounting for Polish currency, but not United States currency, was increased by Polish economic inflation (Ostaszewski, Green, & Myerson, 1998). Such outcome-specific discounting is important because it suggests that greater clinical relevance may be offered when examining discounting of clinically relevant outcomes for the problematic behavior of interest (Odum et al., 2020).

Researchers interested in the role of discounting on sexual behaviors, such as STI risk, have developed discounting procedures using various sex-specific outcomes in hypothetical decision-making methods. Hypothetical decisions have a long history in discounting research, with many studies suggesting that hypothetical monetary outcomes serve as reasonable proxies for real rewards (e.g., Baker et al., 2003; Johnson, 2012; Johnson & Bickel, 2002; Johnson et al., 2007; Lagorio & Madden, 2005; Madden, Begotka, Raiff, & Kastern, 2003, 2004). Discounting processes, including delay and probability discounting, that use hypothetical sexual outcomes have come to be referred to as "sexual discounting." Several different approaches have been used to evaluate sexual discounting. We refer to "pure" sexual discounting tasks as those that evaluate sexual activity itself. These variations closely mirror monetary discounting procedures, wherein a particular sexual outcome (defined by duration, number of events, or quality) is available after a delay (or with a certain probability of occurrence) and another sexual outcome (of lesser duration, number of events, or quality that is adjusted across trials) is available immediately or with certainty. The term "pure" is used because these tasks evaluate the effect of delay or probability of the sexual behavior on the value of sexual behavior itself, in contrast to tasks described later that examine the effect delay or probability of some aspect of the situation relevant to sexual behavior. A total of 11 published articles using pure discounting approaches to sexual behavior were identified (see Table 3).

Discounting of erotica. The earliest evaluation of discounting of a sexually related outcome assessed delay and probability discounting of erotica in undergraduate erotica users and nonusers using hypothetical erotic outcomes (Lawyer, 2008). The study included a delay discounting of erotica task which involved choices between 10 min of watching the participant's favorite variety of erotica after a delay or a shorter duration of watching erotica immediately. In a probability discounting version, participants made choices between 10 min of watching erotica at a less-than-certain probability or a guaranteed shorter duration. Like discounting for other outcomes, choice for the longer duration of erotica access decreased as a function of increased delay or reduced-probability, with the median subjective value of erotica viewing decreasing to approximately 20% or less of its immediate subjective value at the longest delays and lowest probabilities (i.e., highest odds against). Moreover, the decrease in value of the longer duration outcomes was well-described by a hyperbola-like curve for both delay and probability tasks in the erotica users.[2] Relative to nonusers, erotica users exhibited greater discounting for delayed, but not probabilistic, monetary outcomes and both delayed and probabilistic erotica access. Perhaps most importantly, greater delay discounting of erotica, but not money, was significantly associated with higher scores on the sexual compulsivity scale ($r = .41$), and, unexpectedly, lower scores on the sexual opinion survey ($r = -.38$; lower scores indicating a decreased affinity for sexual stimuli).

Expanding on this analysis of hypothetical erotica access, Girard and colleagues (2019) evaluated choices between more immediate access to shorter (1 s) or delayed access to longer (3 s) actual erotic images in an fMRI scanner in male patients with Parkinson's disease. Surprisingly, in contrast to the aforementioned study evaluating hypothetical erotica, patients with co-occurring hypersexual symptoms were willing to wait for longer access to erotic images (i.e., lower delay discounting) than patients without hypersexual symptoms or healthy controls. Notably, differences between Parkinson's patients with and without hypersexuality only emerged when patients were on levodopa medication, but not when tested off of their medication, suggesting a complex role for dopamine in these effects.

Discounting of sexual activity using sexual duration as metric of value. Similar methods as erotica tasks have been used to investigate discounting of sexual activity (e.g., Lawyer & Schoepflin, 2013; Lawyer et al., 2010; Mahoney & Lawyer, 2018). The first of these studies evaluated undergraduate students using delay and probability discounting tasks for the duration of sexual activity (Lawyer et al., 2010). In the delay version, participants made choices between a longer duration of a sex act (defined as any sex act preferred by the participant) after a delay, or a shorter duration immediately (e.g., 10 min of sexual activity in 1 week vs. 3 min now). In the probability discounting version, participants made choices between a specific probability of engaging in a longer duration of a sex act, or a guaranteed shorter duration (e.g., 50% chance of 10 min of sexual activity vs. 2 min of sexual activity for sure). Like the erotica discounting task, the effect of the delay and probability manipulations in this study were large such that the median subjective value of a sexual act decreased to approximately 20% or less of its immediate subjective value at the highest delays and lowest probabilities. Further, sexual delay and probability discounting were well-described by a hyperbola-like model. Follow-up studies have found that, for both delay and probabilistic discounting, discounting was significantly positively correlated between monetary and sexual outcomes, with effect sizes spanning medium to the lower end of the large effect range (Lawyer & Schoepflin, 2013; Mahoney & Lawyer, 2018).

Evaluation of the correlation between discounting and sexual health variables for both sexual and monetary outcomes, however, further emphasizes the benefits of evaluating domain-specific outcomes over more general monetary outcomes. One study found that greater delay ($\beta = .24$) and probability discounting ($\beta = .27$) of sexual outcomes, but not monetary outcomes (β values = .15-.17), were significantly related to greater self-reported sexual

[2] In probability discounting tasks, assessment of function shape is performed after probabilities are transformed to odds against. Fits for discounting of erotica outcomes were generally poorer for individuals in the nonuser group, which would be expected based on the relative lack of erotica use for these participants.

Table 3
Summary of Studies on Discounting of "Pure" Sexual Outcomes

Author/year	*N*	Population	Delay	Probability	Primary outcome(s)
Carrier Emond, Gagnon, Nolet, Cyr, & Rouleau, 2018	98	Undergraduate (male)	Sexual duration; money	—	Greater delay discounting was observed for sexual than monetary outcomes and this difference was greater for individuals with a history of engaging in sexual coercion (e.g., verbal pressure, physical force).
Girard et al., 2019	41	Parkinson's patients and controls	Erotica	—	Parkinson's patients showed lower erotica delay discounting than patients without hypersexual symptoms or healthy controls.
Holt et al., 2014	51	Undergraduate	Sexual quality; food; money	Sexual quality; food; money	Money was discounted by delay to a lesser degree than sex, and food was discounted by delay more than sex or money. However, with probability discounting, significantly greater discounting for food and money was observed relative to sex.
Jarmolowicz et al., 2013	41	*DSM–IV* alcohol dependence and controls	Sexual acts; money	—	The alcohol-dependent group reported greater delay discounting of sexual acts than the control group.
Jarmolowicz et al., 2014	36	*DSM–IV* cocaine dependence	Sexual acts; money	—	Monetary outcomes were discounted less by delay than sexual acts. This difference was only significant for men and not statistically significant in the total sample. In cross-outcome tasks, monetary outcomes were preferred as evidenced by minimal discounting in the sex-now/money-later task and extreme delay discounting in the money-now/sex-later task.
Jarmolowicz et al., 2015	66	Undergraduate	Sexual quality; money	—	Greater delay discounting for sexual quality outcomes significantly correlated with a greater number of lifetime sexual partners, a greater number of vaginal intercourse partners, and an earlier age of first oral sex.
Lawyer & Schoepflin, 2013	103	Undergraduate	Sexual duration; money	Sexual duration; money	Greater delay and probability discounting of sexual duration, but not monetary outcomes, were significantly related to greater self-reported sexual excitation.
Lawyer et al., 2010	89	Undergraduate	Sexual duration; money	Sexual duration; money	Sexual delay and probability discounting were well-described by a hyperbola-like model.
Lawyer, 2008	71	Undergraduate	Erotica; money	Erotica; money	Erotica users exhibited greater discounting for delayed, but not probabilistic, monetary outcomes and both delayed and probabilistic erotica access.
Lemley, Jarmolowicz, Parkhurst, & Celio, 2018	48	Undergraduate (female)	Sexual quality; money	Sexual quality	Greater delay discounting of sexual activity quality was observed under conditions in which a condom was available relative to when no condom was available. This pattern was limited to women with a history of fewer than 4 sexual partners. Probability discounting of sexual partner quality did not significantly differ by condom-availability or sexual history.
Mahoney & Lawyer, 2018	105	Undergraduate	Sexual duration; money	Sexual duration; money	Greater discounting of delayed sexual outcomes, but not monetary outcomes, was significantly related to lower scores on a physical pleasure subscale of the Delaying Gratification Inventory. Probability discounting of sexual or monetary outcomes were not related to the physical pleasure subscale of the Delaying Gratification Inventory.

excitation even after controlling for participant gender (Lawyer & Schoepflin, 2013). Similarly, greater discounting of delayed sexual outcomes ($r = -.24$), but not monetary outcomes ($r = -.13$), was significantly related to lower scores on a physical pleasure subscale of the Delaying Gratification Inventory (i.e., scores that indicate decreased ability to delay physical pleasure gratifications; Mahoney & Lawyer, 2018). Notably, neither probability discounting for sexual ($r = -.05$) or monetary ($r = -.12$) outcomes were significantly related to this physical pleasure subscale indicating specificity to this outcome measure of delayed gratification of sexual activity.

Another study evaluated the relationship between delay discounting and past use of sexual coercion in male undergraduates using this sexual duration method (Carrier Emond, Gagnon, Nolet, Cyr, & Rouleau, 2018). Unadjusted models indicated that participants showed greater delay discounting for sexual than monetary outcomes, but that this difference was greater for individuals with a history of engaging in sexual coercion (e.g., verbal pressure, physical force; $d_z = 1.06$ vs. 0.51). In adjusted models including personality and delay discounting measures, increased delay discounting of sex was significantly associated with perpetration of sexual coercion while decreased delay discounting of money was significantly associated with perpetration of sexual coercion. This bidirectional effect is supportive of domain specificity and suggests that discounting procedures may be useful for helping to predict potential susceptibility to sexual violence against others in addition to personal sexual risk (although replications of these findings in alternative settings and populations are certainly needed given the gravity of sexual violence outcomes). Interestingly, another study by this research group found that an inhibitory control task involving sexual and nonsexual stimuli failed to distinguish men with and without a history of sexual coercion (Carrier Emond, Nolet, Rochat, Rouleau, & Gagnon, 2020). This finding highlights that the predictive power of outcome-specific delay discounting to relate to clinically meaningful real-world behavior may not generalize to other processes sometimes considered "impulsivity." These results also highlight the argument against the overall validity of an overarching construct of impulsivity (Strickland & Johnson, in press).

Discounting of sex using number of sex acts as a metric of value. Another method for evaluating sexual activity in pure sexual discounting tasks is to manipulate the number of separate sexual acts rather than the duration of the sexual act (e.g., Jarmolowicz et al., 2013, 2014). This method addresses some of the limitations in duration variations insofar as the duration presented experimentally might be either shorter or longer than an individual's preferred duration of sexual activity. These sexual act tasks also require participants to indicate the number of sex acts they would consider equivalent to receiving $1,000 so that the value of the larger number of sex acts is roughly equalized across participants. Like traditional monetary discounting tasks, the $1,000 equivalency of sexual activity is presented after a delay or at some degree of uncertainty, whereas an adjusting, smaller number of sex acts is available immediately or guaranteed. For example, a question might ask a participant to choose between eight sexual acts after a month delay versus four sexual acts immediately or eight sexual acts with 50% certainty versus four sexual acts with 100% certainty (guaranteed).

An initial evaluation of this task compared delay discounting for sex and money in participants meeting criteria for *Diagnostic and Statistical Manual of Mental Disorders*, fourth edition (*DSM–IV*) alcohol dependence and healthy control participants (Jarmolowicz et al., 2013). Consistent with other tasks reviewed above, delay significantly reduced the median value of sexual behavior, with the longest delay causing sex to be valued at approximately 20% or less of its immediate subjective value for both alcohol-dependent and control groups. Moreover, as in the previous sexual discounting studies, discounting was well-described by a hyperbola-like fit. In both groups, sex was discounted to a greater extent than money, and the alcohol-dependent group reported greater delay discounting of sex than the control group.

Outcome-specific discounting was further investigated using this procedure in participants meeting criteria for *DSM–IV* cocaine dependence by comparing sexual and monetary delay discounting alone or in cross-outcome tasks (i.e., sex now or money later and vice versa; Jarmolowicz et al., 2014). In the single-outcome tasks, monetary outcomes were discounted less than sexual outcomes (although this difference was only significant for men and not statistically significant in the total sample). In the cross-outcome tasks, the monetary outcomes were preferred as evidenced by minimal discounting in the sex-now/money-later task and extreme delay discounting in the money-now/sex-later task. Although not compared with sex-specific outcome measures or scales as in the sexual duration task, these studies further demonstrate that the value of a sexual activity is discounted by delay as well as the sensitivity of this discounting to individual differences in substance use history.

Discounting of sexual experience using quality as a metric of value. Another method of pure sexual discounting determines the value of delayed or probabilistic sexual behavior by manipulating the quality of sexual behavior rather than quantity (Holt, Newquist, Smits, & Tiry, 2014; Jarmolowicz et al., 2015; Lemley, Jarmolowicz, Parkhurst, & Celio, 2018). One of these variations uses a visual approach wherein the length of a line is analogous to differences in quality relative to an "ideal" sexual experience (Holt et al., 2014). Undergraduate participants in the only study to use this task completed monetary, sex, and food variations. This sample completed each task involving choices between a full-length line representing an "ideal" outcome after a delay (or at a certain probability for a probability discounting version) and a shorter line representing an outcome of diminished-quality relative to the "ideal" available immediately (or for certain). Like other sexual discounting studies, delay and uncertainty of sexual behavior caused substantial decreases in the value of sexual behavior (~40% of its immediate subjective value at the maximum delay or lowest probability), and these reductions in value were relatively well-characterized by a hyperbola-like fit. When the "ideal" outcome was assessed in the delay discounting tasks, money was discounted to a lesser degree than sex, and food was discounted more than sex or money. For probability discounting, significantly greater discounting for food and money was observed relative to sex. The magnitude of correlations between discounting for sex and discounting for food or money was generally medium to large in effect size ($r = .41$ to .65), indicating some relationship within delay discounting processes in general. For probability discounting, correlations between discounting for sex and discounting for

food or money were small and not statistically significant ($r = -.06$ to .15).

Other manipulations of quality as a method for quantifying the devaluation of sexual behavior have represented quality as choices between different qualitatively ranked partners (Jarmolowicz, Lemley, Asmussen, & Reed, 2015; Lemley et al., 2018). Participants in this task variation first select partners they would be willing to have sex with from a series of photographs and then rank the partners in order from their most-preferred to least-preferred sexual partner. Participants then are required to make choices between having sex with the most-preferred partner after a delay (or at a certain probability in the probability discounting version) and having immediate (or certain) sex with a less-preferred partner. Implementations of this task have reported a modest, but clear and systematic decrease in the median value of sexual behavior with discounting of sexual partners well-described by a hyperbola-like curve (Jarmolowicz et al., 2015; Lemley et al., 2018). The initial study using this task was conducted with male and female undergraduate students and found that delay discounting measures were related to sexual health variables in the overall sample (Jarmolowicz et al., 2015). These associations included greater delay discounting significantly correlated with a greater number of lifetime sexual partners ($r = .31$), a greater number of vaginal intercourse partners ($r = .35$), and an earlier age of first oral sex ($r = -.42$). Robust sex differences were also observed reflecting greater delay discounting of sexual partners for men than women.

A second study with undergraduate women used a similar task to evaluate delay and probability discounting of preferred sexual partners in the context of condom availability (Lemley et al., 2018). Participants showed greater delay discounting under conditions in which a condom was available relative to when no condom was available; however, this pattern of effect was limited to women with a history of fewer than four sexual partners. Probability discounting of sexual partners did not significantly differ as a result of condom-availability or sexual history. Delay discounting of sexual partners under the no condom conditions was correlated with recent sexual health risk behaviors (e.g., sex with a partner not trusted variable; $r = .32$) and lifetime sexual partners ($r = .35$). Probability discounting of sexual partners under the no condom conditions was also correlated with recent sexual health risk behaviors, notably behaviors relevant to risk including vaginal sex without birth control ($r = .38$) and sex under influence of substances ($r = .32$). Although these studies did not directly compare monetary discounting with sexual risk measures or against sexual discounting, the medium effect size correlations described above between sexual discounting and risky sexual behaviors further emphasize the benefits of evaluating domain-specific outcomes relevant to sexual health.

Summary of discounting of "pure" sexual outcomes. All of these pure sexual discounting tasks have provided valuable information regarding the effects of delay and probability on the value of sexual behavior. Like discounting for monetary outcomes in humans and the discounting of primary reinforcers in nonhumans and humans (Green, Myerson, & Calvert, 2010; Jimura, Myerson, Hilgard, Braver, & Green, 2009; Mazur, 1987; Rachlin et al., 1991), orderly reductions in indifference points occur as a function of increasing delay or reducing probability, and the indifference points are well-described by a hyperbola-like curve. Despite the wide variation in methods, results from sexual discounting tasks replicate a common pattern of discounting that has been found across multiple species and commodities. This finding provides robust support for the conclusion that these tasks detect delay and probability discounting processes that play a powerful role in affecting sexual behavior, despite using hypothetical outcomes and differing methods for manipulating the value of sexual activity. Furthermore, these tasks significantly correlate with sex-specific outcomes (e.g., Jarmolowicz et al., 2015; Lemley et al., 2018) even when money does not (e.g., Lawyer, 2008; Lawyer & Schoepflin, 2013; Mahoney & Lawyer, 2018). And, although monetary and sexual discounting are generally well-correlated, sexual outcomes in these tasks are discounted to a greater degree than money in a way that is broadly consistent with results observed for other "consumable" commodities like food (e.g., Odum, Baumann, & Rimington, 2006) or drugs (e.g., Petry, 2001). These findings collectively suggest that domain-specific differences in task outcomes may improve domain-specific health predictions relevant to sexual health decision-making.

Discounting of Condom Use

A total of 23 published reports examined the effects of delay and/or probability discounting in regard to condom use within sexual scenarios (see Table 4). The first of these tasks (i.e., the Sexual Delay Discounting Task) was designed to examine the role of delay on clinically relevant choices regarding condom use during sex (Johnson & Bruner, 2012). Participants are asked to pretend that they are not currently in a committed relationship and that there is no chance of pregnancy in the hypothetical sexual scenarios. Each participant then views 60 photographed individuals (30 men and 30 women) and selects those with whom they would consider having casual sex. The participant can select any number of photos and can select from both the men and women. From this subset of selected photographs, the participant then chooses four individuals: the individual whom they most want to have sex with, least want to have sex with, is judged as least likely to have an STI, and judged as most likely to have an STI. For each of these four partners, the participant then uses a visual analog scale (VAS; from 0% to 100%) to rate their likelihood of (a) having unprotected sex immediately versus having condom-protected sex immediately (in a 0-delay trial) and (b) having unprotected sex immediately versus waiting for a series of specified delays (e.g., 1 h, 3 h, 6 h, 1 day, 1 week, 1 month, and 3 months)[3] to have condom-protected sex. The relative difference between a participant's 0-delay trial likelihood value and the value for a given delay trial indicates the degree to which they discounted the value of condom-protected sex as a function of that delay. That is, the value at each delay is "standardized" by dividing it by the 0-delay trial value and multiplying by 100. Thus, the 0-delay value provides a proxy of the reinforcing value of condom use, and the standardized values at various delays reflect the isolated effect of delay on the reinforcing value of condom use. This allows the researcher to determine whether between-subjects comparisons or within-subject manipulations have effects on the

[3] Later studies have used alternative delay sequences with a shorter temporal scope to similar success (e.g., Johnson et al., 2017).

Table 4
Summary of Studies on the Discounting of Condom Use

Author/year	N	Population	Delay	Probability	Primary outcome(s)
Berry et al., 2019	262	Undergraduates	—	Condom use	Probability discounting of condom use was related to STI type with the least discounting in an HIV/AIDS condition.
Berry et al., in press	19	Recreational stimulant use	Condom use; money	—	Methamphetamine did not produce overall changes in delay discounting for condom use or money. Greater increases in sexual arousal following methamphetamine administration were correlated with greater delay discounting for condom use as well as monetary outcomes.
Bolin et al., 2016	9	*DSM–IV* cocaine use disorder	Condom use	—	Maintenance (3 or more days) on buspirone did not alter delay discounting for condom use. Buspirone did increase condom use likelihood at 0-delay.
Collado, Johnson, Loya, Johnson, & Yi, 2017	260	Undergraduates	Condom use	—	Greater sexual risk behavior was significantly related to greater delay discounting for condom use, but not with likelihood of condom use at 0-delay.
Dariotis & Johnson, 2015	126	Young adults	Condom use	—	Greater delay discounting for condom use was related to more lifetime risky sexual partners. Greater delay discounting was also observed in the partners judged to be least (versus most) likely to have an STI and most (versus least) desirable.
Hahn et al., 2019	243	MSM and heterosexual men	Condom use	—	Delay discounting for condom use with a casual sexual partner did not differ between MSM and heterosexual men. Greater delay discounting for condom use with a committed partner was observed among MSM compared to heterosexual men.
Herrmann, Hand, Johnson, Badger, & Heil, 2014	60	*DSM–IV* opioid dependence and controls (female)	Condom use; money	—	Women with opioid dependence showed greater delay discounting of condom use than controls. No significant differences were observed on 0-delay trials.
Herrmann, Johnson, & Johnson, 2015	108	MSM	Condom use	—	Greater delay discounting of condom use among participants reporting unprotected anal intercourse with a male partner in the previous 6 months (both in general and because a condom was not available)
Johnson & Bruner, 2012	62	*DSM–IV* cocaine dependence	Condom use; money	—	Delay discounting of condom use was significantly greater for the "most want to have sex with" (versus "least want to have sex with") and the "least likely to have STI" (versus "most likely to have STI") partners. Greater delay discounting for condom use was significantly correlated with greater sexual risk, whereas, monetary delay discounting was not significantly correlated.
Johnson & Bruner, 2013	31	*DSM–IV* cocaine dependence	Condom use; money	—	The Sexual Delay Discounting Task was stable with evidence of statistical equivalence over a 7-day test interval and good-to-excellent test-retest reliability across the four partner conditions (r_{xx} = .62 to .82). Men generally discounted significantly more than women for condom use but not money.
Johnson et al., 2015	47	*DSM–IV* cocaine use disorder and controls	Condom use; money	Condom use; money	Delay discounting of condom use and money was greater in the cocaine use disorder group than controls. Probability discounting of condom use or money did not differ between those without and without cocaine use disorder. Sexual and monetary discounting were not related.
Johnson, Sweeney, Herrmann, & Johnson, 2016	23	Nondependent alcohol use	Condom use; money	Condom use; money	Alcohol administration (1 g/kg) increased delayed and probability discounting of condom use, but did not alter responding at 0-delay or 0-odds-against. Alcohol administration did not change delay discounting for monetary outcomes, but decreased discounting of probabilistic monetary outcomes.
Johnson, Herrmann, Sweeney, LeComte, & Johnson, 2017	12	*DSM–IV* cocaine use disorder	Condom use; money	Condom use; money	Cocaine dose-dependently increased delay and probability discounting of condom use. No differences were observed on 0-delay or 0-odds-against or for delay or probability discounting of money.

(*table continues*)

Table 4 (*continued*)

Author/year	N	Population	Delay	Probability	Primary outcome(s)
Johnson, Bruner, Johnson, Silverman, & Berry, 2020	39	Treatment-seeking for *DSM–IV* cocaine dependence	Condom use; money	Condom use; money	3 weeks of d-cycloserine maintenance did not alter delay or probability discounting for monetary or condom use outcomes.
Jones et al., 2018b	1,012	MSM	Condom use; money	—	Delay discounting for money and for condom use outcomes were not significantly related.
Jones et al., 2018a	1,012	MSM	Condom use; money	—	Greater delay discounting of condom use, but not money, was associated with condomless anal intercourse in the past year.
Koffarnus et al., 2016	162	*DSM–IV* cocaine dependence, recreational cocaine use, and control	Condom use	—	Higher condom use likelihoods were observed at a 0-delay in a control group compared to individuals reporting recreational cocaine use (and a trend compared to those with cocaine dependence). Both cocaine groups showed greater delay discounting of condom use compared to the control group.
Meredith et al., 2016	874	Young adults	Condom use; money	—	Weekly energy drink use was not associated with delay discounting of condom use, but was related to lower likelihood of condom use when immediately available.
Quisenberry et al., 2016	408	Adults	Condom use; money	—	Lower delay discounting for condom use for all partner types was observed when tasks were completed with a negative consequence health outcome scenario involving regret. Lower delay discounting was also observed for the least attractive and highest STI risk partner under negative health consequence conditions without regret.
Strickland, Bolin, Romanelli, Rush, & Stoops, 2017	11	*DSM–IV* cocaine use disorder	Condom use	—	Acute buspirone or triazolam did not alter delay discounting for condom use.
Sweeney et al., 2020	767/267	Adults	Condom use; money	—	Greater delay discounting for condom use was related to greater sexual risk behaviors as well as greater likelihoods of self-reported unprotected sex because a condom was not immediately available.
Thamotharan, Hahn, & Fields, 2017	155	Adolescents and young adults	Condom use; money	—	Alcohol, cigarette, and cannabis use status among adolescents and young adults was correlated with greater delay discounting of condom use.
Wongsomboon & Robles, 2017	75	Undergraduates	Condom use	Condom use	Delay and probability systematically impacted discounting of condom use. Discounting was greater for partners rated higher on desirability and lower on STI risk.

Note. MSM = men who have sex with men; STI = sexually transmitted infection. Split sample sizes reflect sample sizes in different experiments in the reported study.

value of condom use regardless of delay and the delay discounting of condom use.

Development of and preliminary studies with the sexual delay discounting task. The first studies administered the Sexual Delay Discounting Task along with a monetary delay discounting task and the HIV Risk-Taking Behavior Scale (Darke, Hall, Heather, Ward, & Wodak, 1991) to participants with *DSM–IV* cocaine dependence (Johnson & Bruner, 2012, 2013). Johnson and Bruner (2012) found that participants strongly discounted the value of condom-protected sex. At the longest delays, the median likelihood of condom use decreased to less than 50% of initial values (i.e., values from the 0-delay trials) in the "most want to have sex with" and "least likely to have STI" partners. Moreover, the median decrease in condom use likelihood was orderly and well-fit by a hyperbola-like function. Discounting was significantly greater for the "most want to have sex with" (vs. "least want to have sex with") and the "least likely to have STI" (vs. "most likely to have STI") partner conditions, demonstrating sensitivity to partner characteristics associated with desirability and perceived risk (Johnson & Bruner, 2012).

Analyses examining relations among measures indicated that responses on the Sexual Delay Discounting Task were significantly correlated only with delay discounting of money for the "most likely to have an STI" partner condition ($r = .33$; $r = .08$ to .15 for other partner conditions). For three of the four partner conditions (all but "most want to have sex with"), greater delay discounting for condoms was significantly correlated with greater sexual risk on the HIV Risk-Taking Behavior Scale sexual risk subscale (r values = .25 to .27). In contrast, monetary delay discounting was not significantly correlated with the HIV Risk-Taking Behavior Scale sexual risk subscale ($r = .16$). Importantly, these findings remained robust after controlling for differences in condom use likelihood when no delays were involved (0-delay trials) which isolates sensitivity to delay as the driving factor in likelihood of condom use.

In the second study in this series, Johnson and Bruner (2013) built on their earlier findings by examining sex differences (women vs. men) on responding in the Sexual Delay Discounting Task, and by examining test–retest reliability over two assessments conducted approximately 7 days apart. In addition to replicating earlier findings regarding the orderliness and sensitivity to partner characteristics, women discounted the value of condom-protected sex less than men. Performance on the Sexual Delay Discounting Task was also stable with evidence of statistical equivalence over the 7-day test interval and good-to-excellent test–retest reliability across the four partner conditions ($r_{xx} = .62$ to .82).

The results of these first two studies demonstrate that the Sexual Delay Discounting Task is a valid and reliable measure that captures the effect of delay on ecologically valid and clinically relevant choices about sex and condom use. These two seminal studies prompted additional research using the Sexual Delay Discounting Task that has extended these findings significantly, including the use of a probability discounting variant (i.e., the Sexual Probability Discounting Task). For the purpose of this review, these subsequent studies are grouped into three categories: (a) studies evaluating the generalizability to other general and at-risk populations, (b) studies comparing responding based on a history of high-risk substance use, and (c) studies examining the effects of controlled drug administration on responding in the Sexual Delay Discounting Task.

Studies evaluating generalizability to general and at-risk populations. The preliminary studies evaluating condom use as a discounted commodity revealed substantial effects on condom use decisions. However, the generalizability of these preliminary findings was limited because they focused on a single at-risk population (persons with cocaine use disorder) and on participants who were willing, and able, to participate via in-person, human, laboratory studies involving sensitive subject matter. Further, given that more than two thirds of all sexually transmitted HIV infections are attributable to male–male sexual contact (CDC, 2019), a second major limitation was that the majority of male participants in those studies identified as heterosexual and/or reported exclusively female sexual partners.

Several studies have directly addressed these limitations by collecting data from broader populations of youth or young adults (Berry et al., 2019; Collado, Johnson, Loya, Johnson, & Yi, 2017; Dariotis & Johnson, 2015; Meredith, Sweeney, Johnson, Johnson, & Griffiths, 2016; Thamotharan, Hahn, & Fields, 2017; Wongsomboon & Robles, 2017) and MSM (Hahn et al., 2019; Herrmann, Johnson, & Johnson, 2015; Jones et al., 2018a, 2018b). Other studies have used crowdsourcing methods to evaluate these discounting processes in more general populations of U.S. adults (Quisenberry et al., 2016; Sweeney et al., 2020). Participants in these studies were recruited from undergraduate courses (Berry et al., 2019; Collado et al., 2017; Thamotharan et al., 2017; Wongsomboon & Robles, 2017), the community (Dariotis & Johnson, 2015; Thamotharan et al., 2017), and via online crowdsourcing (Herrmann et al., 2015; Meredith et al., 2016; Quisenberry et al., 2016; Sweeney et al., 2020) or social media (Jones et al., 2018a, 2018b) websites. Nine of these studies used the Sexual Delay Discounting Task (Collado et al., 2017; Dariotis & Johnson, 2015; Herrmann et al., 2015; Jones et al., 2018a, 2018b; Meredith et al., 2016; Quisenberry et al., 2016; Sweeney et al., 2020; Thamotharan et al., 2017), and two used a Sexual Probability Discounting Task (Berry et al., 2019; Wongsomboon & Robles, 2017). All nine Sexual Delay Discounting Task studies examined the four partner conditions described previously, and Berry and colleagues (2019) used a version of the Sexual Probability Discounting Task that examined four different STI risk scenarios (chlamydia, genital herpes, HIV, or an unspecified STI). One study used a variation of the Sexual Probability Discounting Task in which the probability of sex itself (for the protected-sex option) was manipulated, not the probability of STI contraction (Wongsomboon & Robles, 2017). Six of these studies also included measures of monetary delay discounting (Jones et al., 2018a, 2018b; Meredith et al., 2016; Quisenberry et al., 2016; Sweeney et al., 2020; Thamotharan et al., 2017).

Synthesizing the results from these 12 studies reveals several major findings. First, all 12 demonstrated that participants discounted the value of condom-protected sex as a function of delay to availability (Delay Discounting Tasks) and/or likelihood of STI infection (Probability Discounting Tasks). Although variations are observed across task implementations (e.g., in the nature of the hypothetical partner), these findings are consistent with other sexual discounting tasks insofar as the likelihood of condom use decreased to less than 50% of initial values at the longest delays and lowest probabilities. This consistent observation suggests that

the overall finding regarding the discounting of sexual activity can generalize to discounting of condom use and to broad populations such as youth and young adults in student, general populations, and MSM (i.e., the group most severely affected by HIV and other STIs relative to any other group in the United States; CDC, 2019).

Second, the majority of studies examining relations between choices on the Sexual Delay Discounting Task and real-world sexual HIV risk behavior found significant associations in at least some partner conditions between the discounting and sexual risk measures. A particularly compelling demonstration that delay discounting occurs in real-world sexual risk behavior comes from one study evaluating MSM (Herrmann et al., 2015). This study found that 24% of the sample reported unprotected anal intercourse with a male partner in the previous 6 months because they did not have a condom immediately available, and endorsement of this question was related to greater sexual delay discounting in the "most likely to have STI" partner condition (Herrmann et al., 2015). Importantly, studies examining relationships between delay discounting of condom-protected sex and delay discounting of money also reliably report correlations between these two measures that are modest, often not statistically significant, and small or less in effect size (e.g., Quisenberry et al., 2016; $r = .02$ to .06 across the four partner conditions; Thamotharan et al., 2017 $r = -.05$). The lack of correlative overlap between these measures reinforces the notion that assessment of domain-specific outcomes provides unique insight into the relationship between discounting processes and health behaviors.

Finally, these studies have replicated prior findings that the extent of discounting is highly sensitive to partner characteristics (e.g., risk, desirability). Studies using the Sexual Delay Discounting Task have found, for example, that delay discounting for condom-protected sex is greater for partners rated as higher in sexual desirability and lower in sexual risk (e.g., Collado et al., 2017; Dariotis & Johnson, 2015; Hahn et al., 2019). Similarly, manipulation of the STI possible in the Sexual Probability Discounting Task resulted in HIV having the most influence on condom-protected sex (i.e., individuals showed the lowest probability discounting under HIV partner risk conditions; Berry et al., 2019). Related to these manipulations of explicit partner characteristics, another study found that exposure to a vignette about negative health consequences (HIV transmission) and regret relevant to unprotected sex decreased delay discounting across all partner types (Quisenberry et al., 2016). These findings are important because they emphasize that decision-making in these condom discounting tasks is sensitive to environmental factors aside from delay, probability, and partner type, even among individuals with co-occurring risk behavior like substance use (e.g., Johnson & Bruner, 2012). Such results are consistent with a larger body of work demonstrating that maladaptive decision-making that is attributed to behaviors like substance use is often context- or environment-dependent as opposed to global impairments in all decision-making functions (e.g., Strickland et al., 2018, 2019).

Studies comparing condom discounting by substance use history. Three studies have compared discounting of condom-protected sex based on substance use histories (i.e., between individuals with and without a substance use disorder). All three used the same Sexual Delay Discounting Task partner condition and delay parameters as the Johnson and Bruner (2012, 2013) studies, and one also included the Sexual Probability Discounting Task (Johnson et al., 2015). Two compared men and women with Cocaine Use Disorder (Johnson et al., 2015; Koffarnus et al., 2016), and one compared women in opioid maintenance treatment to non-drug-using control women (Herrmann et al., 2014). Two of these studies included measures of monetary discounting (Herrmann et al., 2014; Johnson et al., 2015), two included measures real-world sexual HIV risk behavior (Herrmann et al., 2014; Koffarnus et al., 2016), and one included a questionnaire measure of impulsivity (i.e., the Barratt Impulsiveness Scale; Herrmann et al., 2014).

All three of these studies found that participants in high-risk, drug-using subgroups discounted the value of delayed condom-protected sex more than control groups after controlling for 0-delay trial differences (Herrmann et al., 2014; Johnson et al., 2015; Koffarnus et al., 2016). One of these studies reported higher condom use likelihoods at a 0-delay in a control group compared to individuals reporting recreational cocaine use (and a trend compared to those with cocaine dependence; Koffarnus et al., 2016). Notably, however, similar significant differences were not observed at that 0-delay trial between individuals with *DSM–IV* Cocaine Use Disorder and demographically matched controls (Johnson et al., 2015) or women in opioid maintenance treatment to non-drug-using controls (Herrmann et al., 2014). These findings emphasize that meaningful between-groups differences might only emerge when systematically evaluating the impact of delay rather than simply the value of an immediately available condom, demonstrating the critical role of delay.

Discounting of delayed money in these studies differed between individuals with and without substance use disorder in a similar manner as other sexual discounting tasks (e.g., greater delay discounting in the high-risk substance use group). Notably, probability discounting of condom use or money (in the only study among these to examine it) did not differ between those with and without Cocaine Use Disorder (Johnson et al., 2015). Herrmann and colleagues (2014) also found that greater discounting on the Sexual Delay Discounting Task was associated with higher scores on the Barratt Impulsiveness Scale for three of the four Sexual Delay Discounting Task partner conditions ($r = .31$ to 40; all except for the "most likely to have STI" partner [$r = .24$] which approached a ceiling effect in both groups with high rates of condom use at all delays). Responses on the Sexual Delay Discounting Task and monetary discounting tasks were not significantly correlated (Herrmann et al., 2014; Johnson et al., 2015), again supporting the unique nature of measuring discounted sexual commodities.

Studies examining drug effects on discounting. Five within-subjects and one between-subjects, placebo-controlled human laboratory studies have examined the effects of experimental drug administration on discounting of sexual outcomes using the Sexual Delay Discounting Task (Berry et al., in press; Bolin et al., 2016; Johnson, Sweeney, Herrmann, & Johnson, 2016; Johnson, Bruner, Johnson, Silverman, & Berry, 2020; Johnson, Herrmann, Sweeney, LeComte, & Johnson, 2017; Strickland, Bolin, et al., 2017). Three of these five studies examined the effects of drugs of abuse including alcohol (Johnson et al., 2016), cocaine (Johnson et al., 2017), and methamphetamine (Berry et al., in press). Two studies examined buspirone (BuSpar®), a $5HT_{1A}$ receptor agonist and partial dopamine D_2 receptor antagonist investigated as a potential pharmacotherapy for Cocaine Use Disorder (Bolin et al., 2016; Strickland, Bolin, et al., 2017). The single between-subjects

study evaluated the effects of *d*-cycloserine (Johnson et al., 2020). All six studies used oral administration. Three of these studies examined dose-response by testing two active doses (Berry et al., in press; Johnson et al., 2017; Strickland, Bolin, et al., 2017). Two studies (Johnson et al., 2016, 2017) also included the Sexual Probability Discounting Task and monetary probability discounting tasks.

Four of these six studies observed differences in Sexual Delay/Probability Discounting Task responding when comparing active drug conditions versus placebo (Berry et al., in press; Bolin et al., 2016; Johnson et al., 2016, 2017). All three studies administering drugs of abuse yielded a similar pattern of findings. First, significant decreases (dose-related when examined) in condom use likelihood were a function of decreased sensitivity to delayed condom availability and uncertainty of STI contraction, not significantly decreased condom use under 0-delay or certain-STI-contraction conditions. Second, these changes in responding were either paralleled by increases in self-report measures of sexual arousal/desire (Johnson et al., 2016, 2017) or were related to changes in self-report measures of sexual arousal/desire (Berry et al., in press). Third, these effects did not generalize to delay and probability discounting of money (Johnson et al., 2016, 2017) or delay discounting of cocaine rewards (Johnson et al., 2017). In fact, whereas alcohol administration significantly increased probability discounting for condom use for a highly desirable partner, it significantly decreased probability discounting for money (Johnson et al., 2017).

Conversely, whereas buspirone maintenance increased participants' self-reported likelihood of using immediately available condoms (0-delay trials), effects of delay on condom use intentions were not altered (Bolin et al., 2016), suggesting a positive effect regarding engagement in safer sex, but one not mediated by discounting processes. These effects were not observed after acute dosing (Strickland, Bolin, et al., 2017), further suggesting a difference between the impact of maintenance and acute delivery effects. Individuals receiving *d*-cycloserine also did not demonstrate different patterns of delay discounting of condom-protected sex relative to a group receiving placebo (Johnson et al., 2020).

Summary of discounting of condom use. All 23 studies examining delay and probability discounting regarding condom use choices indicated in group analyses that, under certain conditions, participants discounted the value of condom-protected sex as a function of delay to availability or risk of contracting an STI. Numerous studies have shown specifically that the discounting-based decisions in these tasks (controlling for condom use at 0-delay when STI contract is certain) are significantly associated with self-reported real-world sexual risk and other ratings of sexual behavior, often when monetary discounting processes fail to show significant associations with self-reported sexual risk. The most powerful experimental effects using the condom discounting tasks involve those experimental manipulations involving drugs of abuse like alcohol or cocaine that are associated with sexual risk and associated HIV or other STI contraction. These studies have found that, in certain conditions or with certain individuals, drug administration significantly decreases condom use despite drug administration having no effect on monetary delay or probability discounting nor significantly altering condom use when no delay was involved or STI contraction was certain. This suggests that sexual discounting processes are critical for fully understanding sexual risk because the effects of these drugs on sexual risk would not have been detected had these studies only examined condom use in a nondiscounting context or using only monetary discounting.

Discussion

Examining the behavioral processes underlying sexual behavior is important to fully understand this critical aspect of human functioning and culture and address problems such as STIs and unwanted pregnancies. This systematic review examined studies relevant to the potential relationships between discounting processes and sexual behavior and how these associations may relate to individual differences in substance use and pharmacological effects. First, we reviewed the literature exclusively focusing on the relationship between monetary discounting and sexual risk behavior. These studies have identified small effect size relationships between monetary delay discounting and sexual risk, and this is likely explained by the limited focus on a more general (money) rather than domain-specific commodity relevant to sexual health. Second, we considered extensions of traditional discounting tasks to sexual activity as the discounted commodity. These studies have indexed sexual value using diverse operational definitions (i.e., duration, quantity, quality) yet have reliably found systematic discounting by the delay to sex and the probability of sexual activity, indicating robust applicability of discounting processes to sexual activity itself. Similarly, consistent relationships have been observed between pure sexual discounting measures and measures of sexual health and substance use which supports their utility above and beyond measures of monetary discounting. Finally, we described research on tasks using discounting of condom use as the discounted commodity where the discounting task decisions are directly relevant to sexual health and STI transmission. These observational and experimental studies have shown that greater discounting of condom use is observed in high-risk substance use populations as well as following acute administration of drugs of abuse. Efforts were not made to identify unpublished data, and results of this systematic review should be considered in light of a possible file drawer effect. Below, we review the major conclusions of this research, existing methodological and theoretical gaps, and recommendations for the state of discounting research at the intersection of sexual health, behavioral science, and psychopharmacology.

Sexual Behavior Involves Discounting Processes

The robust conclusion of the reviewed literature is that sexual behavior involves delay and probability discounting (see Figures 2 and 3). Most broadly, studies with sufficiently large samples have found significant relationships between higher ratings for a variety of self-reported sexual behaviors and greater delay discounting of money, and in one case a relationship between lower probability discounting of money and sexual health risk. The second and more clinically applicable evidence comes from studies using hypothetical decisions about sexual behavior to assess the effect of delay and probability. Despite variations in the methods used to measure sexual activity (e.g., erotica viewing, unspecified preferred sexual activity, sex, and condom-protection within sex), to measure sexual discounting (e.g., duration of sexual activity, quantity of sexual

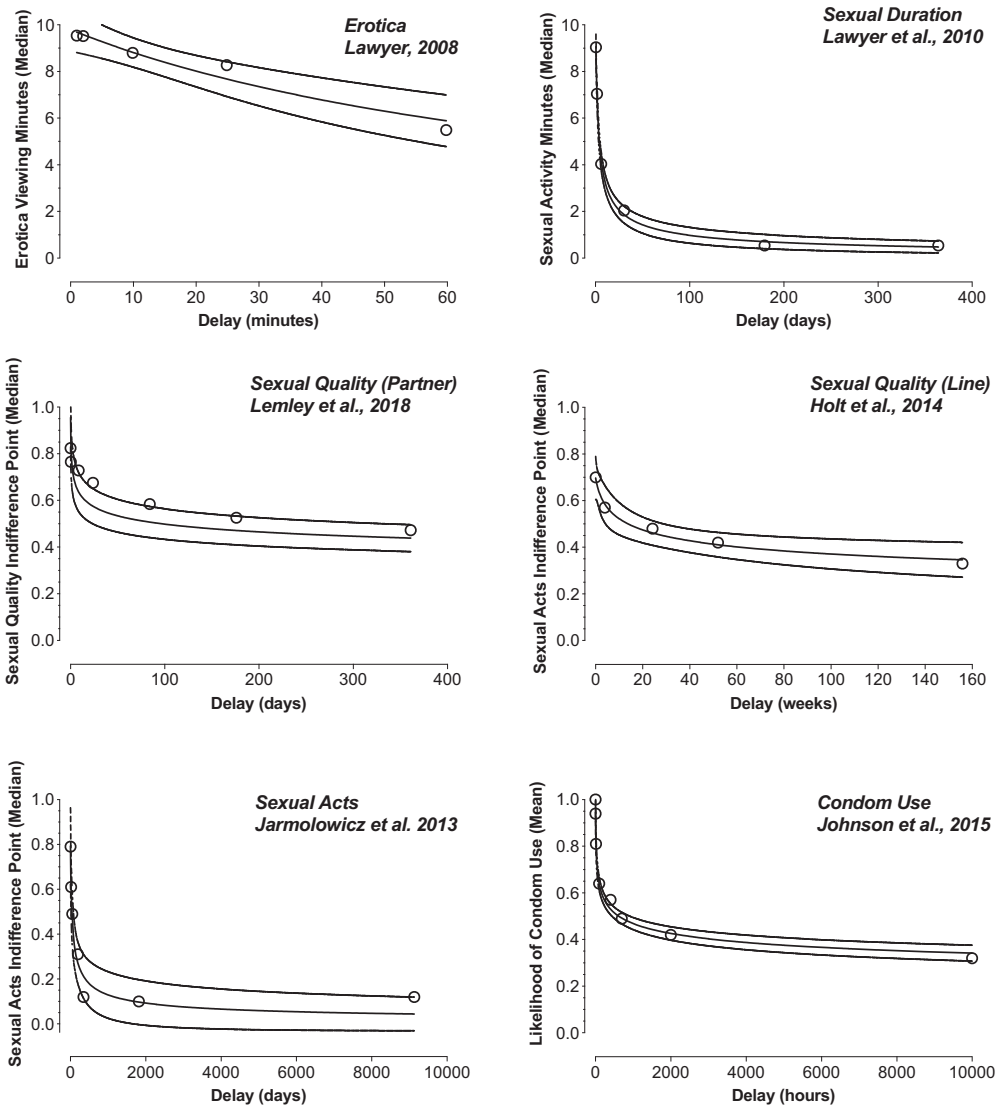

Figure 2. Prototypical delay discounting curves from each task type reviewed. Plotted are delay discounting curves recreated from data presented in reviewed manuscripts (Holt et al., 2014; Jarmolowicz et al., 2013; Johnson et al., 2015; Lawyer, 2008; Lawyer et al., 2010; Lemley et al., 2018). Group discounting curves (mean or median per original study) were plotted using the two-parameter hyperbola-like discounting equation (Green et al., 1999) with 95% confidence intervals surrounding model estimates for group data. Data points were estimated using digital interpolation via WebPlotDigtizer https://apps.automeris.io/wpd/.

acts, quality of sex represented by line, quality of sex by different partners, ratings of likelihood of using a condom), and the sex-related outcome being delayed or that is probabilistic (sexual activity itself or condom use), delay and probability systematically determine sexual behavior. That decision-making surrounding sexual behavior involves discounting processes is not necessarily surprising given the extensive body of work indicating that discounting processes are conserved both across species and for a variety of consumable goods and nonconsumable outcomes (e.g., Ainslie, 1975; Bickel et al., 2014; Chung & Herrnstein, 1967; Green et al., 1999; Mazur, 1987; Rachlin & Green, 1972; Rachlin et al., 1991). The conservation of this discounting process, however, is clinically relevant given that greater discounting in many of these studies was related to greater self-reported real-world sexual risk and other ratings of sexual behavior, often when monetary discounting processes were not significantly associated with self-reported sexual risk.

Sexual Risk Behavior and Preference Reversals

Beyond just being discounted by features of delay, the reviewed studies have also found that sexual risk behavior often follows a hyperbola-like function in this discounting process. Discounting that is characterized by a hyperbola-like pattern is relevant because it is consistent with the idea of preference reversals (Green et al., 1994) that we hypothesize are a key element in sexual risk behav-

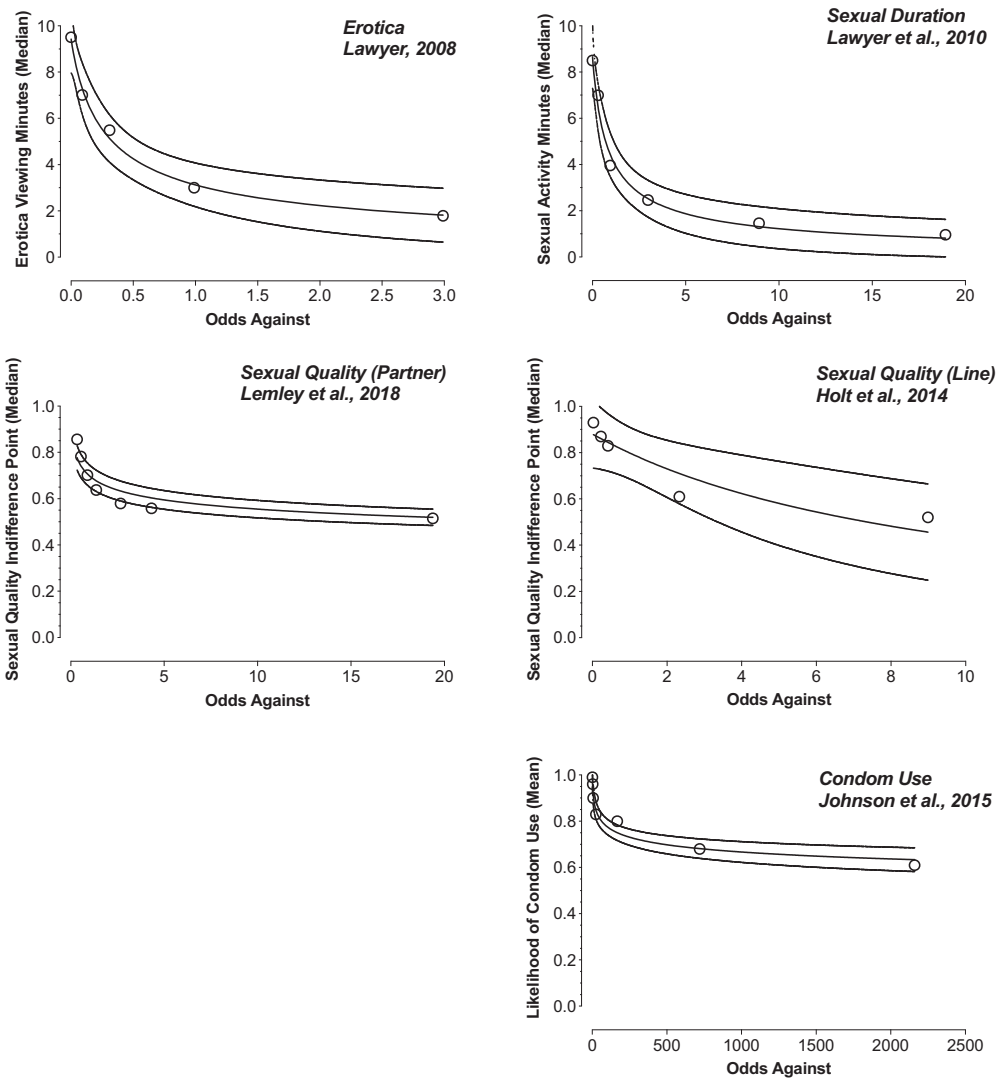

Figure 3. Prototypical probability discounting curves from each task type reviewed. Plotted are probability discounting curves recreated from data presented in reviewed manuscripts (Holt et al., 2014; Johnson et al., 2015; Lawyer, 2008; Lawyer et al., 2010; Lemley et al., 2018). Group discounting curves (mean or median per original study) were plotted using the two-parameter hyperbola-like discounting equation (Green et al., 1999) with 95% confidence intervals surrounding model estimates for group data. Data points were estimated using digital interpolation via WebPlotDigtizer https://apps.automeris.io/wpd/.

ior. For example, it has been reported that a subset of individuals who receive HIV testing do so repeatedly, with interviews of such individuals showing the most frequent reason being engagement of high-risk behaviors (e.g., unprotected sex) rather than routine health practice (Patinkin et al., 2007). Such a pattern is consistent with concern and motivation to decrease future risk, yet defection on that motivation in future sexual events. Similar preference reversals surely also happen regarding concern for unwanted pregnancy and concern over other STIs besides HIV. Tasks assessing sexual discounting processes might be used to clinically identify individuals at high risk for STI contraction or unwanted pregnancy, the particular ways in which they may be at risk, and aspects of behavior targetable for clinical intervention. For example, the Sexual Delay Discounting Task might be used to identify those individuals who simply are unlikely to use a condom even in the most ideal conditions (i.e., when no delay is involved), and those who would use condoms under those ideal conditions, but are likely to practice risky sex when delays are involved (e.g., the 24% of MSM participants reporting recent unprotected sex because they did not have an immediately available condom; Herrmann et al., 2015). Identifying the latter group of individuals could allow for interventions tailored for this unique type of risk. For these individuals, any intervention to ensure consistent condom carrying may have a powerful effect in decreasing unprotected sex by greatly reducing the delay to condom access across multiple contexts. Individuals unlikely to use a condom even in the most ideal conditions, on the other hand, may require entirely different interventions that increase the value of condom use.

A particularly relevant topic for future research, with some relation to sexual preference reversals, is preexposure prophylaxis (PrEP), which describes the use of antiretroviral drugs to prevent HIV infection (Hillis, Germain, Hope, McVeigh, & Van Hout, 2020). This form of therapy can be viewed as a form of precommitment. That is, at least among some patients, the decision to use PrEP might be influenced by the PrEP user's awareness of the potential to defect on precommitment (i.e., engage in unprotected sex when an immediate opportunity is available despite a general desire to avoid sexual risk). As such, decisions to use PrEP might be associated with being an economic *sophisticate* as opposed to an economic *naife* (O'Donoghue & Rabin, 1999). In other words, independent of the extent of discounting or hyperbola-like form of discounting, such individuals might have improved perception of their own future behavior, including their propensity for preference reversals. Future research could examine this hypothesis in conjunction with sexual discounting tasks. Moreover, PrEP is also interesting within sexual health decision-making because it does not afford protection against STIs beyond HIV. Therefore, individuals who use PrEP who continue to practice unprotected sex, especially with casual partners, are still engaging in risky behavior and may be at increased risk for STI transmission (e.g., see Traeger et al., 2019). And given that evidence suggests utility of PrEP in regard to heterosexual sex (Murnane et al., 2013), there might also be risk of unwanted pregnancy if no other form of contraception is used. It would therefore be relevant to administer a task such as that of Berry and colleagues (2019), to determine whether PrEP patients who still engage in risky behavior probability discount least for HIV as a consequence compared with other potential negative consequences, as in the undergraduate sample examined by Berry and colleagues.

Sexual Discounting Is Sensitive to State, Environment, and Context

These findings also emphasize that sexual discounting is highly sensitive to varying aspects of partner characteristics or when the participant's physiological state is altered through acute pharmacological challenge. For example, increasing the sexual desirability or decreasing the STI risk of hypothetical partners results in greater discounting of condom use. Administration of drugs of abuse with epidemiological or cross-sectional relationships to risky sexual behavior has similarly shown to increase sexual discounting. Research in this domain has suggested then that manipulations like drug administration or partner context can alter desirability leading to these changes in discounting, thereby emphasizing the mechanistic value of experimental manipulation and studying discounting processes in the laboratory environment. These findings are also relevant because they support potential clinical utility in targeting discounting insofar as discounting is sensitive to factors that alter the person-state or the person-context (see more on this in Clinical Relevance to Drugs and Other Manipulations below). Such demonstrations are important for theoretical discussions within addiction science as they emphasize that decision-making processes among persons engaging in risky behavior like substance use are still sensitive to factors in the environment and can involve adaptive decision-making given the salience of that context (e.g., when STI risk is made highly salient, individuals tend to report much lower discounting).

The reviewed findings regarding the role of discounting processes in sexual decision making are particularly interesting when considering the state- and trait-like aspects of discounting processes (e.g., Odum, 2011; Odum et al., 2020). Although greater monetary delay discounting is sometimes associated with greater sexual risk and other sexual behaviors when the sample size is large enough, there is evidence of stronger associations between sexual discounting tasks and sexual behaviors, suggesting domain specificity. These findings would still be consistent with a trait interpretation, with each process representing a different trait (e.g., delay discounting of money, delay discounting of sex, probability discounting of money, probability discounting of sex). The differences between high-risk groups and control groups on sexual discounting processes are further evidence that sexual discounting processes (like monetary discounting processes) have a trait-like aspect. However, that administering drugs of abuse increases sexual discounting suggests that these phenomena are subject to state (rather than trait) effects. The inability of these drugs to decrease monetary discounting processes suggests that monetary discounting processes may be more trait-like than sexual discounting processes (although state manipulations of monetary delay discounting do occur; Koffarnus, Jarmolowicz, Mueller, & Bickel, 2013).

Effect Sizes and Clinical Significance

The primary finding and effect of interest for the present review is that delay and probability discounting processes play a consistent, fundamental, and robust role in sexual decision making. Across the variety of tasks, delay and probability manipulations typically caused large reductions in value, with the decay in value following a hyperbola-like function. Often, relatively small increases in delay to or odds against experiencing the task-specific sexual outcomes resulted in marked discounting, highlighting the importance of discounting processes in sexual decision-making. It is also important to note that to understand the clinical significance of these findings will require extension beyond laboratory tasks to real-world decision-making contexts. For example, if an individual shows high condom use likelihood if immediately available, but drastic reductions in condom use likelihood if required to wait for a condom, clinical interventions could aim to eliminate delay or counteract the effects of delay (e.g., training for condom carrying, future episodic thought, visualizations of condom carrying, condom implementation intentions). Effect sizes for differing outcome measures and studies varied, but several thematic patterns emerged. For monetary discounting, small effect size positive correlations with self-reported sexual risk behaviors were observed. Comparatively, for sexual discounting, medium effect size positive correlations with self-reported sexual risk behaviors were observed. The relatively larger effect sizes for sexual as opposed to monetary discounting further demonstrates the value in assessing clinically relevant discounting measures, although indeed does not account for all of the variance in sexual risk. These effect sizes should also be considered in light of empirically extended effect size guidelines (Gignac & Szodorai, 2016). Specifically, original effect size guidelines were based primarily on qualitative impression, rather than empirical, systematic, and quantitative assessment of data, and new guidelines suggest that .30 might be considered a large effect from meta-analytically analyzed data (in an analysis

showing that original guidelines for effect sizes may be too stringent, as less than 3% of correlations reported in the literature were found to be as large as $r = .50$; Gignac & Szodorai, 2016). With that in mind, it should be noted that several of the effect sizes between the various sexual discounting tasks and self-reported sexual behavior often were associated with absolute value correlation coefficients within the general range of approximately .3 to .4 (e.g., Herrmann et al., 2015; Jarmolowicz et al., 2015; Johnson & Bruner, 2012; Lawyer, 2008; Lemley et al., 2018). Such associations when magnified to scale at a population level (e.g., the number of unprotected sexual acts during alcohol use because of delay to condom acquisition) would likely prove clinically relevant and impactful for the public health.

Reliability and Validity

Only one study has examined reliability for any type of sexual discounting task (Johnson & Bruner, 2013). This study found good-to-excellent test–retest reliability across a 7-day test interval for condom use delay discounting. However, this leaves questions regarding the test–retest reliability of longer intervals. Test–retest reliability is unknown for the variety of other sexual discounting tasks described in this review. Such reliability data have relevance to the state versus trait question discussed previously in this review. Stronger test–retest reliability, especially at longer intervals, suggests a stronger trait-like quality, while data suggesting sensitivity to manipulations, such as the previously reviewed data on within-subject differences attributable to partner type and drug administration, suggest a state-like quality. At present, the test–retest data on condom use delay discounting, as well as its sensitivity to within-subject manipulations, suggest both trait and state aspects. It should be noted that trait and state are likely best thought of as a continuum rather than being mutually exclusive.

The research reviewed indicating significant relationships between the various forms of sexual discounting and self-reported sexual behavior provide one form of evidence for ecological validity. The self-report evidence from Herrmann and colleagues (2015) previously reviewed provides another form of evidence of ecological validity, as a substantial number of individuals reported engaging in a high-risk form of unprotected sex specifically because a condom was not immediately available and they chose not to wait for one. However, additional tests of validity would be beneficial. One potential line of inquiry would be prospective investigation of such decisions in the natural environment (in contrast to retrospective self-report) using ecological momentary assessment. Also, variations of the task could examine scenarios where more than two options are available. For example, for condom use delay discounting, tasks could include options to forgo sex altogether, or engagement in less risky forms of sexual behavior (e.g., heavy petting), in addition to options of unprotected sex and waiting for a condom. Of course, there is no perfect design. Including a very large number of options may improve ecological validity but may also impose limits on the ability to rigorously and quantitatively model behavior that is available when examining two discrete options. By analogy, traditional monetary delay discounting tasks could be viewed as low in ecological validity, because such explicit choices between smaller immediate and larger delayed money are rare, and in many real world scenarios, additional options may also be relevant. These include negotiations regarding additional amount versus delay tradeoffs, such as plans with a series of monetary exchanges over time, as with many real world monetary exchanges, for example, compounded interest, student loans, and mortgages. In the real world, alternative options also include assessment of alternative agents, such as checking the interest rate at another bank. Despite the constrained nature of traditional monetary delay discounting research, it has uncovered numerous reliable empirical observations that have advanced decision-making science and have relevance to the real world. Indeed, one definition of economics and behavioral economics (the broader field within which the study of discounting processes falls) is "the study of the allocation of behavior within a system of constraint" (Bickel, Green, & Vuchinich, 1995, p. 258). Nonetheless, despite the analytic value afforded by the two-choice tasks studied to date, more complex tasks with increased ecological validity would be valuable complements to extend our understanding of discounting processes and sexual behavior. Such work could be informed by qualitative analyses of interviews and mixed-method analyses of relevant populations (e.g., Patinkin et al., 2007). As with psychological research in general, addressing validity in sexual discounting includes the need to replicate and generalize results (Kenny, 2019).

Nonsystematic Data

The large majority of the studies (26 of 33; 79%) reported on the extent to which nonsystematic responding was observed in the data sets. All of these 26 studies used one or more criteria proposed by Johnson and Bickel (2008) or Johnson and colleagues (2015), or a variation based on these. The mean percentage of reported nonsystematic data for sexual discounting across these 26 was 12.6%. Among these 26 studies, only eight reported rates of nonsystematic data for both monetary and sexual discounting, the mean of percentages across these eight studies were 13.6% for sexual discounting and 10.1% for monetary discounting. Caution should be used in evaluating the mean percentages reported here given that criteria used to evaluate whether data were nonsystematic differed across studies. Nonetheless, these numbers are generally consistent with a meta-analysis on nonsystematic responding in discounting studies, which found an overall rate of 18% nonsystematic data for delay discounting studies, with somewhat higher rates of nonsystematic responding for nonmonetary than monetary outcomes (Smith, Lawyer, & Swift, 2018). Future research for all discounting tasks should also examine methods to improve systematic data rates (e.g., through instructional checks).

Representation of Sexual Minorities

Although the reviewed studies primarily involved heterosexual individuals, few of the reviewed studies actually excluded participants for nonheterosexual identity. Among the studies assessing monetary discounting and sexual outcomes (see Table 2), only two studies were expressly limited to heterosexual participants (Cheng & Chiou, 2018; Wray et al., 2015) and a third evaluated opposite sex faces, effectively limiting analysis to heterosexual behavior (Wilson & Daly, 2004). Among the studies assessing pure discounting of sexual outcomes (see Table 3), only one study expressly limited participation to individuals of heterosexual identity (Carrier Emond et al., 2018), whereas another two studies ex-

cluded gay, lesbian, and bisexual participants. One study excluded these individuals post hoc from analyses because the limited number of these participants included the final sample precluded meaningful analysis (Jarmolowicz et al., 2015). Another study with women participants excluded lesbian and bisexual women a priori because condom use would not be relevant for all of these participants' sexual partners (Lemley et al., 2018). Among the studies addressing condom use discounting (see Table 4), only one study expressly limited participation to individuals who identified as heterosexual (Herrmann et al., 2014); however, three studies had exclusion criteria based on picture selection, such that female participants who chose pictures of women for use in the task were excluded from completing the task given that HIV risk was a focus and HIV transmission is extremely low in female/female sexual activity (Johnson et al., 2015, 2016; 2017; see Chan et al., 2014). Few of the studies reported participant sexual identity, and among those that did, rates of nonheterosexual identity ranged from 3.5 to 10.5% of the sample (Lawyer, 2008; Lawyer & Mahoney, 2018; Lawyer & Schoepflin, 2013; Lawyer et al., 2010), which suggests representation approximate to societal rates (e.g., Newport, 2018). Given the generally small samples assessed in these studies, there may have been too few participants of sexual minority status for specific analyses of sexual risk behaviors regarding these populations.

Some studies have focused on sexual risk behaviors in MSM (Hahn et al., 2019; Herrmann et al., 2015; Jones & Sullivan, 2015, 2016; Jones et al., 2018a, 2018b), given their disproportionately high rates of STI transmission. However, no studies have evaluated sexual discounting behaviors in transgender individuals. The only study to mention transgender status in any capacity was one addressing MSM sexual risk behaviors, in which participation was limited to individuals who "were male at birth" (Jones & Sullivan, 2015). See the subsection below labeled Future Research in Sexual Minorities and Other Populations for recommendations regarding future research.

Key Directions for Future Research

Benefits and challenges of multidimensional approaches to discounted sexual behavior. The various tasks assessing discounting processes using hypothetical sexual behavior have contributed to a basic science of sexual behavior by showing robust effects of delay and probability on sexual decisions. These methods have, however, widely differed in how sexual behavior was operationally defined, and these variations likely reflect meaningfully different aspects of sexual health decision-making.

Pure approaches have focused on the value of the sexual behavior itself and how delay and probability impact valuation. One challenge in this approach is standardization within studies and across participants. Specifically, individual differences in preferences regarding the preferred duration or frequency of sexual activity presents a challenge for designing the optimal larger, later (or probabilistic) outcome. For example, for some individuals a shorter duration of sexual activity (e.g., 10 min) may be preferred to a longer duration activity (e.g., 30 min), which contradicts some analyses where longer durations have been assumed to have greater value. Standardization of the larger, later option to an equivalent monetary value has proven useful in some contexts (Jarmolowicz et al., 2013, 2014); however, more exploration of the ecological viability and robustness of this approach is needed.

Other approaches, namely the Sexual Delay Discounting Task and Sexual Probability Discounting Task, have evaluated behaviors clinically related to the sexual activity rather than the value of the sexual activity. These likely improve the ecological validity because decisions between different durations of sex, or between the number of sex acts, are likely rarely, if ever, explicitly encountered in the real world. However, sexual discounting tasks involving discounting of condom use likely involve an interaction among multiple underlying processes, including the reinforcing value of sex itself and how this reinforcement is reduced by a potential delay (for delay tasks), the potential reduction of reinforcing value of sex due to condom use (regardless of delay and probability), the perceived aversiveness of a potential STI or pregnancy if involved in task design or if participants do not follow instructions to ignore potential for pregnancy when provided, the relative weighting of reinforcing effects of sex and aversive properties of STIs or pregnancy, the delay and probability discounting of STI contraction and/or pregnancy, and, finally, the ability of condom delay or STI (or pregnancy) probability to devalue whatever value is present for condom use due to its ability to avoid delayed and probabilistic punishment. No studies have systematically deconstructed these various components, and it seems likely that decomposition of these behavioral mechanisms will be relevant for informing clinical applications.

More broadly, we are unaware of published studies that have implemented both the discounting of sexual activity and the discounting of condom use. Additionally, recent methods have been developed to directly measure valuation for sexual activity (Dolan, Johnson, & Johnson, 2020) or condom-protected sex (Strickland, Marks, & Bolin, 2020) via behavioral economic demand approaches thereby providing additional opportunities to determine distinct behavioral mechanisms contributing to sexual behavior. Integrating sexual discounting tasks with demand approaches will help determine how these multidimensional definitions of sexual behavior uniquely contribute to sexual health decision-making and sexual risk behaviors.

Further research and novel tasks. Existing research on sexual discounting has focused primarily on delay processes. Studies that have examined probability mechanisms have described patterns of behavior that are distinct from patterns observed with delay. Research using probability discounting within sexual discounting contexts is limited but does suggest that these probability mechanisms are similarly sensitive to context manipulations (e.g., STI type; Berry et al., 2019) and pharmacological challenge (e.g., Johnson et al., 2016, 2017). More research is needed to determine the relative contributions of probability mechanisms through the design of additional probability discounting tasks and tasks with interactions between probability and delay mechanisms (given evidence that delay interacts in a multiplicative manner with probability to determine the rate of devaluation in other discounted commodities; Cox & Dallery, 2016, 2018; Vanderveldt et al., 2015).

Additional experimental work should focus on underlying factors modulating discounting processes. For example, the fact that drugs that increase sexual arousal, and other manipulations associated with increased arousal, like a more desirable partner, are associated with increased condom use discounting raise the ques-

tion of whether increased discounting in a situation is related to increased reinforcing effects for a relevant outcome. In other words, increased reinforcement from sex, whether through pharmacological enhancement or a more desirable partner, might mediate the increase in discounting of condom use. An analogous finding has been shown for food, with hunger increasing delay discounting primarily for food, along with less pronounced increases in delay discounting for other reinforcers (Skrynka & Vincent, 2019).

A clinically relevant direction for novel tasks is to model decisions with relevance to unwanted pregnancies, or to a more ecologically valid focus on both STIs and unwanted pregnancies. To isolate the processes contributing to STI risk, the instruction sets in the Sexual Delay Discounting Task and Sexual Probability Discounting Task have asked participants to imagine that unwanted pregnancy is not a concern in this sexual scenario presented. Given the clinical problems related to unwanted pregnancies (Ali, 2016; Bahk et al., 2015; de La Rochebrochard & Joshi, 2013; Foster et al., 2019; Gerdts et al., 2016; Patel & Surkan, 2016), there is unexplored potential in leveraging existing tasks to understand how similar sexual discounting processes are between STI risk and unwanted pregnancy.

There are also many additional possibilities for exploring novel sexual discounting tasks examining the effects of delay and/or probability on other potential determinants of sexual behavior. Tasks could assess the effect of delay on infidelity within partnership (e.g., delayed sex with one's committed partner vs. immediate sex with someone else). Tasks could assess the effect of probability that a partner will second guess sex if one proposes condom use (e.g., 100% chance of sex without condom proposition vs. some lesser chance of sex with condom proposition). Tasks could assess how condom use decisions are affected by the probability that a male will lose an erection as a result of condom use (e.g., 100% chance of successful erection without condom use vs. some lesser chance of successful erection with condom use). Tasks could assess how condom use decisions are affected by the probability that they will be accused by the partner of being unfaithful because of the condom request, or that the partner will feel accused of being unfaithful. Evidence suggests these factors have been barriers to the ability of women to negotiate condom use within partnerships, contributing to STI transmission (Chimbiri, 2007; Exavery et al., 2012; Wingood & DiClemente, 1998).

Novel tasks that are developed regarding sexual discounting processes should be rigorously tested for reliability. This includes assessing the shape of resulting discounting functions with the hypothesis that they are hyperbola-like, consistent with discounting processes observed across multiple species and multiple outcome types (reviewed in Cox, Dolan, Johnson, & Johnson, 2020). An even more fundamental expectation than a hyperbola-like form is the expectation of a function that either remains stable or monotonically decreases with increased delay or uncertainty, and this can be assessed using the general framework for assessing nonsystematic discounting data proposed by Johnson and Bickel (2008). Validity can also be assessed by examining correspondence with self-reported behaviors relevant to the task, as with the various associations between the various sexual discounting and self-reported sexual behavior described in this review. Additional considerations relevant to assessing novel tasks are described in the section Reliability and Validity above.

Future research in sexual minorities and other populations. In clinically relevant assessments of sexual discounting processes, more work should also focus on targeted groups at high risk. One critical group for further research are MSM. MSM are a marginalized group who continue to be the most severely affected by HIV and other STIs relative to any other group in the United States (CDC, 2019, 2020). The high rates of HIV and other STIs among MSM are attributable to several factors. These include the biological factor of substantially higher HIV transmission probability via anal sex compared with vaginal sex (Baggaley, White, & Boily, 2010; Varghese, Maher, Peterman, Branson, & Steketee, 2002). They also include behavioral factors such as a group tendencies for a greater number of sexual partners (Levin, Koopman, Aral, Holmes, & Foxman, 2009), greater rates of concurrent partnerships, and greater duration of lifetime partnership acquisition (Glick et al., 2012) in MSM compared with heterosexual men. Finally, societal factors play a role. For example, stigma can reduce the propensity for MSM to disclose sexual behaviors to health care providers, which can reduce STI prevention efforts (Qiao, Zhou, & Li, 2018).

Although HIV prevalence has decreased in the general population in recent years, HIV prevalence increased among MSM (CDC, 2019). MSM make up only 2% of the population yet accounted for 70% of all new HIV infections in the United States in 2017 (CDC, 2019). MSM are more likely than other populations to have risky unprotected sex while under the influence of alcohol (Irwin, Morgenstern, Parsons, Wainberg, & Labouvie, 2006), particularly with nonprimary "casual" partners (Vanable et al., 2004). Research in these and other vulnerable populations may help to identify unique and targetable risk factors relevant to sexual health risk. For example, given the finding in one study that 24% of sampled MSM reported recent unprotected anal intercourse because they did not have a condom immediately available, and that this response was associated with increased discounting of condom use (Herrmann et al., 2015), we believe that incorporation of discounting processes into research examining sexual risk among MSM would provide a clinically relevant mechanism for intervention development.

Future research should bring increased attention to sexual minorities and other populations beyond MSM. Studies should be more explicit in describing both the sexual orientation and transgender status of participants. Further, studies that explicitly recruit sexual minority individuals who have been understudied in this area (e.g., women who have sex with women, and transgender individuals) would be valuable. Like MSM, transgender individuals are also disproportionally affected by HIV, with a recent analysis suggesting a staggering rate of 14% of transgender individuals having HIV (Becasen, Denard, Mullins, Higa, & Sipe, 2019).

More research is also needed among survivors of child sexual abuse, which affects millions of children worldwide each year, and is a global epidemic (Murray, Nguyen, & Cohen, 2014). Child sexual abuse, particularly for girls/women, has been linked to disrupted development and sexual decision-making, higher rates of STIs, and unprotected sex (Lodico & DiClemente, 1994; Negriff, Noll, Shenk, Putnam, & Trickett, 2010; Silovsky et al., 2007; Wingood & DiClemente, 1997). More broadly, child sexual abuse is associated with a host of severe mental health and sexual problems later in life (e.g., Briere & Runtz, 1993). The contribution of discounting processes in these populations, however, remains unknown. These evaluations may use the currently available tasks discussed in this review, or may benefit from further adaptation to include outcomes, scenarios, and variables unique to the sexual populations being studied. Understanding sexual risk-related decision-making processes across the sexual-

identity spectrum and in specific populations at risk will provide insight into the differential sexual risks faced across groups and inform clinical interventions.

Biological bases of sexual risk. Another fruitful future direction is to explore the biological bases of sexual discounting processes. Functional MRI (fMRI) has allowed researchers to make progress in understanding brain area activation during money (Bickel et al., 2007; McClure, Laibson, Loewenstein, & Cohen, 2004) and liquid reward (McClure, Ericson, Laibson, Loewenstein, & Cohen, 2007) delay discounting. Moreover, fMRI research has contributed to an understanding of activation underlying risky sexual behavior and response to sexual stimuli (Cyders, Dzemidzic, Eiler, & Kareken, 2016; Eckstrand et al., 2017; Smith, Xue, et al., 2018). These lines of research could be brought together with new brain imaging research to investigate the structural, functional, and biochemical factors underlying discounting processes involved in sexual decisions, including sexual risk behavior. Another clinically important direction of biological research would be to examine the potential degree to which changes in cognitive and associated brain function result from HIV (Rackstraw, 2011) affect sexual discounting processes.

Clinical relevance to drugs and other manipulations and interventions. Perhaps the most clinically relevant finding is that administering three drugs of abuse (cocaine, alcohol, methamphetamine) with a long history of being associated with sexual risk behavior were found to affect discounting processes for condom protected sex (for a subset of participants in the methamphetamine study depending on sexual desire), whereas administering these drugs did not increase monetary discounting. Moreover, that administering these drugs had significant effects on the delay or probability discounting related to condom use and had no significant effects when delay or probability were not involved strongly suggests specific behavioral mechanisms by which these drugs increase sexual behavior in the real world. Indeed, it is likely that many casual sex scenarios in which unprotected sex occurs are the ones modeled by these tasks, when a condom is not immediately available and when the probability of STI contraction is uncertain. In many such cases, light sexual interaction between the partners likely builds until it becomes apparent that intercourse will occur, and then, in a state of strong sexual desire with the immediately available reinforcer of sexual activity, the parties would need to break the sexual action and seek out/wait for a condom.

Millions of dollars have been spent examining the relationship between these drugs and HIV risk, particularly cocaine and methamphetamine. Yet, a recent review showed that among 2,750 studies related to drugs and sexual risk behavior, only 43 administered drugs to examine effects on sexual risk behavior directly, and the large majority of these were with alcohol (Berry & Johnson, 2018). One conclusion of the current review, combined with this previous review, is that drug administration research is needed to understand the association between substance use, pharmacological effects, and sexual risk and that those studies should include discounting processes in models of sexual behavior among other measures.

In addition to studies administering drugs of abuse, future research should use sexual discounting tasks to explore the potential effect of pharmacotherapies to reduce sexual risk behavior, as has been conducted in the studies on buspirone (Bolin et al., 2016; Strickland, Bolin, et al., 2017). Aside from drug administration studies, important theoretical and clinical questions can be addressed by experimental research involving other acute or chronic manipulations, including the different lengths of sexual abstinence, arousal manipulations (e.g., exposure to erotica), and the effects of contexts and cues (e.g., sexually oriented advertising) on sexual discounting processes. In addition to pharmacotherapies, behavioral interventions should be explored. For example, using the Sexual Delay Discounting Task, individuals who would likely use condoms when available, but not likely use them after a delay, would be ideal participants in research with the therapeutic aim of increasing condom carrying, for example, by text reminders and/or reinforcement-based approaches.

Conclusions

The reviewed research has provided robust support for the notion that sexual behaviors, including sexual risk behaviors, are highly dependent on delay and probability discounting. Individual differences in substance use are related to sexual discounting and acute pharmacological challenge can modify these discounting processes emphasizing the relevance of discounting theory for understanding sexual risk behaviors in addiction science and other behavioral sciences. Importantly, this research emphasizes that both delay and probability aspects of the environment can strongly modulate behavior from safer to riskier within the individual, emphasizing the relevance of identifiable and clinically targetable context-specific changes in sexual risk. Future research will benefit from explicitly exploiting these systematic relationships to further understand human sexual behavior, to determine for whom and at what times sexual risk behaviors are most likely, and to best design behavioral and pharmacological approaches to decrease sexual risk behavior.

References

Ainslie, G. (1975). Specious reward: A behavioral theory of impulsiveness and impulse control. *Psychological Bulletin, 82,* 463–496. http://dx.doi.org/10.1037/h0076860

Ali, A. (2016). Relationship between unwanted pregnancy and health-related quality of life in pregnant women. *Journal of the College of Physicians and Surgeons—Pakistan, 26,* 507–512.

Amlung, M., Vedelago, L., Acker, J., Balodis, I., & MacKillop, J. (2017). Steep delay discounting and addictive behavior: A meta-analysis of continuous associations. *Addiction, 112,* 51–62. http://dx.doi.org/10.1111/add.13535

Appelhans, B. M., Woolf, K., Pagoto, S. L., Schneider, K. L., Whited, M. C., & Liebman, R. (2011). Inhibiting food reward: Delay discounting, food reward sensitivity, and palatable food intake in overweight and obese women. *Obesity, 19,* 2175–2182. http://dx.doi.org/10.1038/oby.2011.57

Baggaley, R. F., White, R. G., & Boily, M. C. (2010). HIV transmission risk through anal intercourse: Systematic review, meta-analysis and implications for HIV prevention. *International Journal of Epidemiology, 39,* 1048–1063. http://dx.doi.org/10.1093/ije/dyq057

Bahk, J., Yun, S. C., Kim, Y. M., & Khang, Y. H. (2015). Impact of unintended pregnancy on maternal mental health: A causal analysis using follow up data of the Panel Study on Korean Children (PSKC). *BMC Pregnancy and Childbirth, 15,* 85. http://dx.doi.org/10.1186/s12884-015-0505-4

Baker, F., Johnson, M. W., & Bickel, W. K. (2003). Delay discounting in current and never-before cigarette smokers: Similarities and differences across commodity, sign, and magnitude. *Journal of Abnormal Psychology, 112,* 382–392. http://dx.doi.org/10.1037/0021-843X.112.3.382

Becasen, J. S., Denard, C. L., Mullins, M. M., Higa, D. H., & Sipe, T. A. (2019). Estimating the prevalence of HIV and sexual behaviors among the U.S. transgender population: A systematic review and meta-analysis,

2006–2017. *American Journal of Public Health, 109,* e1–e8. http://dx.doi.org/10.2105/AJPH.2018.304727

Berry, M. S., Bruner, N. R., Herrmann, E. S., Johnson, P. S., & Johnson, M. W. (in press). Methamphetamine administration dose effects on sexual desire, sexual decision making, and delay discounting. *Experimental and Clinical Psychopharmacology*.

Berry, M. S., & Johnson, M. W. (2018). Does being drunk or high cause HIV sexual risk behavior? A systematic review of drug administration studies. *Pharmacology, Biochemistry, and Behavior, 164,* 125–138. http://dx.doi.org/10.1016/j.pbb.2017.08.009

Berry, M. S., Johnson, P. S., Collado, A., Loya, J. M., Yi, R., & Johnson, M. W. (2019). Sexual probability discounting: A mechanism for sexually transmitted infection among undergraduate students. *Archives of Sexual Behavior, 48,* 495–505. http://dx.doi.org/10.1007/s10508-018-1155-1

Bickel, W. K., Green, L., & Vuchinich, R. E. (1995). Behavioral economics (Editorial). *Journal of the Experimental Analysis of Behavior, 64,* 257–262. http://dx.doi.org/10.1901/jeab.1995.64-257

Bickel, W. K., Jarmolowicz, D. P., Mueller, E. T., Koffarnus, M. N., & Gatchalian, K. M. (2012). Excessive discounting of delayed reinforcers as a trans-disease process contributing to addiction and other disease-related vulnerabilities: Emerging evidence. *Pharmacology & Therapeutics, 134,* 287–297. http://dx.doi.org/10.1016/j.pharmthera.2012.02.004

Bickel, W. K., Johnson, M. W., Koffarnus, M. N., MacKillop, J., & Murphy, J. G. (2014). The behavioral economics of substance use disorders: Reinforcement pathologies and their repair. *Annual Review of Clinical Psychology, 10,* 641–677. http://dx.doi.org/10.1146/annurev-clinpsy-032813-153724

Bickel, W. K., Miller, M. L., Yi, R., Kowal, B. P., Lindquist, D. M., & Pitcock, J. A. (2007). Behavioral and neuroeconomics of drug addiction: Competing neural systems and temporal discounting processes. *Drug and Alcohol Dependence, 90,* S85–S91. http://dx.doi.org/10.1016/j.drugalcdep.2006.09.016

Black, R. A., Serowik, K. L., & Rosen, M. I. (2009). Associations between impulsivity and high risk sexual behaviors in dually diagnosed outpatients. *The American Journal of Drug and Alcohol Abuse, 35,* 325–328. http://dx.doi.org/10.1080/00952990903075034

Bolin, B. L., Lile, J. A., Marks, K. R., Beckmann, J. S., Rush, C. R., & Stoops, W. W. (2016). Buspirone reduces sexual risk-taking intent but not cocaine self-administration. *Experimental and Clinical Psychopharmacology, 24,* 162–173. http://dx.doi.org/10.1037/pha0000076

Briere, J., & Runtz, M. (1993). Childhood sexual abuse: Long-term sequelae and implications for psychological assessment. *Journal of Interpersonal Violence, 8,* 312–330. http://dx.doi.org/10.1177/088626093008003002

Bryan, A., Ray, L. A., & Cooper, M. L. (2007). Alcohol use and protective sexual behaviors among high-risk adolescents. *Journal of Studies on Alcohol and Drugs, 68,* 327–335. http://dx.doi.org/10.15288/jsad.2007.68.327

Carrier Emond, F., Gagnon, J., Nolet, K., Cyr, G., & Rouleau, J. L. (2018). What money can't buy: Different patterns in decision making about sex and money predict sexual coercion perpetration. *Archives of Sexual Behavior, 47,* 429–441. http://dx.doi.org/10.1007/s10508-017-1116-0

Carrier Emond, F., Nolet, K., Rochat, L., Rouleau, J. L., & Gagnon, J. (2020). Inhibitory control in sexually coercive men: Behavioral insights using a stop-signal task with neutral, emotional, and erotic stimuli. *Sexual Abuse, 32,* 301–319. http://dx.doi.org/10.1177/1079063219825866

Celentano, D. D., Latimore, A. D., & Mehta, S. H. (2008). Variations in sexual risks in drug users: Emerging themes in a behavioral context. *Current HIV/AIDS Reports, 5,* 212–218. http://dx.doi.org/10.1007/s11904-008-0030-4

Celio, M. A., MacKillop, J., Caswell, A. J., Mastroleo, N. R., Kahler, C. W., Barnett, N. P., . . . Monti, P. M. (2016). Interactive relationships between sex-related alcohol expectancies and delay discounting on risky sex. *Alcoholism: Clinical and Experimental Research, 40,* 638–646. http://dx.doi.org/10.1111/acer.12988

Centers for Disease Control and Prevention. (2013). *Incidence, prevalence, and cost of sexually transmitted infections in the United States*. Atlanta, GA: Department of Health and Human Services, Centers for Disease Control and Prevention.

Centers for Disease Control and Prevention. (2019). *HIV among gay and bisexual men*. Atlanta, GA: Department of Health and Human Services, Centers for Disease Control and Prevention. Retrieved from https://www.cdc.gov/hiv/group/msm/index.html

Centers for Disease Control and Prevention. (2020). *HIV in the United States: At a glance*. Atlanta, GA: Department of Health and Human Services, Centers for Disease Control and Prevention. Retrieved from https://www.cdc.gov/hiv/statistics/overview/ataglance.html

Chan, S. K., Thornton, L. R., Chronister, K. J., Meyer, J., Wolverton, M., Johnson, C. K., . . . the Centers for Disease Control and Prevention. (2014). Likely female-to-female sexual transmission of HIV—Texas, 2012. *Morbidity and Mortality Weekly Report, 63,* 209–212.

Cheng, W., & Chiou, W. B. (2018). Exposure to sexual stimuli induces greater discounting leading to increased involvement in cyber delinquency among men. *Cyberpsychology, Behavior, and Social Networking, 21,* 99–104. http://dx.doi.org/10.1089/cyber.2016.0582

Chesson, H. W. (2012). Sexonomics: A commentary and review of selected sexually transmitted disease studies in the economics literature. *Sexually Transmitted Diseases, 39,* 161–166. http://dx.doi.org/10.1097/OLQ.0b013e3182389a11

Chesson, H. W., Leichliter, J. S., Zimet, G. D., Rosenthal, S. L., Bernstein, D. I., & Fife, K. H. (2006). Discount rates and risky sexual behaviors among teenagers and young adults. *Journal of Risk and Uncertainty, 32,* 217–230. http://dx.doi.org/10.1007/s11166-006-9520-1

Chimbiri, A. M. (2007). The condom is an 'intruder' in marriage: Evidence from rural Malawi. *Social Science & Medicine, 64,* 1102–1115. http://dx.doi.org/10.1016/j.socscimed.2006.10.012

Chung, S. H., & Herrnstein, R. J. (1967). Choice and delay of reinforcement. *Journal of the Experimental Analysis of Behavior, 10,* 67–74. http://dx.doi.org/10.1901/jeab.1967.10-67

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. New York, NY: Routledge Academic.

Collado, A., Johnson, P. S., Loya, J. M., Johnson, M. W., & Yi, R. (2017). Discounting of condom-protected sex as a measure of high risk for sexually transmitted infection among college students. *Archives of Sexual Behavior, 46,* 2187–2195. http://dx.doi.org/10.1007/s10508-016-0836-x

Cox, D. J., & Dallery, J. (2016). Effects of delay and probability combinations on discounting in humans. *Behavioural Processes, 131,* 15–23. http://dx.doi.org/10.1016/j.beproc.2016.08.002

Cox, D. J., & Dallery, J. (2018). Influence of second outcome on monetary discounting. *Behavioural Processes, 153,* 84–91. http://dx.doi.org/10.1016/j.beproc.2018.05.012

Cox, D. J., Dolan, S. B., Johnson, P., & Johnson, M. W. (2020). Delay and probability discounting in cocaine use disorder: Comprehensive examination of money, cocaine, and health outcomes using gains and losses at multiple magnitudes. *Experimental and Clinical Psychopharmacology*. Advance online publication. http://dx.doi.org/10.1037/pha0000341

Cyders, M. A., Dzemidzic, M., Eiler, W. J., & Kareken, D. A. (2016). An fMRI study of responses to sexual stimuli as a function of gender and sensation seeking: A preliminary analysis. *Journal of Sex Research, 53,* 1020–1026. http://dx.doi.org/10.1080/00224499.2015.1112340

Dariotis, J. K., & Johnson, M. W. (2015). Sexual discounting among high-risk youth ages 18–24: Implications for sexual and substance use risk behaviors. *Experimental and Clinical Psychopharmacology, 23,* 49–58. http://dx.doi.org/10.1037/a0038399

Darke, S., Hall, W., Heather, N., Ward, J., & Wodak, A. (1991). The reliability and validity of a scale to measure HIV risk-taking behaviour among intravenous drug users. *AIDS, 5,* 181–186. http://dx.doi.org/10.1097/00002030-199102000-00008

de La Rochebrochard, E., & Joshi, H. (2013). Children born after unplanned pregnancies and cognitive development at 3 years: Social differentials in the United Kingdom Millennium Cohort. *American Journal of Epidemiology, 178,* 910–920. http://dx.doi.org/10.1093/aje/kwt063

Dermen, K. H., Cooper, M. L., & Agocha, V. B. (1998). Sex-related alcohol expectancies as moderators of the relationship between alcohol use and risky sex in adolescents. *Journal of Studies on Alcohol and Drugs, 59,* 71–77. http://dx.doi.org/10.15288/jsa.1998.59.71

Dolan, S. B., Johnson, P. S., & Johnson, M. W. (2020). The hotel room purchase task: Effects of gender and partner desirability on demand for hypothetical sex in individuals with disordered cocaine use and controls. *Archives of Sexual Behavior, 49,* 1251–1262. http://dx.doi.org/10.1007/s10508-020-01634-w

Dong, D., Wang, Y., Jackson, T., Chen, S., Wang, Y., Zhou, F., & Chen, H. (2016). Impulse control and restrained eating among young women: Evidence for compensatory cortical activation during a chocolate-specific delayed discounting task. *Appetite, 105,* 477–486. http://dx.doi.org/10.1016/j.appet.2016.05.017

Eckstrand, K. L., Choukas-Bradley, S., Mohanty, A., Cross, M., Allen, N. B., Silk, J. S., . . . Forbes, E. E. (2017). Heightened activity in social reward networks is associated with adolescents' risky sexual behaviors. *Developmental Cognitive Neuroscience, 27,* 1–9. http://dx.doi.org/10.1016/j.dcn.2017.07.004

Evenden, J. L., & Ryan, C. N. (1996). The pharmacology of impulsive behaviour in rats: The effects of drugs on response choice with varying delays of reinforcement. *Psychopharmacology, 128,* 161–170. http://dx.doi.org/10.1007/s002130050121

Exavery, A., Kanté, A. M., Jackson, E., Noronha, J., Sikustahili, G., Tani, K., . . . Phillips, J. F. (2012). Role of condom negotiation on condom use among women of reproductive age in three districts in Tanzania. *BMC Public Health, 12,* 1097. http://dx.doi.org/10.1186/1471-2458-12-1097

Feaster, D. J., Parish, C. L., Gooden, L., Matheson, T., Castellon, P. C., Duan, R., . . . Metsch, L. R. (2016). Substance use and STI acquisition: Secondary analysis from the AWARE study. *Drug and Alcohol Dependence, 169,* 171–179. http://dx.doi.org/10.1016/j.drugalcdep.2016.10.027

Foster, D. G., Raifman, S. E., Gipson, J. D., Rocca, C. H., & Biggs, M. A. (2019). Effects of carrying an unwanted pregnancy to term on women's existing children. *The Journal of Pediatrics, 205,* 183–189.e1. http://dx.doi.org/10.1016/j.jpeds.2018.09.026

Gardiner, C. K., Karoly, H. C., Thayer, R. E., Gillman, A. S., Sabbineni, A., & Bryan, A. D. (2018). Neural activation during delay discounting is associated with 6-month change in risky sexual behavior in adolescents. *Annals of Behavioral Medicine, 52,* 356–366. http://dx.doi.org/10.1093/abm/kax028

Gerdts, C., Dobkin, L., Foster, D. G., & Schwarz, E. B. (2016). Side effects, physical health consequences, and mortality associated with abortion and birth after an unwanted pregnancy. *Women's Health Issues, 26,* 55–59. http://dx.doi.org/10.1016/j.whi.2015.10.001

Gignac, G. E., & Szodorai, E. T. (2016). Effect size guidelines for individual differences researchers. *Personality and Individual Differences, 102,* 74–78. http://dx.doi.org/10.1016/j.paid.2016.06.069

Girard, R., Obeso, I., Thobois, S., Park, S. A., Vidal, T., Favre, E., . . . Dreher, J. C. (2019). Wait and you shall see: Sexual delay discounting in hypersexual Parkinson's disease. *Brain: A Journal of Neurology, 142,* 146–162. http://dx.doi.org/10.1093/brain/awy298

Glick, S. N., Morris, M., Foxman, B., Aral, S. O., Manhart, L. E., Holmes, K. K., & Golden, M. R. (2012). A comparison of sexual behavior patterns among men who have sex with men and heterosexual men and women. *Journal of Acquired Immune Deficiency Syndromes, 60,* 83–90.

Green, L., Fristoe, N., & Myerson, J. (1994). Temporal discounting and preference reversals in choice between delayed outcomes. *Psychonomic Bulletin & Review, 1,* 383–389. http://dx.doi.org/10.3758/BF03213979

Green, L., Myerson, J., & Calvert, A. L. (2010). Pigeons' discounting of probabilistic and delayed reinforcers. *Journal of the Experimental Analysis of Behavior, 94,* 113–123. http://dx.doi.org/10.1901/jeab.2010.94-113

Green, L., Myerson, J., & Ostaszewski, P. (1999). Amount of reward has opposite effects on the discounting of delayed and probabilistic outcomes. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 25,* 418–427. http://dx.doi.org/10.1037/0278-7393.25.2.418

Hahn, H., Kalnitsky, S., Haines, N., Thamotharan, S., Beauchaine, T. P., & Ahn, W. Y. (2019). Delay discounting of protected sex: Relationship type and sexual orientation influence sexual risk behavior. *Archives of Sexual Behavior, 48,* 2089–2102. http://dx.doi.org/10.1007/s10508-019-1450-5

Heil, S. H., Johnson, M. W., Higgins, S. T., & Bickel, W. K. (2006). Delay discounting in currently using and currently abstinent cocaine-dependent outpatients and non-drug-using matched controls. *Addictive Behaviors, 31,* 1290–1294. http://dx.doi.org/10.1016/j.addbeh.2005.09.005

Hendrickson, K. L., Rasmussen, E. B., & Lawyer, S. R. (2015). Measurement and validation of measures for impulsive food choice across obese and healthy-weight individuals. *Appetite, 90,* 254–263. http://dx.doi.org/10.1016/j.appet.2015.03.015

Herrmann, E. S., Hand, D. J., Johnson, M. W., Badger, G. J., & Heil, S. H. (2014). Examining delay discounting of condom-protected sex among opioid-dependent women and non-drug-using control women. *Drug and Alcohol Dependence, 144,* 53–60. http://dx.doi.org/10.1016/j.drugalcdep.2014.07.026

Herrmann, E. S., Johnson, P. S., & Johnson, M. W. (2015). Examining delay discounting of condom-protected sex among men who have sex with men using crowdsourcing technology. *AIDS and Behavior, 19,* 1655–1665. http://dx.doi.org/10.1007/s10461-015-1107-x

Hillis, A., Germain, J., Hope, V., McVeigh, J., & Van Hout, M. C. (2020). Pre-exposure Prophylaxis (PrEP) for HIV prevention among men who have sex with men (MSM): A scoping review on PrEP service delivery and programming. *AIDS and Behavior*. Advance online publication. http://dx.doi.org/10.1007/s10461-020-02855-9

Hoffman, W. F., Moore, M., Templin, R., McFarland, B., Hitzemann, R. J., & Mitchell, S. H. (2006). Neuropsychological function and delay discounting in methamphetamine-dependent individuals. *Psychopharmacology, 188,* 162–170. http://dx.doi.org/10.1007/s00213-006-0494-0

Holt, D. D., Green, L., & Myerson, J. (2003). Is discounting impulsive? Evidence from temporal and probability discounting in gambling and non-gambling college students. *Behavioural Processes, 64,* 355–367. http://dx.doi.org/10.1016/S0376-6357(03)00141-4

Holt, D. D., Newquist, M. H., Smits, R. R., & Tiry, A. M. (2014). Discounting of food, sex, and money. *Psychonomic Bulletin & Review, 21,* 794–802. http://dx.doi.org/10.3758/s13423-013-0557-2

Hyde, J. S. (2005). The gender similarities hypothesis. *American Psychologist, 60,* 581–592. http://dx.doi.org/10.1037/0003-066X.60.6.581

Irwin, T. W., Morgenstern, J., Parsons, J. T., Wainberg, M., & Labouvie, E. (2006). Alcohol and sexual HIV risk behavior among problem drinking men who have sex with men: An event level analysis of timeline followback data. *AIDS and Behavior, 10,* 299–307. http://dx.doi.org/10.1007/s10461-005-9045-7

Jarmolowicz, D. P., Bickel, W. K., & Gatchalian, K. M. (2013). Alcohol-dependent individuals discount sex at higher rates than controls. *Drug and Alcohol Dependence, 131,* 320–323. http://dx.doi.org/10.1016/j.drugalcdep.2012.12.014

Jarmolowicz, D. P., Landes, R. D., Christensen, D. R., Jones, B. A., Jackson, L., Yi, R., & Bickel, W. K. (2014). Discounting of money and sex: Effects of commodity and temporal position in stimulant-dependent

men and women. *Addictive Behaviors, 39,* 1652–1657. http://dx.doi.org/10.1016/j.addbeh.2014.04.026

Jarmolowicz, D. P., Lemley, S. M., Asmussen, L., & Reed, D. D. (2015). Mr. right versus Mr. right now: A discounting-based approach to promiscuity. *Behavioural Processes, 115,* 117–122. http://dx.doi.org/10.1016/j.beproc.2015.03.005

Jimura, K., Myerson, J., Hilgard, J., Braver, T. S., & Green, L. (2009). Are people really more patient than other animals? Evidence from human discounting of real liquid rewards. *Psychonomic Bulletin & Review, 16,* 1071–1075. http://dx.doi.org/10.3758/PBR.16.6.1071

Johnson, M. W. (2012). An efficient operant choice procedure for assessing delay discounting in humans: Initial validation in cocaine-dependent and control individuals. *Experimental and Clinical Psychopharmacology, 20,* 191–204. http://dx.doi.org/10.1037/a0027088

Johnson, M. W., & Bickel, W. K. (2002). Within-subject comparison of real and hypothetical money rewards in delay discounting. *Journal of the Experimental Analysis of Behavior, 77,* 129–146. http://dx.doi.org/10.1901/jeab.2002.77-129

Johnson, M. W., & Bickel, W. K. (2008). An algorithm for identifying nonsystematic delay-discounting data. *Experimental and Clinical Psychopharmacology, 16,* 264–274. http://dx.doi.org/10.1037/1064-1297.16.3.264

Johnson, M. W., Bickel, W. K., & Baker, F. (2007). Moderate drug use and delay discounting: A comparison of heavy, light, and never smokers. *Experimental and Clinical Psychopharmacology, 15,* 187–194. http://dx.doi.org/10.1037/1064-1297.15.2.187

Johnson, M. W., & Bruner, N. R. (2012). The Sexual Discounting Task: HIV risk behavior and the discounting of delayed sexual rewards in cocaine dependence. *Drug and Alcohol Dependence, 123,* 15–21. http://dx.doi.org/10.1016/j.drugalcdep.2011.09.032

Johnson, M. W., & Bruner, N. R. (2013). Test-retest reliability and gender differences in the sexual discounting task among cocaine-dependent individuals. *Experimental and Clinical Psychopharmacology, 21,* 277–286. http://dx.doi.org/10.1037/a0033071

Johnson, M. W., Bruner, N. R., Johnson, P. S., Silverman, K., & Berry, M. S. (2020). Randomized controlled trial of d-cycloserine in cocaine dependence: Effects on contingency management and cue-induced cocaine craving in a naturalistic setting. *Experimental and Clinical Psychopharmacology, 28,* 157–168. http://dx.doi.org/10.1037/pha0000306

Johnson, M. W., Herrmann, E. S., Sweeney, M. M., LeComte, R. S., & Johnson, P. S. (2017). Cocaine administration dose-dependently increases sexual desire and decreases condom use likelihood: The role of delay and probability discounting in connecting cocaine with HIV. *Psychopharmacology, 234,* 599–612. http://dx.doi.org/10.1007/s00213-016-4493-5

Johnson, M. W., Johnson, P. S., Herrmann, E. S., & Sweeney, M. M. (2015). Delay and probability discounting of sexual and monetary outcomes in individuals with cocaine use disorders and matched controls. *PLoS ONE, 10,* e0128641. http://dx.doi.org/10.1371/journal.pone.0128641

Johnson, P. S., Sweeney, M. M., Herrmann, E. S., & Johnson, M. W. (2016). Alcohol increases delay and probability discounting of condom-protected sex: A novel vector for alcohol-related HIV transmission. *Alcoholism: Clinical and Experimental Research, 40,* 1339–1350. http://dx.doi.org/10.1111/acer.13079

Jones, J., Guest, J. L., Sullivan, P. S., Sales, J. M., Jenness, S. M., & Kramer, M. R. (2018a). The association between monetary and sexual delay discounting and risky sexual behavior in an online sample of men who have sex with men. *AIDS Care, 30,* 844–852. http://dx.doi.org/10.1080/09540121.2018.1427851

Jones, J., Guest, J. L., Sullivan, P. S., Kramer, M. R., Jenness, S. M., & Sales, J. M. (2018b). Concordance between monetary and sexual delay discounting in men who have sex with men. *Sexual Health, 15,* 214–222. http://dx.doi.org/10.1071/SH17111

Jones, J., & Sullivan, P. S. (2015). Impulsivity as a risk factor for HIV transmission in men who have sex with men: A delay discounting approach. *Journal of Homosexuality, 62,* 588–603. http://dx.doi.org/10.1080/00918369.2014.987568

Jones, J., & Sullivan, P. S. (2016). Age-dependent effects in the association between monetary delay discounting and risky sexual behavior. *SpringerPlus, 5,* 852. http://dx.doi.org/10.1186/s40064-016-2570-1

Kahn, R. E., Holmes, C., Farley, J. P., & Kim-Spoon, J. (2015). Delay discounting mediates parent-adolescent relationship quality and risky sexual behavior for low self-control adolescents. *Journal of Youth and Adolescence, 44,* 1674–1687. http://dx.doi.org/10.1007/s10964-015-0332-y

Kenny, D. A. (2019). Enhancing validity in psychological research. *American Psychologist, 74,* 1018–1028. http://dx.doi.org/10.1037/amp0000531

Khan, M. R., Berger, A., Hemberg, J., O'Neill, A., Dyer, T. P., & Smyrk, K. (2013). Non-injection and injection drug use and STI/HIV risk in the United States: The degree to which sexual risk behaviors versus sex with an STI-infected partner account for infection transmission among drug users. *AIDS and Behavior, 17,* 1185–1194. http://dx.doi.org/10.1007/s10461-012-0276-0

Khurana, A., Romer, D., Betancourt, L. M., Brodsky, N. L., Giannetta, J. M., & Hurt, H. (2012). Early adolescent sexual debut: The mediating role of working memory ability, sensation seeking, and impulsivity. *Developmental Psychology, 48,* 1416–1428. http://dx.doi.org/10.1037/a0027491

Koffarnus, M. N., Jarmolowicz, D. P., Mueller, E. T., & Bickel, W. K. (2013). Changing delay discounting in the light of the competing neurobehavioral decision systems theory: A review. *Journal of the Experimental Analysis of Behavior, 99,* 32–57. http://dx.doi.org/10.1002/jeab.2

Koffarnus, M. N., Johnson, M. W., Thompson-Lake, D. G., Wesley, M. J., Lohrenz, T., Montague, P. R., & Bickel, W. K. (2016). Cocaine-dependent adults and recreational cocaine users are more likely than controls to choose immediate unsafe sex over delayed safer sex. *Experimental and Clinical Psychopharmacology, 24,* 297–304. http://dx.doi.org/10.1037/pha0000080

Lagorio, C. H., & Madden, G. J. (2005). Delay discounting in human subjects when the consequence of every choice is real. *Behavioural Processes, 69,* 173–187. http://dx.doi.org/10.1016/j.beproc.2005.02.003

Lawyer, S. R. (2008). Probability and delay discounting of erotic stimuli. *Behavioural Processes, 79,* 36–42. http://dx.doi.org/10.1016/j.beproc.2008.04.009

Lawyer, S. R., & Mahoney, C. T. (2018). Delay discounting and probability discounting, but not response inhibition, are associated with sexual risk taking in adults. *Journal of Sex Research, 55,* 863–870. http://dx.doi.org/10.1080/00224499.2017.1350627

Lawyer, S. R., & Schoepflin, F. J. (2013). Predicting domain-specific outcomes using delay and probability discounting for sexual versus monetary outcomes. *Behavioural Processes, 96,* 71–78. http://dx.doi.org/10.1016/j.beproc.2013.03.001

Lawyer, S. R., Williams, S. A., Prihodova, T., Rollins, J. D., & Lester, A. C. (2010). Probability and delay discounting of hypothetical sexual outcomes. *Behavioural Processes, 84,* 687–692. http://dx.doi.org/10.1016/j.beproc.2010.04.002

Leeman, R. F., Rowland, B. H. P., Gebru, N. M., & Potenza, M. N. (2019). Relationships among impulsive, addictive and sexual tendencies and behaviours: A systematic review of experimental and prospective studies in humans. *Philosophical Transactions of the Royal Society, 374,* 20180129. http://dx.doi.org/10.1098/rstb.2018.0129

Lemley, S. M., Jarmolowicz, D. P., Parkhurst, D., & Celio, M. A. (2018). The effects of condom availability on college women's sexual discounting. *Archives of Sexual Behavior, 47,* 551–563. http://dx.doi.org/10.1007/s10508-017-1040-3

Levin, E. M., Koopman, J. S., Aral, S. O., Holmes, K. K., & Foxman, B. (2009). Characteristics of men who have sex with men and women and women who have sex with women and men: Results from the 2003 Seattle sex survey. *Sexually Transmitted Diseases, 36,* 541–546. http://dx.doi.org/10.1097/OLQ.0b013e3181a819db

Lodico, M. A., & DiClemente, R. J. (1994). The association between childhood sexual abuse and prevalence of HIV-related risk behaviors. *Clinical Pediatrics, 33,* 498–502. http://dx.doi.org/10.1177/000992289403300810

MacKillop, J., Amlung, M. T., Few, L. R., Ray, L. A., Sweet, L. H., & Munafò, M. R. (2011). Delayed reward discounting and addictive behavior: A meta-analysis. *Psychopharmacology, 216,* 305–321. http://dx.doi.org/10.1007/s00213-011-2229-0

MacKillop, J., Celio, M. A., Mastroleo, N. R., Kahler, C. W., Operario, D., Colby, S. M., . . . Monti, P. M. (2015). Behavioral economic decision making and alcohol-related sexual risk behavior. *AIDS and Behavior, 19,* 450–458. http://dx.doi.org/10.1007/s10461-014-0909-6

Madden, G. J., Begotka, A. M., Raiff, B. R., & Kastern, L. L. (2003). Delay discounting of real and hypothetical rewards. *Experimental and Clinical Psychopharmacology, 11,* 139–145. http://dx.doi.org/10.1037/1064-1297.11.2.139

Madden, G. J., Petry, N. M., & Johnson, P. S. (2009). Pathological gamblers discount probabilistic rewards less steeply than matched controls. *Experimental and Clinical Psychopharmacology, 17,* 283–290. http://dx.doi.org/10.1037/a0016806

Madden, G. J., Raiff, B. R., Lagorio, C. H., Begotka, A. M., Mueller, A. M., Hehli, D. J., & Wegener, A. A. (2004). Delay discounting of potentially real and hypothetical rewards: II. Between- and within-subject comparisons. *Experimental and Clinical Psychopharmacology, 12,* 251–261. http://dx.doi.org/10.1037/1064-1297.12.4.251

Mahoney, C. T., & Lawyer, S. R. (2018). Domain-specific relationships in sexual measures of impulsive behavior. *Archives of Sexual Behavior, 47,* 1591–1599. http://dx.doi.org/10.1007/s10508-018-1210-y

Mazur, J. E. (1987). An adjusting procedure for studying delayed reinforcement. In M. L. Commons, J. E. Mazur, J. A. Nevin, & H. Rachlin (Eds.), *The effect of delay and of intervening events on reinforcement value: Quantitative analyses of behavior* (Vol. V, pp. 55–73). London, UK: Psychology Press.

McClure, S. M., Ericson, K. M., Laibson, D. I., Loewenstein, G., & Cohen, J. D. (2007). Time discounting for primary rewards. *The Journal of Neuroscience, 27,* 5796–5804. http://dx.doi.org/10.1523/JNEUROSCI.4246-06.2007

McClure, S. M., Laibson, D. I., Loewenstein, G., & Cohen, J. D. (2004). Separate neural systems value immediate and delayed monetary rewards. *Science, 306,* 503–507. http://dx.doi.org/10.1126/science.1100907

Meredith, S. E., Sweeney, M. M., Johnson, P. S., Johnson, M. W., & Griffiths, R. R. (2016). Weekly energy drink use is positively associated with delay discounting and risk behavior in a nationwide sample of young adults. *Journal of Caffeine Research, 6,* 10–19. http://dx.doi.org/10.1089/jcr.2015.0024

Mitchell, J. M., Fields, H. L., D'Esposito, M., & Boettiger, C. A. (2005). Impulsive responding in alcoholics. *Alcoholism, Clinical and Experimental Research, 29,* 2158–2169. http://dx.doi.org/10.1097/01.alc.0000191755.63639.4a

Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G., & the PRISMA Group. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *Annals of Internal Medicine, 151,* 264–269. http://dx.doi.org/10.7326/0003-4819-151-4-200908180-00135

Murnane, P. M., Celum, C., Mugo, N., Campbell, J. D., Donnell, D., Bukusi, E., . . . the Partners PrEP Study Team. (2013). Efficacy of preexposure prophylaxis for HIV-1 prevention among high-risk heterosexuals: Subgroup analyses from a randomized trial. *AIDS, 27,* 2155–2160. http://dx.doi.org/10.1097/QAD.0b013e3283629037

Murray, L. K., Nguyen, A., & Cohen, J. A. (2014). Child sexual abuse. *Child and Adolescent Psychiatric Clinics, 23,* 321–337. http://dx.doi.org/10.1016/j.chc.2014.01.003

Negash, S., Sheppard, N. V., Lambert, N. M., & Fincham, F. D. (2016). Trading later rewards for current pleasure: Pornography consumption and delay discounting. *Journal of Sex Research, 53,* 689–700. http://dx.doi.org/10.1080/00224499.2015.1025123

Negriff, S., Noll, J. G., Shenk, C. E., Putnam, F. W., & Trickett, P. K. (2010). Associations between nonverbal behaviors and subsequent sexual attitudes and behaviors of sexually abused and comparison girls. *Child Maltreatment, 15,* 180–189. http://dx.doi.org/10.1177/1077559509356020

Newport, F. (2018, May 22). In U.S., estimate of LGBT population rises to 4.5%. *Gallup News*. Retrieved from https://news.gallup.com/poll/234863/estimate-lgbt-population-rises.aspx

O'Donoghue, T., & Rabin, M. (1999). Doing it now or later. *The American Economic Review, 89,* 103–124. http://dx.doi.org/10.1257/aer.89.1.103

Odum, A. L. (2011). Delay discounting: I'm a k, you're a k. *Journal of the Experimental Analysis of Behavior, 96,* 427–439. http://dx.doi.org/10.1901/jeab.2011.96-423

Odum, A. L., Baumann, A. A., & Rimington, D. D. (2006). Discounting of delayed hypothetical money and food: Effects of amount. *Behavioural Processes, 73,* 278–284. http://dx.doi.org/10.1016/j.beproc.2006.06.008

Odum, A. L., Becker, R. J., Haynes, J. M., Galizio, A., Frye, C. C. J., Downey, H., . . . Perez, D. M. (2020). Delay discounting of different outcomes: Review and theory. *Journal of the Experimental Analysis of Behavior, 113,* 657–679. http://dx.doi.org/10.1002/jeab.589

Oliver, M. B., & Hyde, J. S. (1993). Gender differences in sexuality: A meta-analysis. *Psychological Bulletin, 114,* 29–51. http://dx.doi.org/10.1037/0033-2909.114.1.29

Ong, C. W., Graves, K., Berry, M. S., Odum, A. L., & Twohig, M. P. (2019). Obsessive- compulsive symptoms are associated with increased delay discounting in a novel hand- washing task. *Behavior Analysis: Research and Practice, 19,* 136–149. http://dx.doi.org/10.1037/bar0000096

Ostaszewski, P., Green, L., & Myerson, J. (1998). Effects of inflation on the subjective value of delayed and probabilistic rewards. *Psychonomic Bulletin & Review, 5,* 324–333. http://dx.doi.org/10.3758/BF03212959

Owusu-Edusei, K., Jr., Chesson, H. W., Gift, T. L., Tao, G., Mahajan, R., Ocfemia, M. C. B., & Kent, C. K. (2013). The estimated direct medical cost of selected sexually transmitted infections in the United States, 2008. *Sexually Transmitted Diseases, 40,* 197–201. http://dx.doi.org/10.1097/OLQ.0b013e318285c6d2

Patel, S. A., & Surkan, P. J. (2016). Unwanted childbearing and household food insecurity in the United States. *Maternal and Child Nutrition, 12,* 362–372. http://dx.doi.org/10.1111/mcn.12143

Patinkin, N., Werner, B., Yust, I., Yagil, Y., Drory, M., & Burke, M. (2007). An investigation of the practice of unsafe sex yet repeated HIV testing. *Social Work in Health Care, 44,* 73–90. http://dx.doi.org/10.1300/J010v44n01_07

Petry, N. M. (2001). Delay discounting of money and alcohol in actively using alcoholics, currently abstinent alcoholics, and controls. *Psychopharmacology, 154,* 243–250. http://dx.doi.org/10.1007/s002130000638

Qiao, S., Zhou, G., & Li, X. (2018). Disclosure of same-sex behaviors to health-care providers and uptake of HIV testing for men who have sex with men: A systematic review. *American Journal of Men's Health, 12,* 1197–1214. http://dx.doi.org/10.1177/1557988318784149

Quisenberry, A. J., Koffarnus, M. N., Hatz, L. E., Epstein, L. H., & Bickel, W. K. (2016). The experimental tobacco marketplace I: Substitutability as a function of the price of conventional cigarettes. *Nicotine & Tobacco Research, 18,* 1642–1648. http://dx.doi.org/10.1093/ntr/ntv230

Rachlin, H., & Green, L. (1972). Commitment, choice and self-control. *Journal of the Experimental Analysis of Behavior, 17,* 15–22. http://dx.doi.org/10.1901/jeab.1972.17-15

Rachlin, H., Raineri, A., & Cross, D. (1991). Subjective probability and delay. *Journal of the Experimental Analysis of Behavior, 55,* 233–244. http://dx.doi.org/10.1901/jeab.1991.55-233

Rackstraw, S. (2011). HIV-related neurocognitive impairment—A review. *Psychology, Health & Medicine, 16,* 548–563. http://dx.doi.org/10.1080/13548506.2011.579992

Rasmussen, E. B., Lawyer, S. R., & Reilly, W. (2010). Percent body fat is related to delay and probability discounting for food in humans. *Behavioural Processes, 83,* 23–30. http://dx.doi.org/10.1016/j.beproc.2009.09.001

Reimers, S., Maylor, E. A., Stewart, N., & Chater, N. (2009). Associations between a one-shot delay discounting measure and age, income, education and real-world impulsive behavior. *Personality and Individual Differences, 47,* 973–978. http://dx.doi.org/10.1016/j.paid.2009.07.026

Reynolds, B., Richards, J. B., & de Wit, H. (2006). Acute-alcohol effects on the Experiential Discounting Task (EDT) and a question-based measure of delay discounting. *Pharmacology, Biochemistry, and Behavior, 83,* 194–202. http://dx.doi.org/10.1016/j.pbb.2006.01.007

Reynolds, B., & Schiffbauer, R. (2004). Measuring state changes in human delay discounting: An experiential discounting task. *Behavioural Processes, 67,* 343–356. http://dx.doi.org/10.1016/S0376-6357(04)00140-8

Schiff, S., Amodio, P., Testa, G., Nardi, M., Montagnese, S., Caregaro, L., . . . Sellitto, M. (2016). Impulsivity toward food reward is related to BMI: Evidence from intertemporal choice in obese and normal-weight individuals. *Brain and Cognition, 110,* 112–119. http://dx.doi.org/10.1016/j.bandc.2015.10.001

Scott-Sheldon, L. A., Carey, K. B., Cunningham, K., Johnson, B. T., & Carey, M. P., & the MASH Research Team. (2016). Alcohol use predicts sexual decision-making: A systematic review and meta-analysis of the experimental literature. *AIDS and Behavior, 20,* S19–S39. http://dx.doi.org/10.1007/s10461-015-1108-9

Silovsky, J. F., Niec, L., Bard, D., & Hecht, D. B. (2007). Treatment for preschool children with interpersonal sexual behavior problems: A pilot study. *Journal of Clinical Child and Adolescent Psychology, 36,* 378–391. http://dx.doi.org/10.1080/15374410701444330

Skrynka, J., & Vincent, B. T. (2019). Hunger increases delay discounting of food and non-food rewards. *Psychonomic Bulletin & Review, 26,* 1729–1737. http://dx.doi.org/10.3758/s13423-019-01655-0

Smith, B. J., Xue, F., Droutman, V., Barkley-Levenson, E., Melrose, A. J., Miller, L. C., . . . Read, S. J. (2018). Virtually 'in the heat of the moment': Insula activation in safe sex negotiation among risky men. *Social Cognitive and Affective Neuroscience, 13,* 80–91. http://dx.doi.org/10.1093/scan/nsx137

Smith, K. R., Lawyer, S. R., & Swift, J. K. (2018). A meta-analysis of nonsystematic responding in delay and probability reward discounting. *Experimental and Clinical Psychopharmacology, 26,* 94–107. http://dx.doi.org/10.1037/pha0000167

Sparks, J. C., Isen, J. D., & Iacono, W. G. (2014). Preference on cash-choice task predicts externalizing outcomes in 17-year-olds. *Behavior Genetics, 44,* 102–112. http://dx.doi.org/10.1007/s10519-013-9638-2

Strickland, J. C., Bolin, B. L., Romanelli, M. R., Rush, C. R., & Stoops, W. W. (2017). Effects of acute buspirone administration on inhibitory control and sexual discounting in cocaine users. *Human Psychopharmacology, 32,* e2567. http://dx.doi.org/10.1002/hup.2567

Strickland, J. C., & Johnson M. W. (in press). Rejecting impulsivity as a psychological construct: A theoretical, empirical, and sociocultural argument. *Psychological Review*.

Strickland, J. C., Lile, J. A., & Stoops, W. W. (2017). Unique prediction of cannabis use severity and behaviors by delay discounting and behavioral economic demand. *Behavioural Processes, 140,* 33–40. http://dx.doi.org/10.1016/j.beproc.2017.03.017

Strickland, J. C., Lile, J. A., & Stoops, W. W. (2019). Contribution of cannabis-related cues to concurrent reinforcer choice in humans. *Drug and Alcohol Dependence, 199,* 85–91. http://dx.doi.org/10.1016/j.drugalcdep.2019.02.022

Strickland, J. C., Marks, K. R., Beckmann, J. S., Lile, J. A., Rush, C. R., & Stoops, W. W. (2018). Contribution of cocaine-related cues to concurrent monetary choice in humans. *Psychopharmacology, 235,* 2871–2881. http://dx.doi.org/10.1007/s00213-018-4978-5

Strickland, J. C., Marks, K. R., & Bolin, B. L. (2020). The condom purchase task: A hypothetical demand method for evaluating sexual health decision-making. *Journal of the Experimental Analysis of Behavior, 113,* 435–448. http://dx.doi.org/10.1002/jeab.585

Sweeney, M. M., Berry, M. S., Johnson, P. S., Herrmann, E. S., Meredith, S. E., & Johnson, M. W. (2020). Demographic and sexual risk predictors of delay discounting of condom-protected sex. *Psychology & Health, 35,* 366–386. http://dx.doi.org/10.1080/08870446.2019.1631306

Thamotharan, S., Hahn, H., & Fields, S. (2017). Drug use status in youth: The role of gender and delay discounting. *Substance Use & Misuse, 52,* 1338–1347. http://dx.doi.org/10.1080/10826084.2017.1280831

Traeger, M. W., Cornelisse, V. J., Asselin, J., Price, B., Roth, N. J., Willcox, J., . . . the PrEPX Study Team. (2019). Association of HIV preexposure prophylaxis with incidence of sexually transmitted infections among individuals at high risk of HIV infection. *Journal of the American Medical Association, 321,* 1380–1390. http://dx.doi.org/10.1001/jama.2019.2947

Vanable, P. A., McKirnan, D. J., Buchbinder, S. P., Bartholow, B. N., Douglas, J. M., Jr., Judson, F. N., & MacQueen, K. M. (2004). Alcohol use and high-risk sexual behavior among men who have sex with men: The effects of consumption level and partner type. *Health Psychology, 23,* 525–532. http://dx.doi.org/10.1037/0278-6133.23.5.525

Vanderveldt, A., Green, L., & Myerson, J. (2015). Discounting of monetary rewards that are both delayed and probabilistic: Delay and probability combine multiplicatively, not additively. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 41,* 148–162. http://dx.doi.org/10.1037/xlm0000029

Varghese, B., Maher, J. E., Peterman, T. A., Branson, B. M., & Steketee, R. W. (2002). Reducing the risk of sexual HIV transmission: Quantifying the per-act risk for HIV on the basis of choice of partner, sex act, and condom use. *Sexually Transmitted Diseases, 29,* 38–43. http://dx.doi.org/10.1097/00007435-200201000-00007

Wilson, M., & Daly, M. (2004). Do pretty women inspire men to discount the future? *Proceedings of the Royal Society of London. Series B: Biological Sciences, 271,* S177–S179.

Wingood, G. M., & DiClemente, R. J. (1997). The effects of an abusive primary partner on the condom use and sexual negotiation practices of African-American women. *American Journal of Public Health, 87,* 1016–1018. http://dx.doi.org/10.2105/AJPH.87.6.1016

Wingood, G. M., & DiClemente, R. J. (1998). Partner influences and gender-related factors associated with noncondom use among young adult African American women. *American Journal of Community Psychology, 26,* 29–51. http://dx.doi.org/10.1023/A:1021830023545

Wongsomboon, V., & Robles, E. (2017). Devaluation of safe sex by delay or uncertainty: A within-subjects study of mechanisms underlying sexual risk behavior. *Archives of Sexual Behavior, 46,* 2131–2144. http://dx.doi.org/10.1007/s10508-016-0788-1

Wray, T. B., Simons, J. S., & Maisto, S. A. (2015). Effects of alcohol intoxication and autonomic arousal on delay discounting and risky sex in young adult heterosexual men. *Addictive Behaviors, 42,* 9–13. http://dx.doi.org/10.1016/j.addbeh.2014.10.037

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