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Discounting of money and sex: Effects of commodity and temporal position in stimulant-dependent men and women

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Abstract

Research on delay discounting has contributed to the understanding of numerous addiction-related phenomena. For example, studies have shown that substance dependent individuals discount their addictive substances (e.g., cocaine) more rapidly than they do other commodities (e.g., money).

Recent research has shown that substance dependent individuals discount delayed sex more rapidly than delayed money, and their discounting rates for delayed sex were higher than those of non-addicted individuals. The particular reason that delay discounting rates for sex are higher than those for money, however, are unclear. Do individuals discount delayed sex rapidly because

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immediate sex is particularly appealing or because delayed sex does not retain its value? Moreover, do the same factors influence men and women's choices? The current study examined delay discounting in four conditions (money now versus money later; sex now versus sex later; money now, versus sex later; sex now versus money later) in cocaine dependent men and women. The procedures used isolated the role of the immediate versus delayed commodity. For men, the higher rates of delay discounting for sex were because delayed sex did not retain its value, whereas both the immediate and delayed commodity influenced the female participants' decisions.

Keywords

Delay discounting; sex; cocaine; gender differences; temporal position

1. Introduction

When individuals choose between immediate and larger-yet-delayed rewards, tradeoffs between the size and the immediacy of the rewards occur. Specifically, the subjective value of the delayed commodity decreases (i.e., is discounted) as the delay increases. This phenomenon, called *delay discounting*, is often quantified via Mazur's (1987) hyperbolic discounting equation:

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

which describes how the value (V) of some amount (A) of the commodity decreases at a given rate (k) as it is delayed (D). Because the discounting rate (i.e., k) is the only free parameter in this equation, k is said to quantify this behavioral process.

Substance-dependent individuals discount delayed rewards at higher rates than controls (see Bickel, Jarmolowicz, Mueller, Koffarnus, & Gatchalian, 2012, for a review). Moreover, they discount consumable commodities like cocaine (Bickel et al., 2011a; Coffey, Gudleski, Saladin, & Brady, 2003), heroin (Madden, Bickel, & Jacobs, 1999; Madden, Petry, Badger, & Bickel, 1997), or food (Estle, Green, Myerson, & Holt, 2007; Odum & Baumann, 2007) at a steeper rates than money. This suggests that addicted individuals exhibit a reduced ability to value future events (Bickel, Jarmolowicz, Mueller, Gatchalian, & McClure, 2012; Bickel & Yi, 2008), manifest as impulsive choices, particularly for consumable commodities. Although these studies are typically present choices between hypothetical outcomes, a number of studies have demonstrated that both choice (e.g., Johnson & Bickel, 2002; Kirby & Marakovic, 1996; Madden, Begotka, Raiff, & Kastern, 2003) and patterns of neural activation (Bickel, Pitcock, Yi, & Angtuaco, 2009) are consistent when participants choose between real or between hypothetical outcomes.

Addicted individuals' poor valuation of future events may manifest as impulsive choices for sexual activity (Jarmolowicz, Bickel, & Gatchalian, 2013; Johnson & Bruner, 2011). For example, Jarmolowicz et al. compared delay discounting rates for money and for sexual activity in samples of alcohol-dependent ($n=20$) and control participants ($n=21$). After

determining how many sex acts would be subjectively equivalent to receiving \$1000, participants completed delay discounting assessments for money and for sexual acts. Discounting rates for sexual activity were higher than for money in all participants (cf. Lawyer, Williams, Prihodova, Rollins, & Lester, 2010). Moreover, discounting rates for sexual activity were higher in the alcohol dependent group than in the control group. Hence, like other consumable commodities, delayed sexual activity is discounted at higher rates than delayed money (Lawyer et al., 2010), and addicted individuals discounted delayed sex more steeply than controls.

Impulsive sexual choices may be particularly relevant to cocaine dependence. Cocaine users often make seemingly impulsive sexual choices such as sex with multiple partners, inconsistent condom use, and trading sex for other commodities (typically drugs, food, housing, and/or money; Farley, 2006; Fleming, Lansky, Lee, & Nakashima, 2006). The risk of spreading sexually transmitted infections (STI) and the potential for unwanted pregnancies, make these behaviors a major public health concern (Center for disease control and prevention, 2014; Centers for Disease Control and Prevention, 1998). Understanding the ways which cocaine users devalue delayed sexual activity may inform efforts to curb this seemingly impulsive sexual activity. Using a similar procedure, Johnson and Bruner (2011) examined the discounting of delayed safe sex relative to immediate unprotected sex in sixty cocaine-dependent individuals. After choosing pictures of individuals that they would have sex with, participants indicated the likelihood that they could wait various amounts of time (from one hour to three months) for a condom to have sex with the person 1) they most wanted to have sex with, 2) they least wanted to have sex with, 3) they felt was most likely to have an STI, and 4) they felt was least likely to have an STI. Individuals' ability to wait for a condom decreased as the delays increased, particularly for the individual they most wanted to have sex with, and the individual least likely to have an STI.

As noted above, discounting rates for consumables (e.g., drugs, sex, etc.) tend to be higher than for money. Studies comparing the discounting rates across commodities, however, almost exclusively present choices between some amounts of Commodity A now vs. after a delay. This single-commodity discounting (SCD) may not represent the complex choices encountered outside of the laboratory. In life we often choose between Commodity A now and Commodity B after a delay (e.g., drugs now vs. paycheck later), choices which we will refer to as cross-commodity discounting (CCD).

By presenting the entire array of SCD and CCD conditions, delay discounting studies can isolate the relative roles of the immediate and delayed commodities. For example, Bickel and colleagues (Bickel et al., 2011a) examined SCD for money and cocaine as well as CCD for both cocaine now vs. money later and money now vs. cocaine later. Consistent with previous findings (Coffey et al., 2003), Bickel et al. found SCD for cocaine was steeper than SCD for money. Novel to their experiment, however, CCD rates for cocaine now vs. money later were intermediate to the two SCD rates, yet rates of CCD for money now vs. cocaine later were higher than SCD for cocaine. Bickel et al.'s findings suggest a strong role of the delayed commodity (i.e., delayed cocaine did not retain its value) and lesser effects of the immediate commodity (i.e., immediate cocaine is very appealing).

The present study built from Bickel et al.'s (2011a) and Jarmolowicz et al.'s (2013) findings to examine the relative roles of immediate and delayed sex or money by comparing the SCD and CCD for money and sexual activity in treatment-seeking cocaine-dependent individuals.

2. Methods

2.1 Participants

The data in this study were taken from a subset in a larger study of a novel treatment for cocaine and methamphetamine use. Recruitment for the original study consisted of placing fliers in the local community, and referrals from other study participants. We selected participants who met DSM-IV (American Psychiatric Association, 2000) criteria for cocaine dependence and indicated that cocaine was their drug of choice. Exclusion criteria for the study included dependence on other drugs (other than tobacco), psychological diagnosis that would interfere with informed consent, medical illness that would interfere with participation, age less than 18 years old, pregnancy, and a sex-money equivalency of 3 or less sex acts per \$1000 (see *procedure* for details). All participants from the original study that met this criteria were included in the present study. Thirty-six participants met these criteria (31 men, 5 women). The participants reported here were 47.7 years old on average ($SD=9.0$), with a mean education of 12.5 years ($SD: 1.1$) and mean annual income of \$11,963 ($SD: \$10,964$). The sample was composed of 36% single participants, 40% divorced, 16% married, 4% widowed, and 4% legally separated.

2.2 Delay Discounting Procedure

Participant responses to delay-discounting measures were recorded during the first session of the overall study, prior to any treatment intervention. Participants completed the delay measures as part of a series of other assessments. In this analysis, we compare only the data from the two SCD and the two CCD measures that were collected at that time.

Delay-discounting measures were presented using a computer program similar to previous studies of delay discounting (Du, Green, & Myerson, 2002; Johnson & Bickel, 2002) with the addition of cross-commodity conditions. All measures used hypothetical amounts of money or hypothetical amounts of sex. Prior to starting the discounting procedure, participants were asked to give their estimate of how many sexual encounters would be worth \$1,000 to them. The question presented to them was similar to the following example:

I want you to imagine that you have the opportunity to have sex with your ideal sexual partner. Think about who that person would be. It could be someone you know, someone famous, or a fictional character. **Write that person's name on a sheet of paper** for your reference throughout the following tasks. No one other than you will see this paper, and staff will destroy the paper after this assessment. For the following scenario, I want you to imagine that you have a choice of receiving some money and engaging in a series of sexual encounters with your ideal sexual partner that you have written on the sheet of paper. In the following question, fill in the number of sexual encounters that would make the two choices equally attractive to you.

Receiving \$1,000 right now would be just as attractive as engaging in _____ sexual encounters.

Only data collected from participants who selected cocaine as their preferred stimulant were used in this study. For each delay discounting measure that included sex, researchers entered the estimated equivalent \$1000 worth of sex for each participant into the discounting program. Next, each participant completed four delay discounting measures in a counterbalanced order: money now versus money later (M-M), sex now sex later (S-S), sex now versus money later (S-M), and money now versus sex later (M-S).

Each discounting task consisted of a series of trials where participants chose between an amount of the commodity available immediately and an amount of the commodity available after a hypothetical delay. Trials in the SCD conditions (M-M and S-S) were presented in a format identical to previous studies of discounting, money, and drugs (Madden et al., 1999). The novel CCD (S-M and M-S) conditions looked similar to the following example:

S-M example: Would you rather have _____ sexual encounters now or \$1000 after a 6-month delay?

M-S example: Would you rather have \$500 now or _____ sexual encounters after a 6-month delay?

The initial amount offered for the immediate choice was 50% of the undiscounted value (only whole numbers of sexual acts were presented); the delayed amount was always the undiscounted amount. For example, if a participant completing a S-S measure indicated that \$1000 was subjectively worth 8 sexual encounters, the immediate number of sexual encounters offered initially was 4 in each trial while the number of sexual encounters offered after a delay was always the undiscounted amount (i.e., 8). For conditions with money, the immediate value was initially set at \$500 and the delayed value was fixed at \$1000.

The discounting measures employed a decreasing adjusting amount paradigm (Du et al., 2002) to determine the values offered in each successive trial. When the participants chose one of the two options, the immediate amount offered in the next trial was adjusted by +/– 50% of the current offer. If the participant chose the immediate amount, the immediate amount decreased by 50%; if s/he chose the delayed amount, the immediate offer increased by 50%. Participants made the choice between immediate and delayed amounts six times for each of the seven delays (1 day, 1 week, 1 month, 6 months, 1 year, 5 years, and 25 years). The sixth choice for each delay was used as the estimated indifference point, or the value at which the participant would be indifferent between immediate and delayed option. Thus, the estimated preference for each delayed commodity ranged between 0.8% and 100% of the undiscounted amount, describing those who always chose the immediate to those who always chose the delayed option, respectively. The discount rate for each measure was then calculated using these seven indifference points.

2.3 Data Analysis

We compared mean discounting rates across the different discounting conditions. The four conditions under study were framed in a 2×2 factorial framework (see Table 1), with a 2×2 ANOVA permitting a test of whether (a) altering the immediate commodity changes

discounting rates, while holding the delayed commodity constant, (b) altering the delayed commodity changes discounting rates, while holding the immediate commodity constant, or (c) whether the alteration in (a) or (b) depends on the constant commodity. These three effects provide valuable insight into both the commodity types (money and sex) and times to obtaining the commodity (immediate and delayed). In addition, we compare between the SCD conditions to replicate previous findings and between the CCD conditions for the novelty of this study.

3. Results

Data from the M-M (Median $R^2 = 0.89$; IQR = 0.76 – 0.95), S-S (Median $R^2 = 0.89$; IQR = 0.80, 0.96), M-S (Median $R^2 = 0.55$; IQR = 0.16, 0.76), and S-M (Median $R^2 = 0.87$; IQR = 0.81, 0.90) conditions were well described by the hyperbolic discounting equation (cf. M-S). Figure 1 shows the $\ln(k)$ in each condition for each individual, as well as the mean $\ln(k)$ (± 1 standard error) for each condition. Log transformed discounting rates, $\ln(k)$, were highest in the M-S condition (2.7926), followed by the S-S (-1.4394), M-M (-3.0526), and S-M (-4.9242) conditions.

Comparing the SCD conditions, the mean of S-S was estimated to be 1.6132 higher [95% CI: (-0.4072, 3.6335)] than the M-M mean, yet this difference was not statistically significant ($t[102] = 1.58, p = .1164$). However, the two CCD conditions, S-M and M-S, did statistically differ ($t[102] = 7.58, p < .0001$). Comparing conditions wherein sex was delayed, switching the immediate commodity from sex (S-S) to money (M-S) increased discounting by 4.2320 [95% CI: (2.2116, 6.2523), $t[102] = 4.15, p < .0001$]. Comparing conditions wherein money was delayed, switching the immediate commodity from money (M-M) to sex (S-M) decreased discounting by 1.8716 [95% CI: (-0.1487, 3.8920), $t[102] = 1.84, p = .0690$].

Figure 2 shows the $\ln(k)$ data broken down by gender. The ordinal position of discounting rates (i.e., M-S highest, then S-S, M-M, and S-M) was consistent across genders, but gender differences in delay discounting were evident. Specifically, $\ln(k)$ values for men's discounting M-S were 2.799 lower than women's discounting M-S [95% CI: (-0.4532, 2.8990), $t[117] = 1.70, p = .0909$], whereas $\ln(k)$ values for men's discounting S-M and S-S were 3.3628 [95% CI: (0.11060, 6.6149), $t[117] = 2.05, p = 0.0428$] and 3.2355 [95% CI: (-0.01667, 6.4876), $t[117] = 1.97, p = 0.0512$] higher, respectively. Although a significant difference was only obtained in the S-M comparison, the differences in $\ln(k)$ were robust suggesting that comparisons with greater power (i.e., more than 5 female participants) may have revealed other significant differences. By contrast, the only condition in which the gender comparison was neither robust or significant was the condition not entailing decisions about sex (i.e., M-M): the $\ln(k)$ was 0.3531 higher in men [95% CI: (-2.8990, 3.6053), $t[117] = 0.22, p = .8301$]. These gender differences manifest in S-S being significantly higher than M-M in men (diff = 3.0543, $t[102] = 4.02, p = .0001$) but not women (diff = 0.1720, $t[102] = 0.09, p = .9277$) participants. Moreover, conditions with delayed money (S-M vs. M-M) and conditions with delayed sex (S-S vs. M-S) did not differ significantly in male participants (delayed money (diff = 0.3668, $t[102] = 0.48, p = .6300$); delayed sex (diff = 1.2147, $t[102] = 1.60, p = .1127$)) but did in female participants (delayed

money (diff = 3.3764, $t[102] = 1.79, p=.0771$); delayed sex (diff = 7.2492, $t[102] = 3.83, p = .0002$).

Figure 3 shows the data from Figure 1 averaged across immediate (top panel) and delayed (bottom panel) commodities. When averaging over delayed commodities, switching the immediate commodity from money to sex decreased the mean $\ln(k)$ by 3.0518 [95% CI: (1.6232, 4.4804), $t[102] = 4.24, p<.0001$]. On the other hand, when averaging over the immediate commodities, changing the delayed commodity from money to sex, the mean $\ln(k)$ significantly increased by 4.6649 [95% CI: (3.2363, 6.0936), $t[102] = 6.48, p < .0001$]. There was no significant interaction between the immediate and delayed commodities ($F[1,102] = 2.68, p = .1044$).

Figure 4 shows the same data as Figure 3 separated into male (open circles) and female (closed circles) participants. Although changing the immediate commodity from money to sex decreases the mean $\ln(k)$ by 5.3128 in women, changing the immediate commodity from money to sex only decreases the mean $\ln(k)$ by 0.7908 in men, representing a significant interaction of gender with the immediate commodity ($F[1, 102] = 9.85, p=.0022$). By contrast, changing the delayed commodity from money to sex resulted in a 5.4848 increase in $\ln(k)$ for women, and a 3.8451 increase in $\ln(k)$ for men, not a significant interaction ($F[1, 102] = 1.30, p=.2577$).

4. Discussion

Patterns of discounting for sexual outcomes bore the same quantitative signature as the discounting of other commodities like money or drugs (Bickel, Jarmolowicz, Mueller, Koffarnus, et al., 2012), further demonstrating the generality of delay discounting processes. Consistent with previous studies, delay discounting rates were higher for sex than money (Jarmolowicz et al., 2013; Lawyer et al., 2010). Moreover, consistent with Bickel et al. (2011), the CCD procedures provided insight into the relative roles of the immediate and delayed commodities. Discounting, rates, however, may have interacted with both commodity and gender in potentially interesting ways.

Discounting rates in conditions that entailed delayed sex were higher than the discounting rates in conditions that entailed delayed money. These elevated rates of sexual discounting expand findings from alcohol-dependent individuals (Jarmolowicz et al., 2013) and non-clinical populations (Jarmolowicz et al., 2013; Lawyer, 2008; Lawyer et al., 2010) to cocaine dependence. While these findings should be viewed cautiously because SCD rates only significantly differed in men (discussed below), these data, and previous comparisons of discounting delayed money versus delayed cocaine (Bickel et al., 2011a; Coffey et al., 2003), heroin (Madden et al., 1999; Madden et al., 1997), alcohol (Petry, 2001), and food (Estle et al., 2007; Odum & Baumann, 2007), suggest that consumable commodities (e.g., sex, drugs, food, ect.) are discounted at higher rates than money (see Bickel, Jarmolowicz, Mueller, Koffarnus, et al., 2012, for a review).

Moreover, sexual discounting rates relate to individuals' levels of sexual excitability (Lawyer & Schoepflin, 2013). Thus, cocaine-dependent individuals' high sexual discounting

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rates may contribute to their elevated HIV risk. Using a related procedure, Johnson and Bruner (2011) found that cocaine-dependent individuals' likelihood of waiting for safe sex rapidly decreased as the delay to condom access increased, particularly when the potential sex partner was very attractive. Combined with the rapid devaluation of delayed sex in the current study, Johnson and Bruner's data suggest that any delay in condom access may preempt safe sexual practices. As such, low cost/free and readily available condoms may decrease the spread of HIV amongst this population.

Studies demonstrating elevated discounting rates for consumable commodities, however, generally say little about the variables driving these differential rates. For example, in Jarmolowicz et al.'s (2013) comparison of S-S and M-M conditions both the immediate (sex vs. money) and the delayed commodity (sex vs. money) differed, obscuring the relative contribution of immediate vs. delayed commodities. It was unclear if immediate sex was particularly appealing and/or if delayed sex failed to retain its value. The current study isolated variables responsible for this rapid discounting of delayed sex. Specifically, conditions in the present experiment facilitated comparisons of: (1) discounting rates for delayed sex (i.e., S-S & M-S) to those of delayed money (i.e., M-M & S-M), irrespective of the immediate commodity, and (2) discounting rates for immediate sex (i.e., S-S, S-M) to those entailing immediate money (i.e., MM, M-S), irrespective of the delayed commodity. Thus, the CCD conditions isolated the influences of immediate and delayed sex, enabling assertions about the cause of the discrepant SCD rates.

In a similar analysis of discounting cocaine versus money, Bickel et al. (2011b) found that the elevated discounting rates in their cocaine now, cocaine later condition were due to the devaluation of delayed cocaine. The current study also found that devaluing the delayed commodity significantly impacted choice. The findings of the current study, however, suggest that the immediate commodity significantly impacted women's choices. Hence, the delayed commodity consistently drives the elevated discounting rates seen for consumable commodities, whereas the role of the immediate commodity may differ based on the commodity (e.g., sex vs. cocaine) or participant characteristics (e.g., gender).

As noted above, the relative roles of immediate versus delayed sex appear to have interacted with gender. Specifically, the immediate commodity significantly impacted choice in women ($n = 5$) but not men ($n = 31$). This gender-related differential impact of the immediate commodity on discounting rates may explain why the SCD significantly differed in men but not women (cf. Jarmolowicz et al., 2013). These gender-related findings, however, should be viewed cautiously for at least two reasons. 1) Sexual discounting was examined in 5 female participants and 31 male participants. Stronger statements could be made from a larger and more balanced sample. And, 2) the reasons for this difference are unclear. Bickel et al (2011) did not report their data by gender, however, so we cannot determine the generality of this potential gender effect. Future research should examine this unexpected, yet robust, finding.

Additional research should address limitations of the present research. First, this study was conducted in treatment-seeking cocaine-dependent individuals. Although all sessions were conducted prior to treatment procedures, this population may differ from other cocaine users. Additionally, as is often the case with this population, the present participants had

poverty level incomes, and many of the participants were unemployed. A replication of this study in individuals with higher incomes would add to the generality of the present findings. This experiment should be repeated in non-treatment-seeking individuals. Moreover, no comparisons were made to non-drug using individuals. Future studies, which make such a comparison, could make stronger statements regarding the generality of the present findings. Additionally, although drug users may make many of their sexual decisions while under the influence, the present study only examined decision making while the participants were sober. Future studies that examine decision making in intoxicated participants may provide additional, ecologically valid, data. Also, although manipulating of the number of immediate versus delayed sex acts is consistent with the approach used to equating quantities of money to drugs (Bickel et al., 2011a) and other reinforcers such as health (Odum, Madden, & Bickel, 2002; Petry, 2003), freedom (Petry, 2003), and even sex (Jarmolowicz et al., 2013), it limits the conclusions that can be made. For example, the discounting algorithm resulted in participants with sex/money equivalences lower than 4 sex acts/\$1000 being excluded from the analysis. Future studies should develop an algorithm that allows all data to be included. Moreover, although this approach is consistent with Jarmolowicz et al.'s approach, it differed from the Lawyer et al. (2010), and the Johnson and Bruner (2011) approaches. All three approaches, however, yield consistent findings (i.e., orderly discounting of delayed sex), highlighting the generality of the sexual discounting process.

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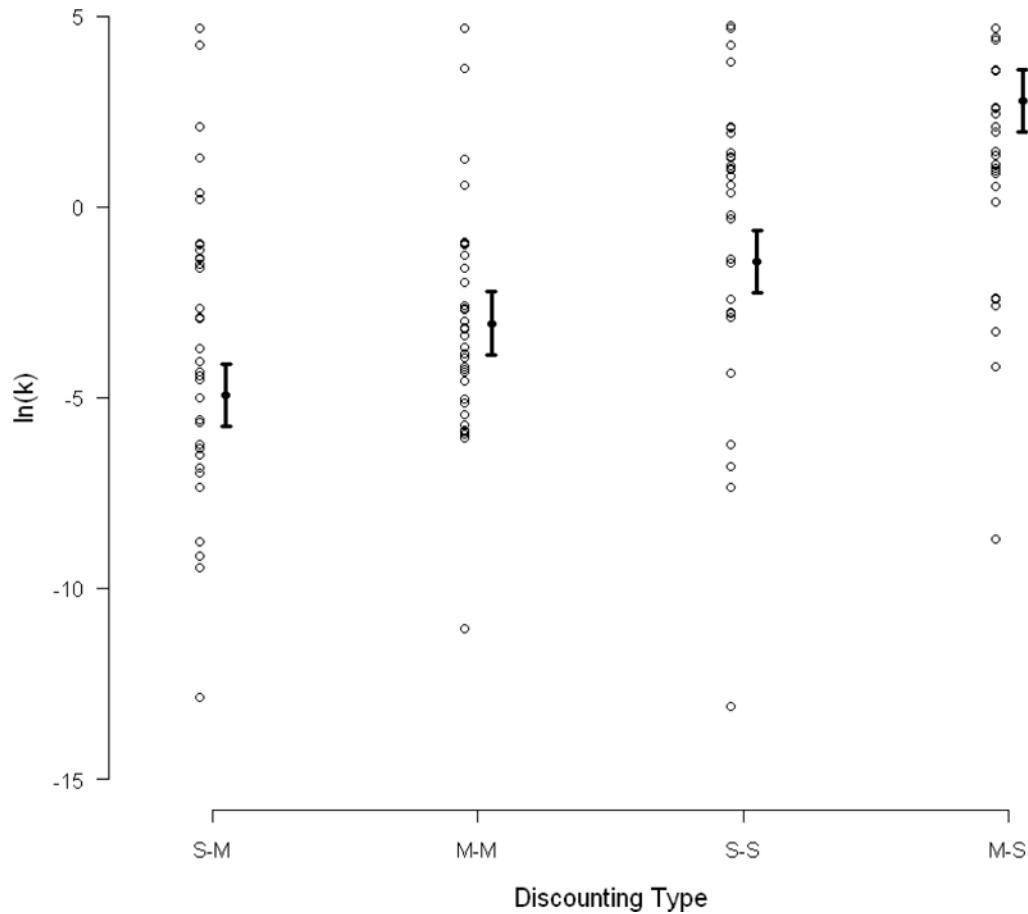
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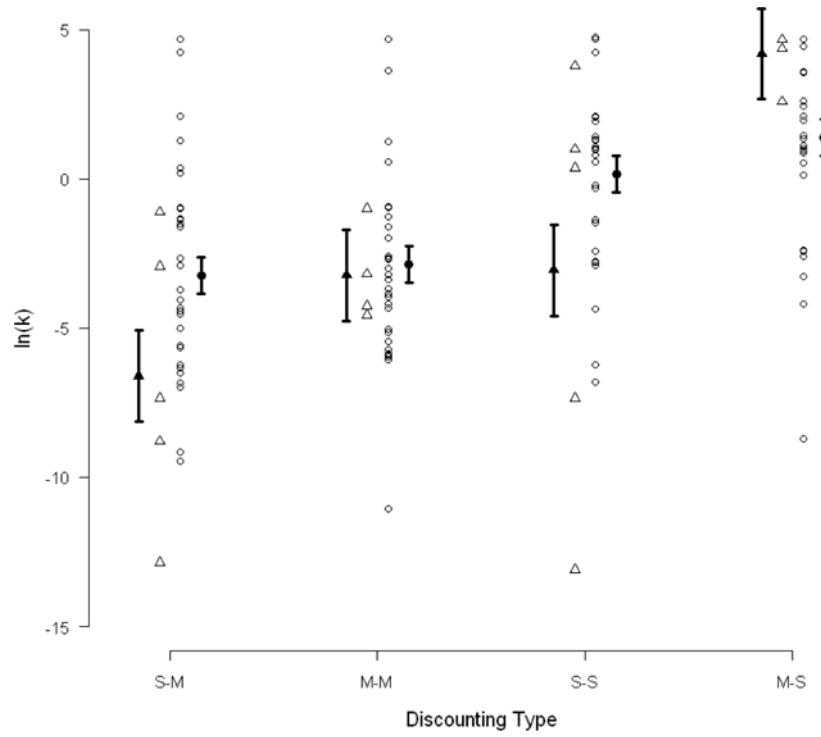
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Highlights

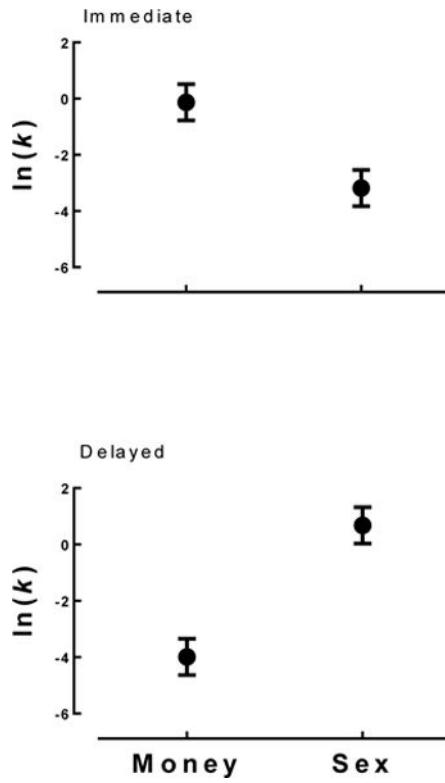
- Cocaine users rates of delay discounting were higher for delayed sex than delayed money
- For men, this appeared to be because delayed sex did not maintain its value
- For the small sample of women, it appears that this delayed sex was rapidly discounted because it did not retain its value and because immediate sex was particularly appealing

**Figure 1.**

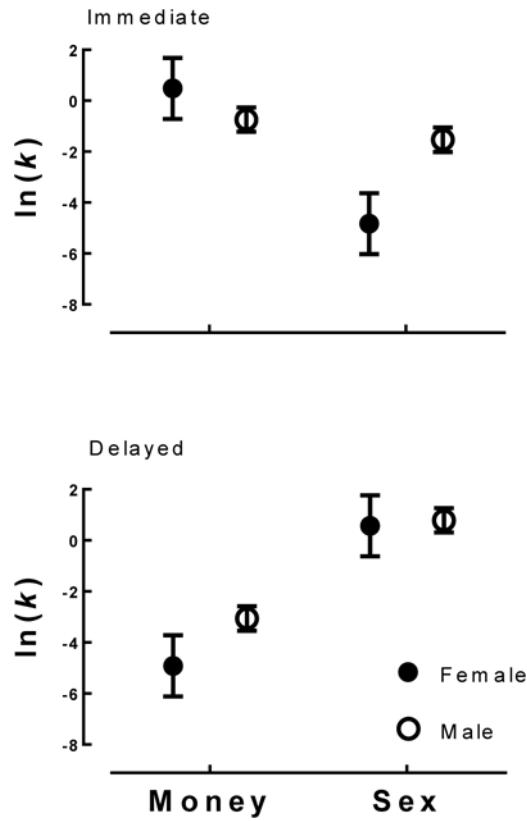
Means (closed circles) and standard errors (error bars) of discounting rates ($\ln[k]$; y-axis) across each of the four delay discounting conditions (money now, money later [M-M], sex now, sex later [S-S], money now, sex later [M-S], and sex now, money later [S-M]; x-axis). Individuals' delay discounting rates ($\ln[k]$) are shown to the left of each condition mean (open circles).

**Figure 2.**

Mean delay discounting rates ($\ln[k]$) for male (closed circles) and female (closed triangles) participants across each of the four delay discounting conditions (money now, money later [M-M], sex now, sex later [S-S], money now, sex later [M-S], and sex now, money later [S-M]; x-axis). Error bars show one standard error or the mean. Delay discounting rates for individual male participants (open circles) are to the left of the male participant condition means whereas discounting rates for individual female participants (open triangles) are to the right of the female participant condition means.

**Figure 3.**

The top panel shows mean delay discounting rates ($\ln[k]$) for averaged across conditions entailing immediate money (money now, money later [M-M] & money now, sex later [M-S]) versus immediate sex (sex now, sex later [S-S] & sex now, money later [S-M]). Error bars show one standard error of the mean. The bottom panel shows mean delay discounting rates ($\ln[k]$) for averaged across conditions entailing delayed money (M-M & S-M) versus delayed sex (S-S & M-S). Error bars show one standard error of the mean.

**Figure 4.**

The top panel shows mean delay discounting rates ($\ln[k]$) for averaged across conditions entailing immediate money (money now, money later [M-M] & money now, sex later [M-S]) versus immediate sex (sex now, sex later [S-S] & sex now, money later [S-M]). Error bars show one standard error of the mean. The bottom panel shows mean delay discounting rates ($\ln[k]$) for averaged across conditions entailing delayed money (M-M & S-M) versus delayed sex (S-S & M-S). Data for male participants is indicated by closed circles, whereas data for female participants is shown by open circles. Error bars show one standard error of the mean.

Table 1

Four discounting conditions in a 2×2 framework

		Delayed Commodity	
		<i>Sex</i>	<i>Money</i>
Immediate	<i>Sex</i>	S-S	S-M
Commodity	<i>Money</i>	M-S	M-M