Delay Discounting: Innovation in Understanding Risk Behavior

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Medicine’s Biggest Challenge: Behavior

- HIV and other STI prevention
- Sedentary lifestyle (lack of exercise)
- Obesity
- Nutrition
- Drug abuse (including tobacco and alcohol)
- Preventative medicine (e.g., screenings)
- Medication compliance (e.g., psychiatric, HIV antiretrovirals)
- Impaired driving
- Gambling

Preventable illness estimated to cost U.S. 1.3 trillion annually (DeVol & Bedroussian, 2007)
What ties these behaviors together?

Delay discounting: Devaluation of future consequences
Money delay discounting choice presentation

Receive $600.00 right away

Wait 1 year and then receive $1,000.00

Option 1

Option 2
Delay Discounting And Drug Addictions

- Immediate short-lived effects of drug use vs. delayed but valuable improvements in functioning with sustained abstinence
Heavy and Light Cigarette Smokers vs. Controls

Steeper Delay Discounting Associated with Drug Use Disorders

• Tobacco
  Baker et al., 2003
  Bickel et al., 1999
  Heyman & Gibb, 2006
  Johnson et al., 2007
  Mitchell, 1999
  Reynolds, 2006

• Alcohol
  Bjork et al., 2004
  Claus et al., 2011
  Mitchell et al., 2005
  Petry, 2001
  Vuchinich & Simpson, 1998
  Yankelevitz et al., 2012

• Cocaine
  Heil, et al., 2006
  Coffey, et al., 2003
  Johnson, 2012

• Opioids
  Kirby & Petry, 2004
  Kirby et al., 1999
  Madden et al., 1997

• Methamphetamine
  Hoffman et al., 2006
  Hoffman et al., 2008
  Monterosso et al., 2007

• Marijuana (trend)
  Johnson et al. 2010
Associated with Treatment Response

- Preference for smaller sooner rewards associated with poor response to drug dependence treatment (e.g., MacKillop & Kahler 2009; Sheffer et al 2012; Stanger et al 2012; Washio et al 2011)
Hyperbolic Discounting: A Quantitative Account of Preference Reversal

Value = $e^{-k \times \text{Delay}}$

Value = $1/(k \times \text{Delay})$
Beyond Drugs: Increased Discounting of Future is Pervasive in Maladaptive Behavior

• Obesity
• Skipping breakfast
• Not using safety belts
• Not using sunscreen
• No having mammograms
• Not having Pap smears
• No having prostrate examinations
• Not having dental visits
• Not having cholesterol tests
• Not getting a flu shot
• Lack of exercise

Axon et al., 2009; Bradford, 2010; Daugherty & Brase, 2010; Dixon et al., 2003; MacKillop et al., 2011; Weller et al., 2008
Delay discounting and HIV sexual risk

- Abuse of certain drugs (cocaine, methamphetamine, alcohol) is associated with increased rates of sexual risk and HIV infection
- HIV risk research consistent with hyperbolic delay discounting
  - Engagement in HIV sexual risk despite knowledge of risk
  - Continued risk behavior despite repeated testing
- Delay discounting may model the choice between immediate unprotected sex (less valuable given the increased risk of HIV and other health problems) vs. waiting for a condom to have protected sex (more valuable given a healthier life)
Sexual Discounting Task in Cocaine Dependence
Johnson & Bruner (2012) Drug and Alcohol Dependence

• Participant asked to imagine there was no chance of pregnancy, and that he/she was not in a committed relationship

• Viewed 60 photos of individuals (30 female, 30 male)

• Selected all photos of people he/she would be willing to have casual sex with based on appearance (could select from 0 to all 60 photos)

• Among all selected photos, participant identified the person:
  1. Least likely to have an STI
  2. Most likely to have an STI
  3. He/she least wants to have sex with
  4. He/she most wants to have sex with
     (1 photo could serve for multiple categories)

• For each of the 4 categories (random order) participant completed 8 visual analog scales (VAS; 100 mm line) with that photo in sight:
• Visual analog scale 1: No delay trial

I will definitely have sex with this person without a condom.

I will definitely have sex with this person with a condom.

• Visual analog scales 2-8: Delay trials

I will definitely have sex with this person now without a condom.

I will definitely wait 1 hour to have sex with this person with a condom.
Results (N=62)

- Orderly effects of delay
- Differences discounting dependent on partner
- Astonishing effect of delay in this high risk group
<table>
<thead>
<tr>
<th>Delay discounting condition</th>
<th>Hyperbolic best describes</th>
<th>Exponential best describes</th>
<th>Equivalent fits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sexual Discounting Task (all conditions combined)</td>
<td>70 (46.1%)</td>
<td>27 (17.8%)</td>
<td>55 (36.2%)</td>
</tr>
<tr>
<td>Least want to have sex with</td>
<td>18 (47.4%)</td>
<td>7 (18.4%)</td>
<td>13 (34.2%)</td>
</tr>
<tr>
<td>Most want to have sex with</td>
<td>15 (39.5%)</td>
<td>8 (21.0%)</td>
<td>15 (39.5%)</td>
</tr>
<tr>
<td>Least likely to have STI</td>
<td>20 (52.6%)</td>
<td>4 (10.5%)</td>
<td>14 (36.8%)</td>
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<tr>
<td>Most likely to have STI</td>
<td>17 (44.7%)</td>
<td>8 (21.1%)</td>
<td>13 (34.2%)</td>
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<tr>
<td>Money delay discounting</td>
<td>36 (94.7%)</td>
<td>2 (5.3%)</td>
<td>0 (0.0%)</td>
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## Relationship between sex and money, and to real world sexual risk

Pearson’s r (p values)

<table>
<thead>
<tr>
<th>Condition</th>
<th>HRBS Sexual Risk Score</th>
<th>Money discounting</th>
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<tbody>
<tr>
<td>Least want to have sex with</td>
<td>−.273 (.03)*</td>
<td>.080 (.54)</td>
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<tr>
<td>Most want to have sex with</td>
<td>−.127 (.33)</td>
<td>.125 (.34)</td>
</tr>
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<td>Least likely to have STI</td>
<td>−.249 (.05)*</td>
<td>.146 (.26)</td>
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<tr>
<td>Most likely to have STI</td>
<td>−.268 (.04)*</td>
<td>.326 (.01)*</td>
</tr>
<tr>
<td>Money discounting</td>
<td>−.162 (.21)</td>
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•3 of 4 sexual discounting conditions, but not money discounting, was sig. correlated with self-reported HIV risk behavior
Area Under the Curve

![Graph showing the area under the curve for median likelihood of condom use against delay (hours).]
Test-retest reliability (N=31)
Johnson & Bruner (2013) Experimental and Clinical Psychopharmacology

Least Want to Have Sex With

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126 18-24 year young adults

Preference for immediate, unprotected sex in the 'most want to have sex with' and 'least likely to have an STI' conditions was significantly related to more lifetime risky sexual partners.
Men Who Have Sex With Men (MSM) Sexual Delay Discounting Related to Drug Use

Most want to have sex with
- Illicit drug use other than marijuana (n = 21)
- No illicit drug use other than marijuana (n = 55)

Least want to have sex with

Least likely to have STI

Most likely to have STI
Cocaine Dependent vs. Controls
Sexual Delay Discounting

Most want to have sex with

Most likely to have STI

Least want to have sex with

Least likely to have STI
Cocaine Dependent vs. Controls
Sexual Probability Discounting

Most want to have sex with

Least want to have sex with

Median likelihood of condom use

Odds Against STI

- Control (n = 18)
- Cocaine (n = 11)
Effects of Buspirone – Stoops, Univ. of Kentucky

Least want to have sex with

Most want to have sex with

Least likely to have an STI

Most likely to have an STI
Sexual Probability Discounting in Undergrads (N=58) Collaboration with Richard Yi

- Chlamydia
- Genital Herpes
- ALL STIs
- HIV/AIDS

Graphs showing median likelihood of condom use against odds against STI.
Opioid Dependent Women (N=27) vs. Controls (N=33) with Sarah Heil Laboratory

Most want to have sex with

Least want to have sex with

Least likely to have STI

Most likely to have STI

Normalized likelihood of condom use

Delay (hours)
Acute Drug Effects on Sexual Discounting
Dose Effects of Methamphetamine (N=11)

Most want to have sex with

Most likely to have STI

Least likely to have STI

Least want to have sex with
Dose- and Time-Related Effects of Methamphetamine on Sexual Desire

"Sexual Desire"

Mean Rating

Time (minutes)

- 0
- 20
- 40
Effect Of Methamphetamine on Sexual Discounting Depends on Sexual Desire
Effects of Alcohol (1 g/kg) on Sexual Delay Discounting (N=14)
Effects of Alcohol (1 g/kg) on Sexual Probability Discounting (N=14)

Most want to have sex with

Least want to have sex with

Median likelihood of condom use vs. Odds Against STI
Effects of Hypothetical Cocaine Use on Sexual Discounting (N=11)

Most want to have sex with

Most likely to have STI

Least want to have sex with

Least likely to have STI
Current and Future Directions

- Acute effects of cocaine (R01)
- Develop methods to decrease delay discounting in drug dependent individuals (R01)
- Alcohol acute dose effects (submitted R01)
Collaborations Involving the Sexual Discounting Task and Other Discounting Tasks

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- Sherecce Fields, Ph.D. (Texas A&M)
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- Margaret Zeller, Ph.D. (Univ. of Cincinnati College of Medicine)
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