Delay Discounting: Innovation in Understanding Risk Behavior

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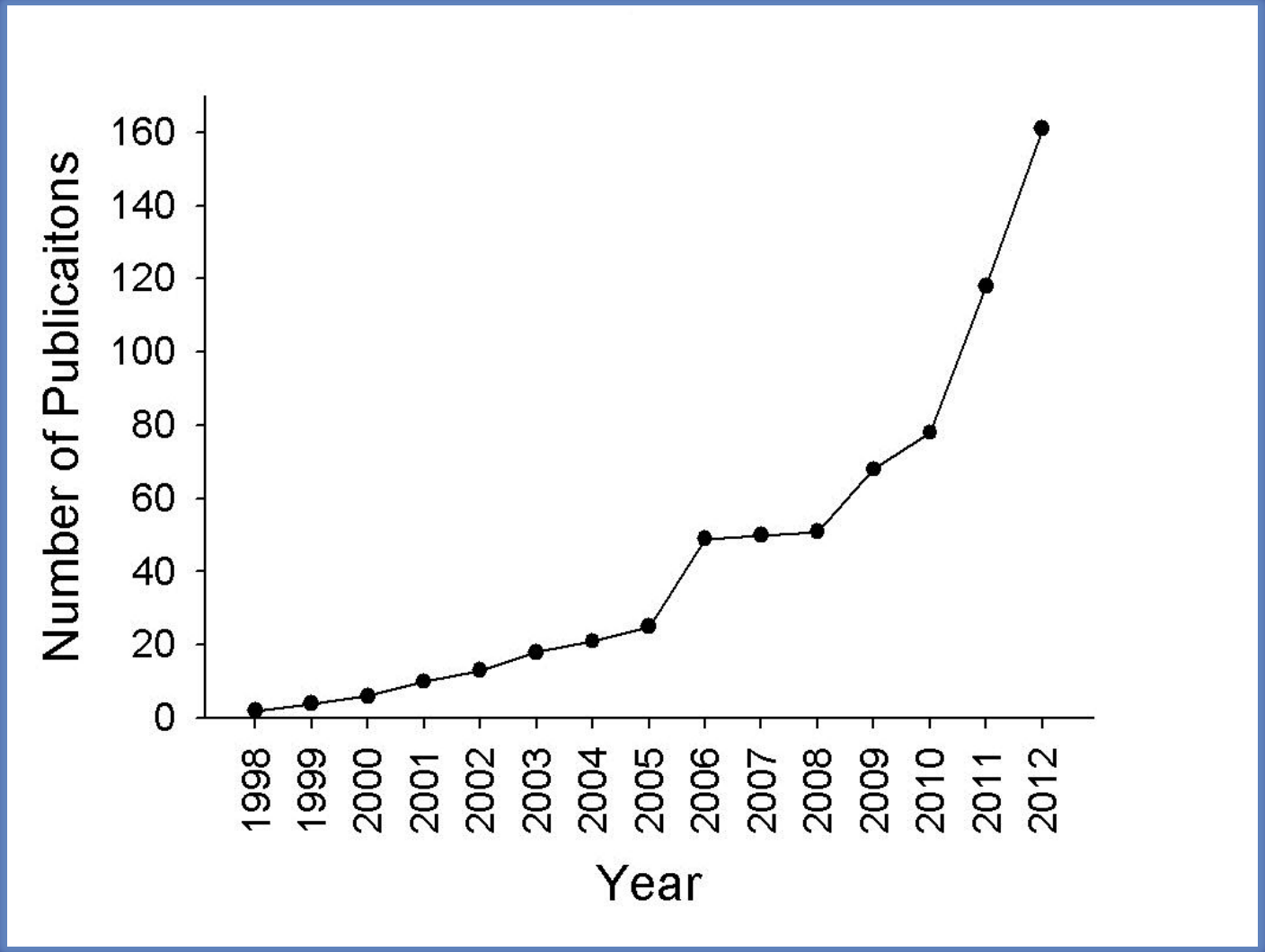
PubMed Hits/Year for Delay Discounting



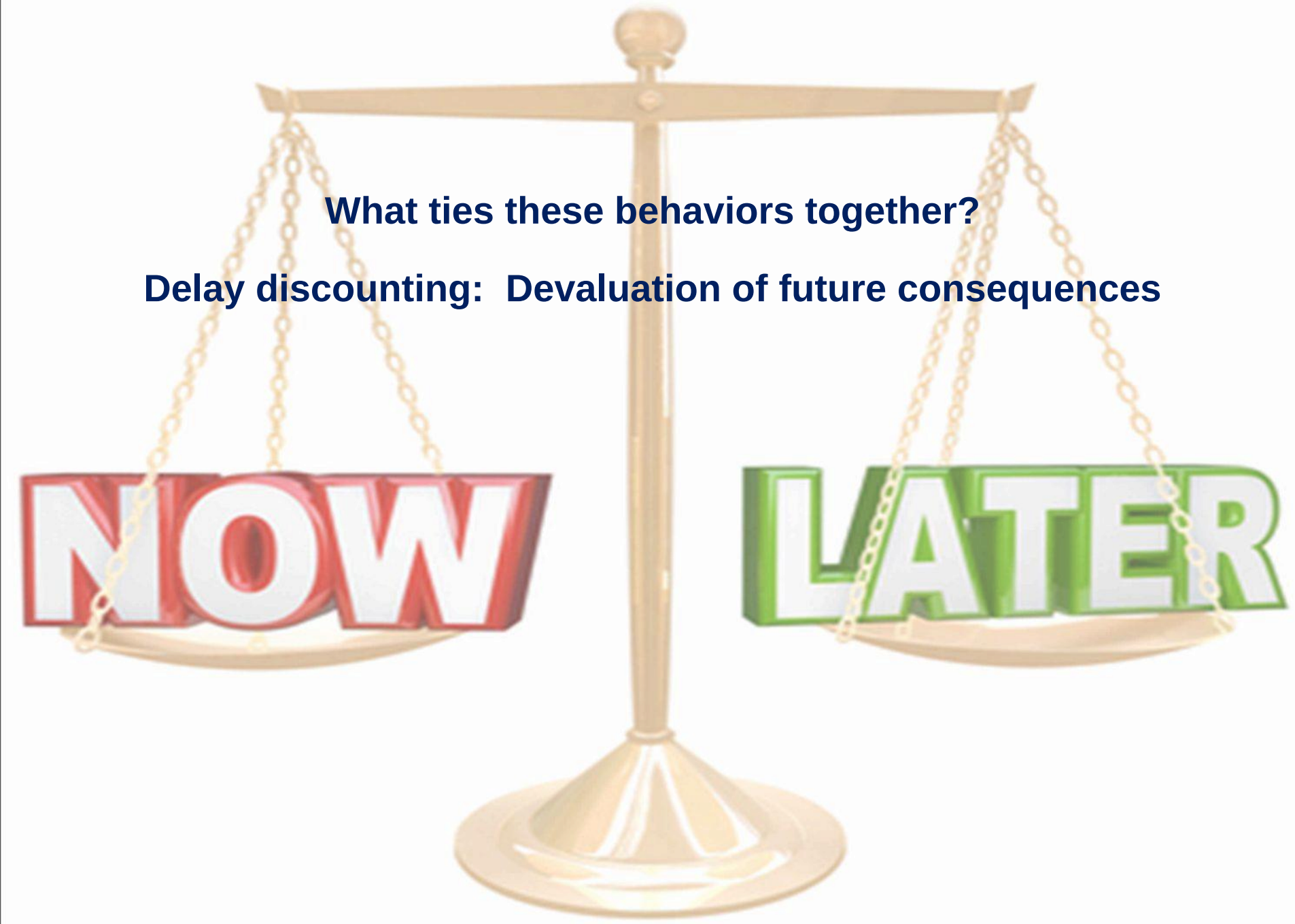
Medicine's Biggest Challenge: Behavior

- 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

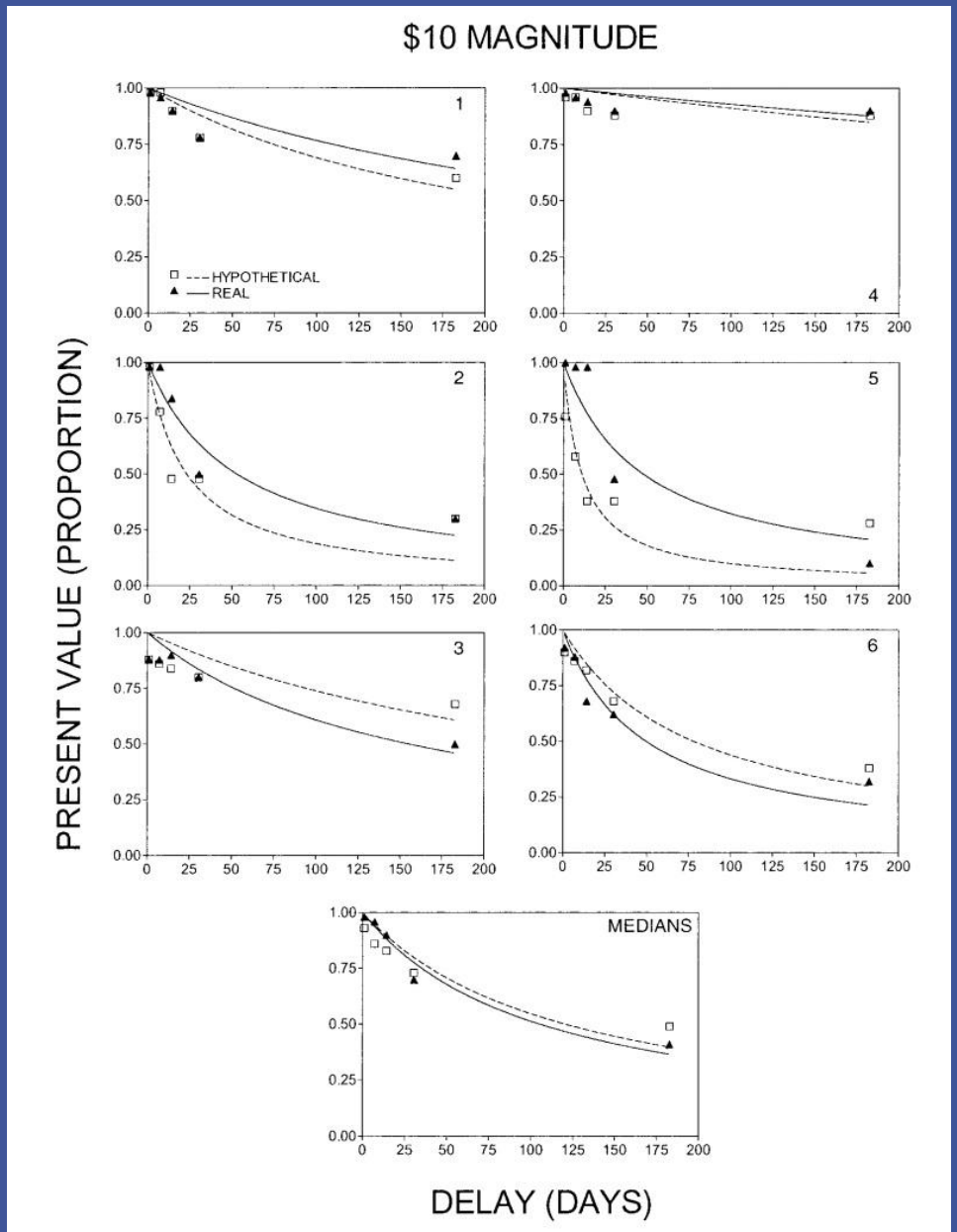
Receive $600.00 right away

Option 1

Wait 1 year and then receive $1,000.00

Option 2

Johnson & Bickel (2002)
Journal of the Experimental Analysis of Behavior

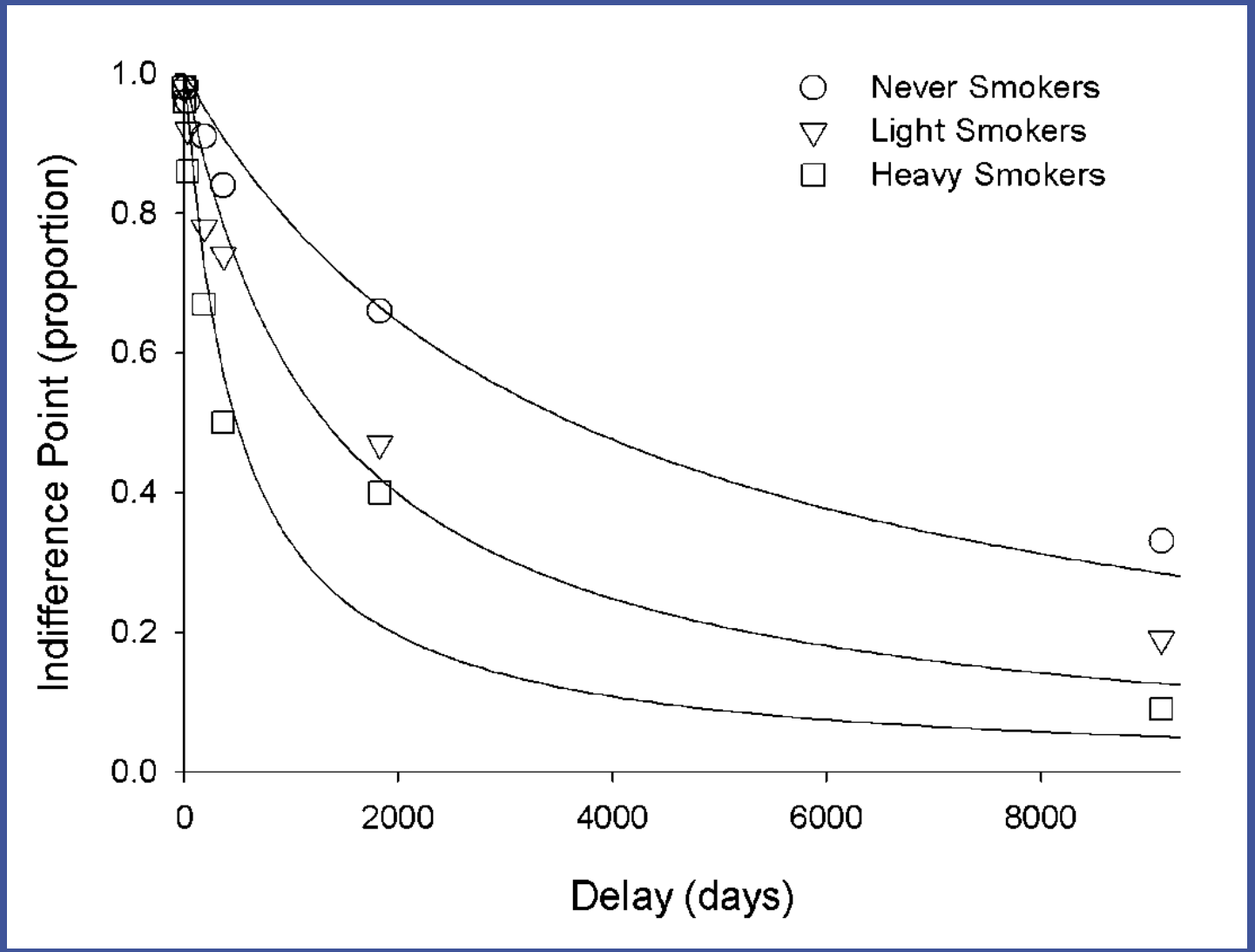


Delay Discounting And Drug Addictions

- **Immediate short-lived effects of drug use vs. delayed but valuable improvements in functioning with sustained abstinence**

Heavy and Light Cigarette Smokers vs. Controls

Johnson Baker Bickel (2007) Experimental and Clinical Psychopharmacology



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

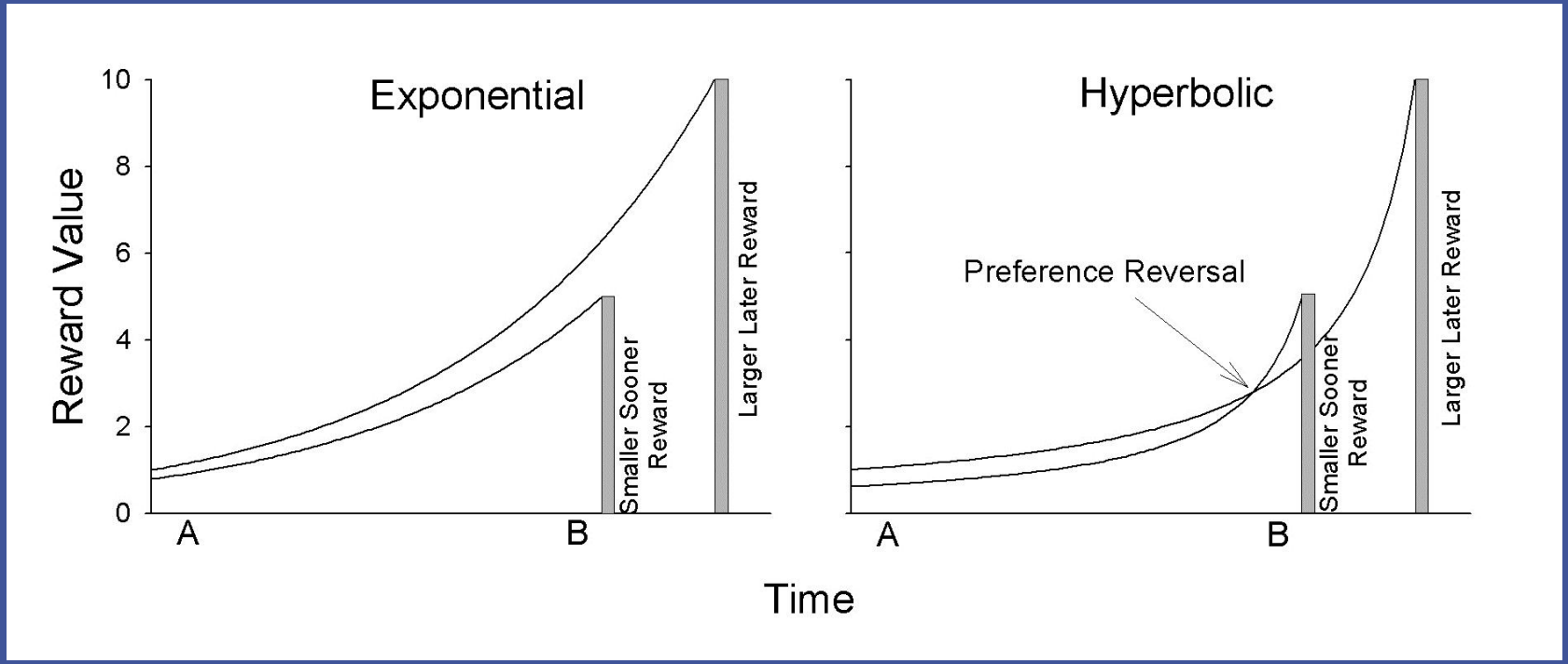
Associated with Treatment Response

- **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 x 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

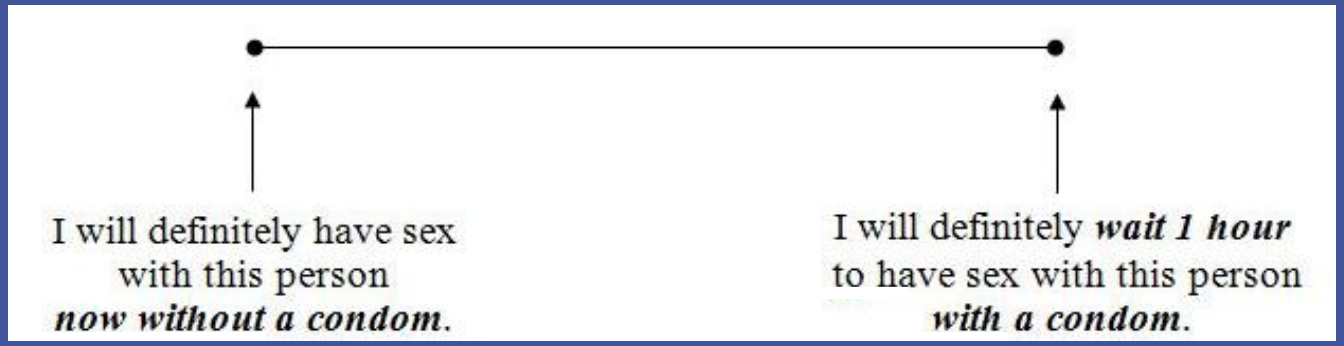
- Participant asked to imagine there was no chance of pregnancy, and that he/she was not in a committed relationship
- Viewed 60 photos of individuals (30 female, 30 male)
- Selected all photos of people he/she would be willing to have casual sex with based on appearance (could select from 0 to all 60 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:

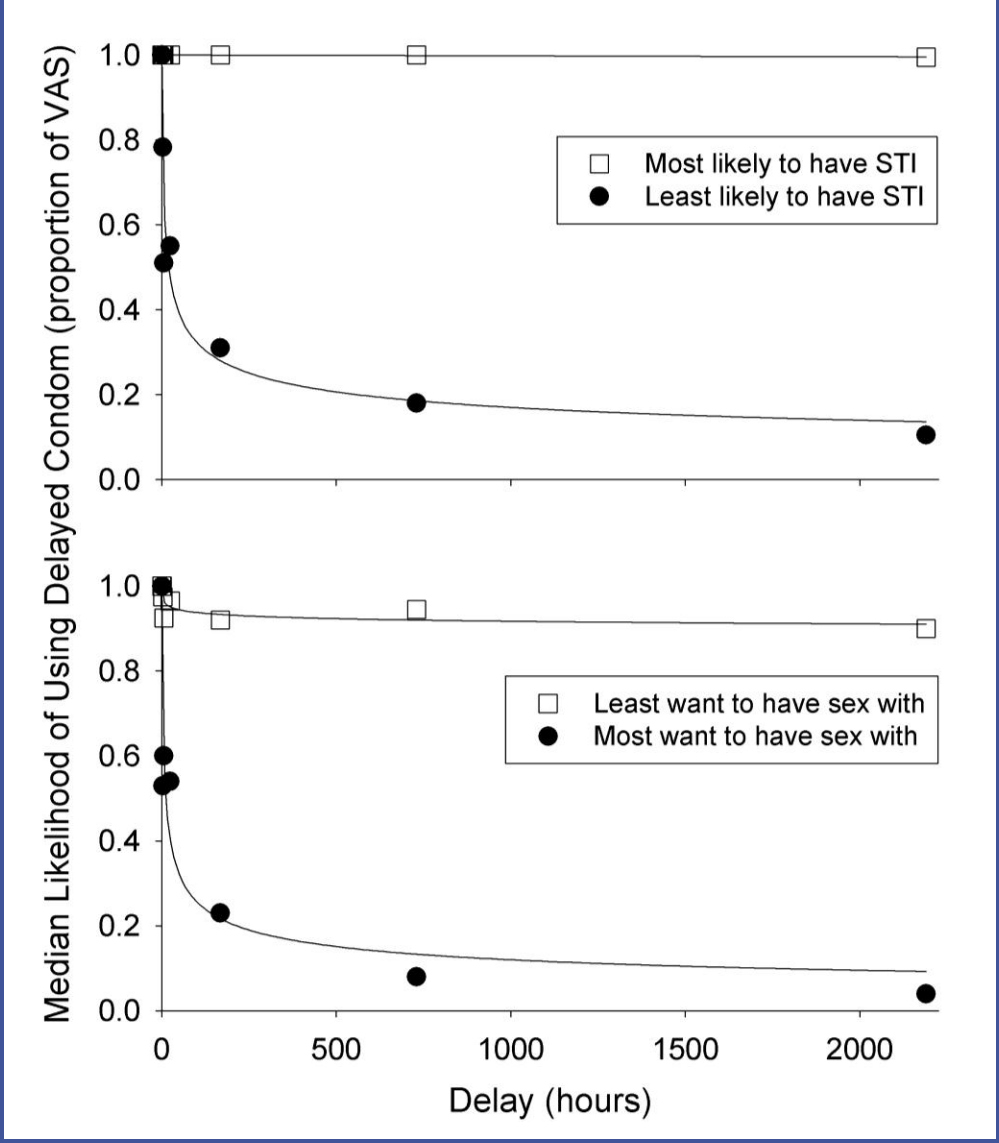
Example Photos

- **Visual analog scale 1: No delay trial**

- **Visual analog scales 2-8: Delay trials**



Results (N=62)



- Orderly effects of delay
- Differences discounting dependent on partner
- Astonishing effect of delay in this high risk group

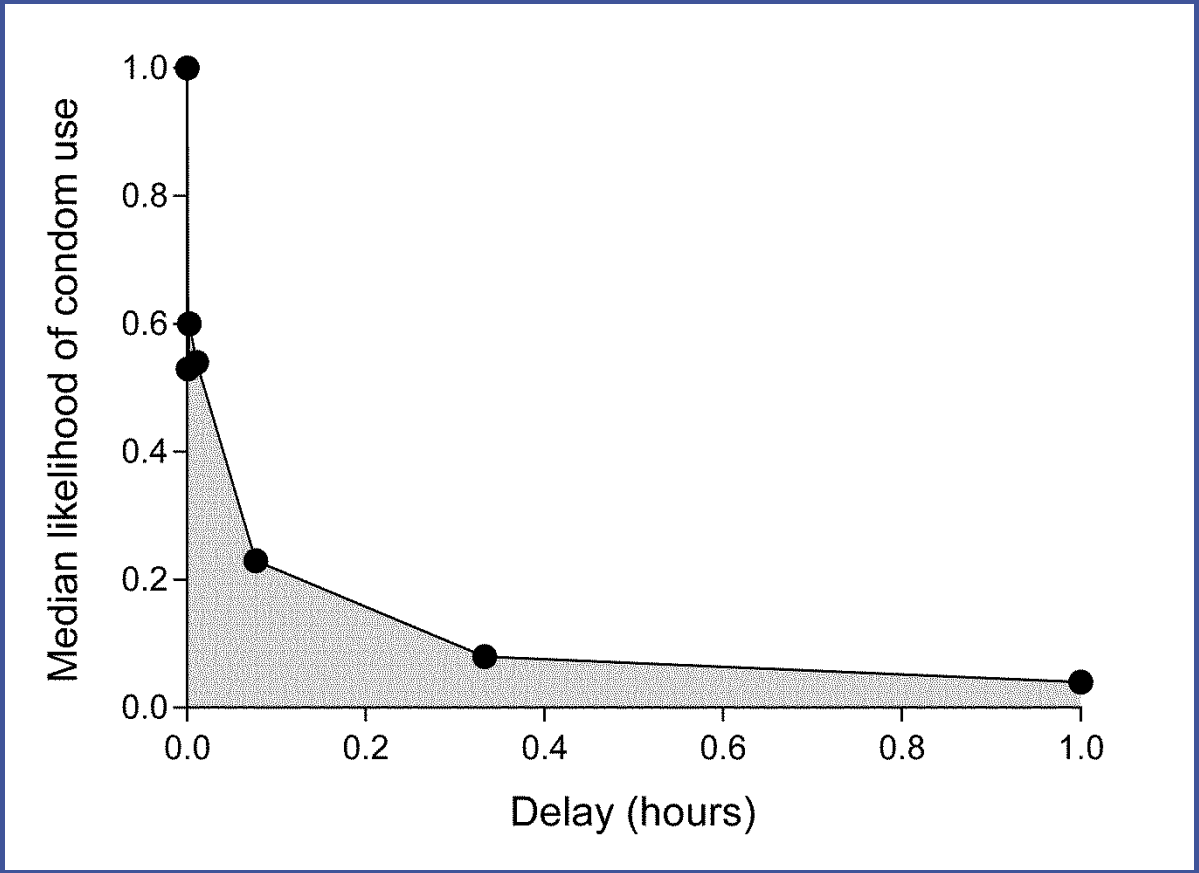
Delay discounting condition	Hyperbolic best describes	Exponential best describes	Equivalent fits
Sexual Discounting Task (all conditions combined)	70 (46.1%)	27 (17.8%)	55 (36.2%)
Least want to have sex with	18 (47.4%)	7 (18.4%)	13 (34.2%)
Most want to have sex with	15 (39.5%)	8 (21.0%)	15 (39.5%)
Least likely to have STI	20 (52.6%)	4 (10.5%)	14 (36.8%)
Most likely to have STI	17 (44.7%)	8 (21.1%)	13 (34.2%)
Money delay discounting	36 (94.7%)	2 (5.3%)	0 (0.0%)

Relationship between sex and money, and to real world sexual risk Pearson's r (p values)

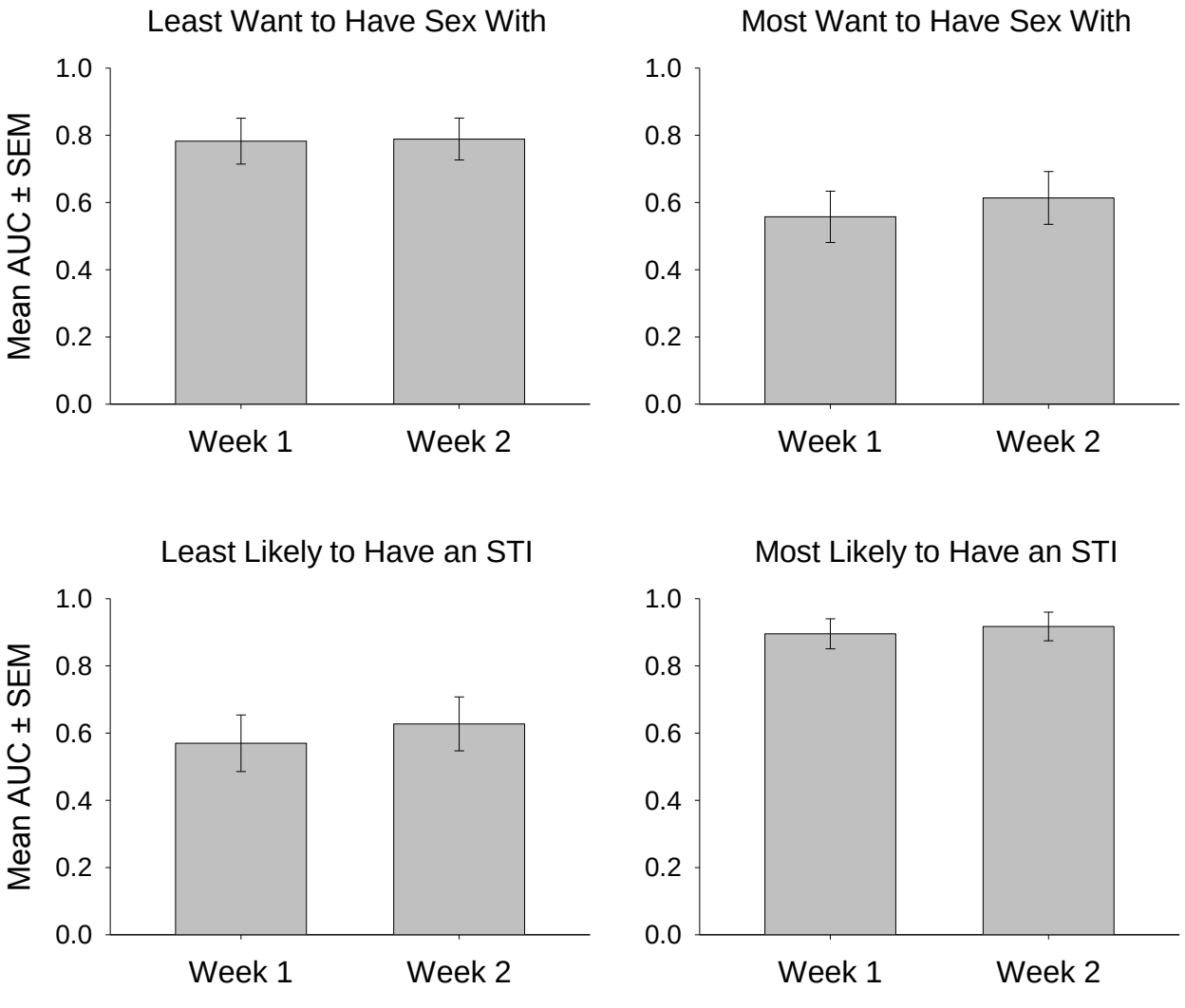
Condition	HRBS Sexual Risk Score	Money discounting
Least want to have sex with	−.273 (.03)*	.080 (.54)
Most want to have sex with	−.127 (.33)	.125 (.34)
Least likely to have STI	−.249 (.05)*	.146 (.26)
Most likely to have STI	−.268 (.04)*	.326 (.01)*
Money discounting	−.162 (.21)	-

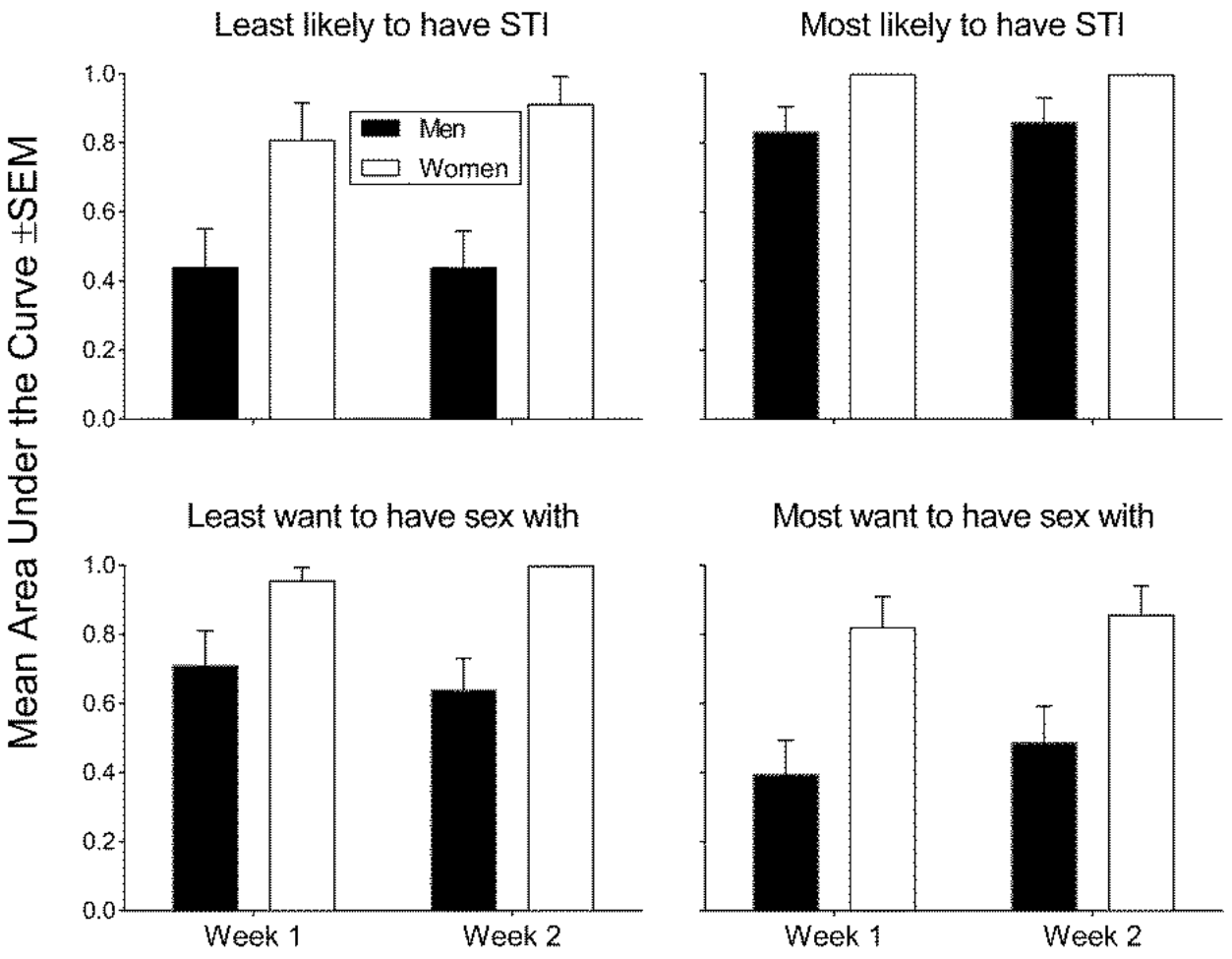
- 3 of 4 sexual discounting conditions, but not money discounting, was sig. correlated with self-reported HIV risk behavior

Area Under the Curve



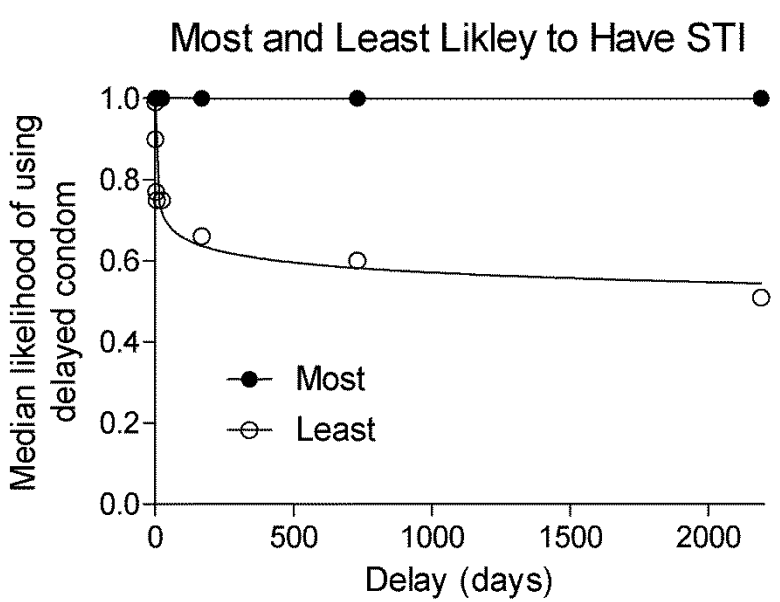
Test-retest reliability (N=31)
Johnson & Bruner (2013) Experimental and Clinical Psychopharmacology

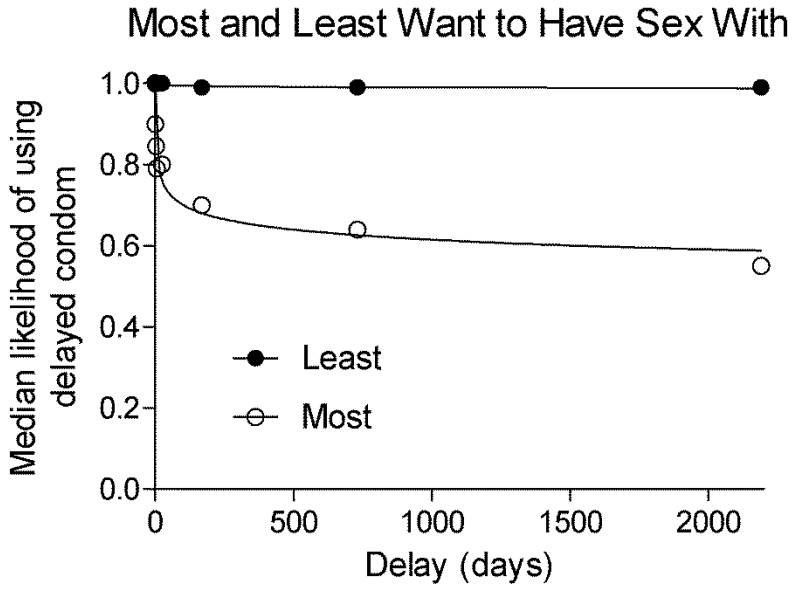



Least likely to have STI
Most likely to have STI
Least want to have sex with
Most want to have sex with
Mean Area Under the Curve ±SEM
1.0
0.8
0.6
0.4
0.2
0.0
Men
Women
Week 1
Week 2
Week 1
Week 2

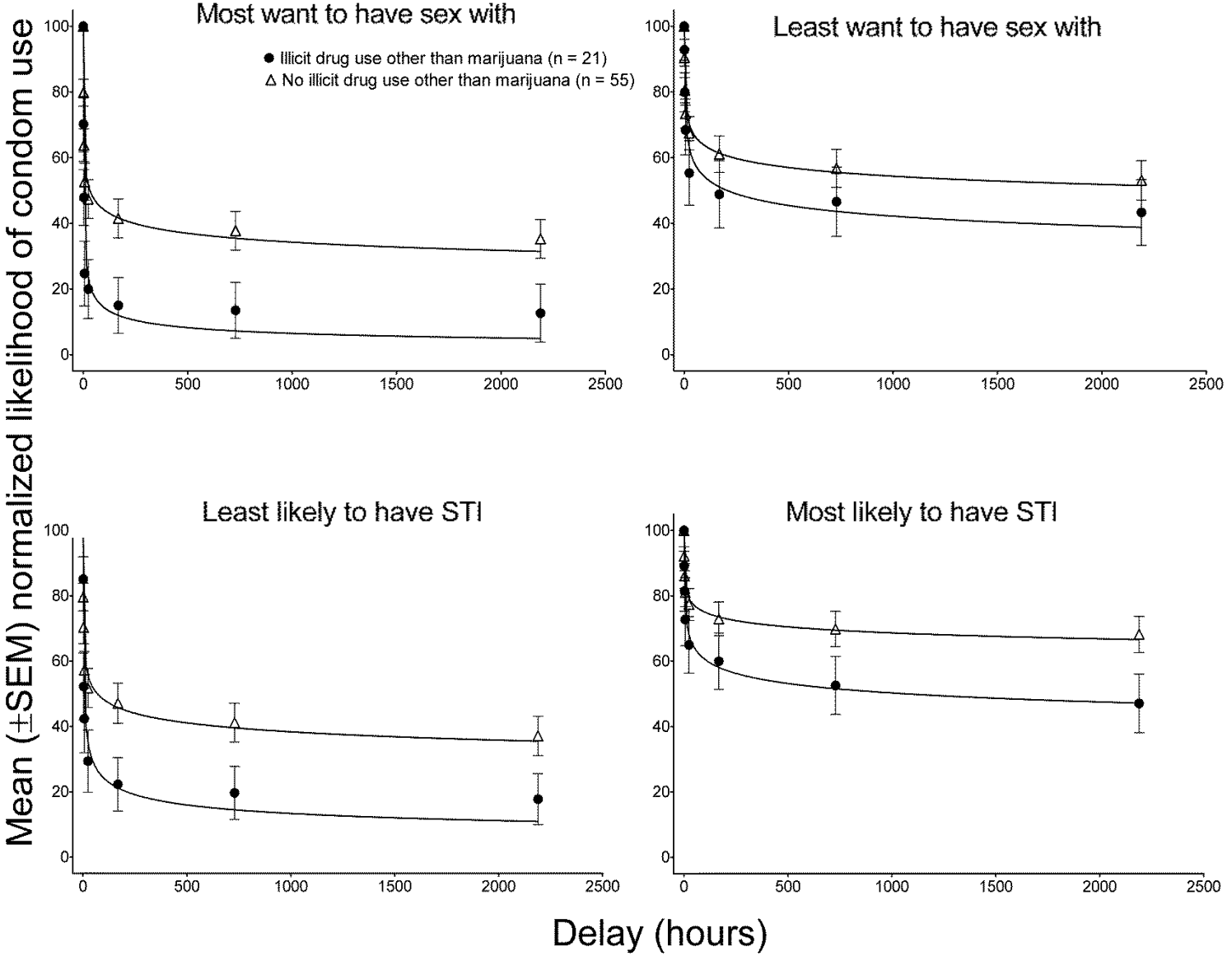
Dariotis & Johnson (submitted)

- 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

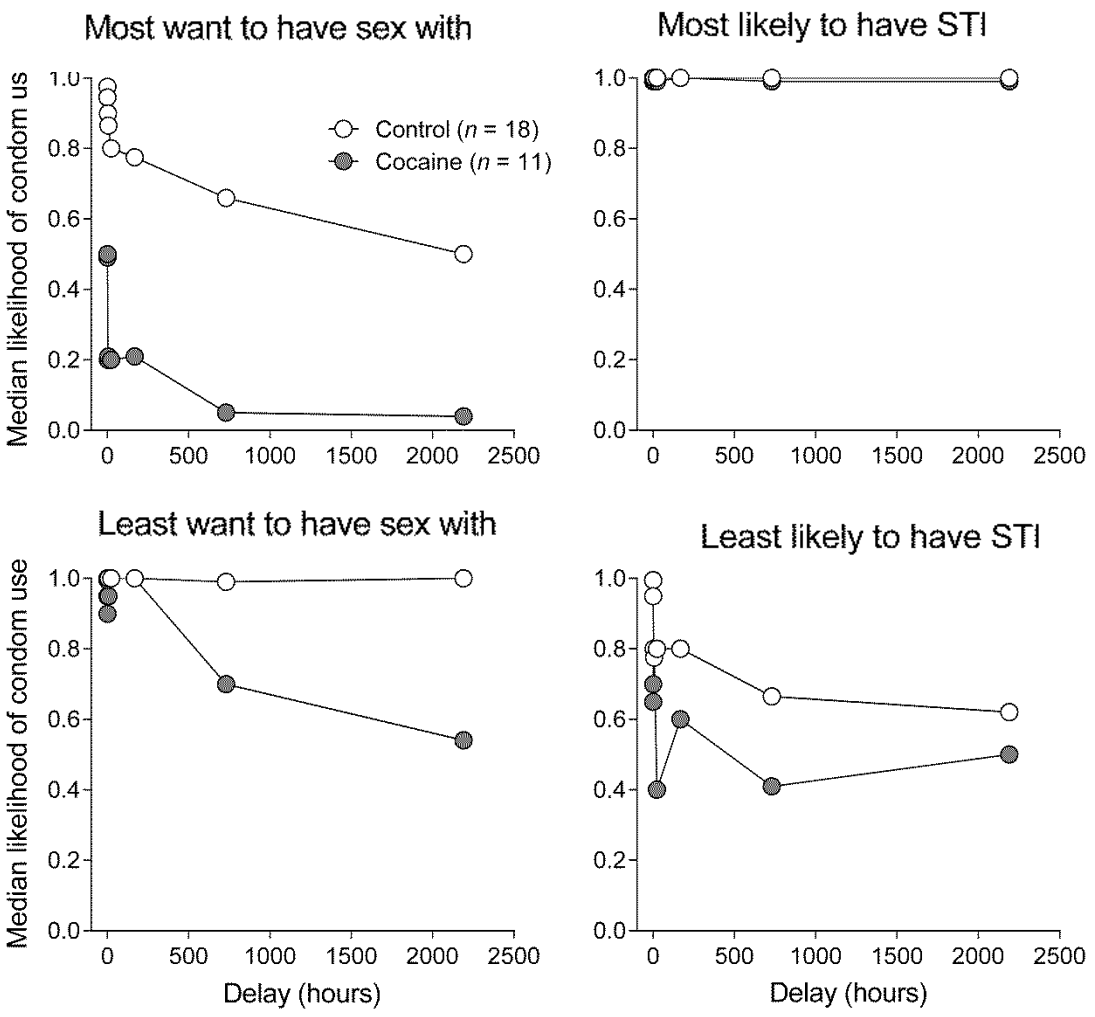




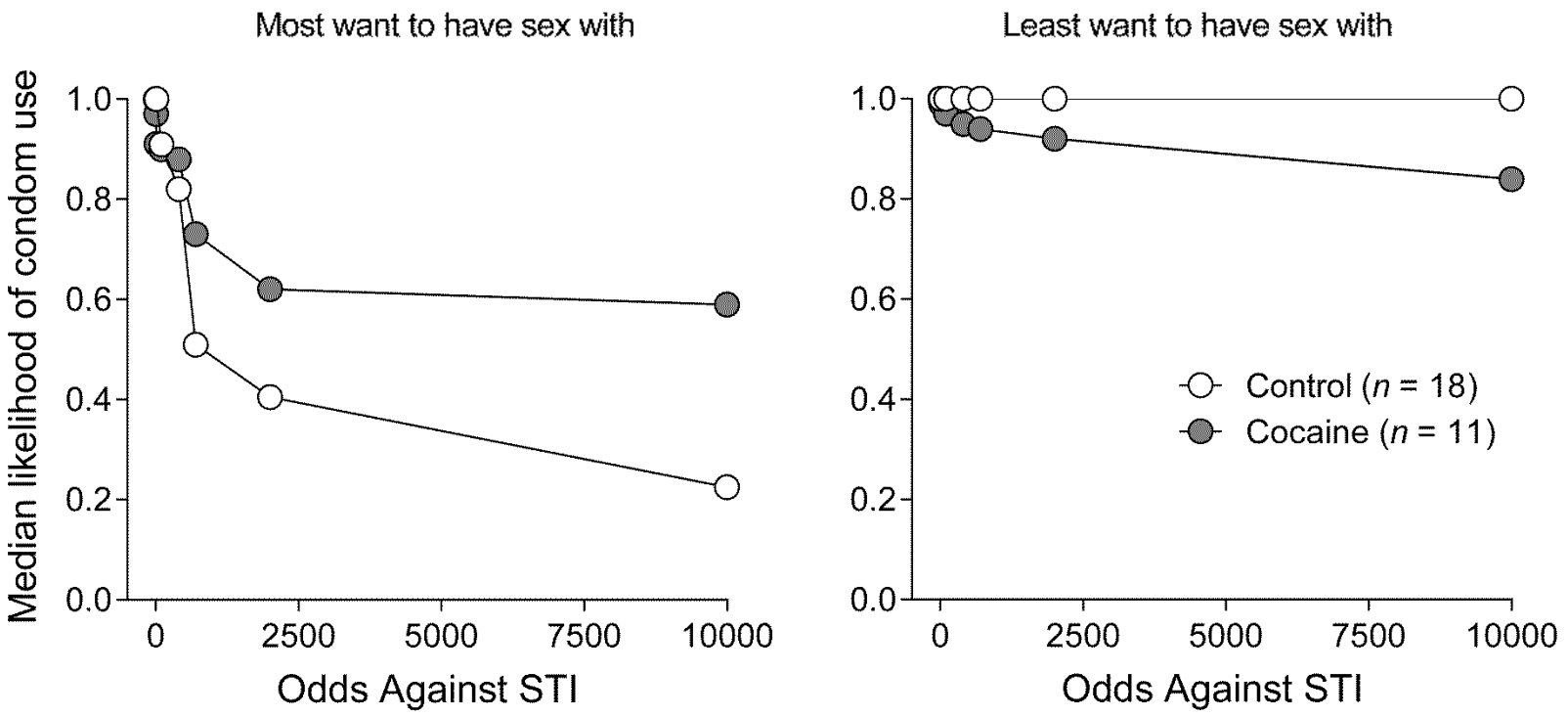
Men Who Have Sex With Men (MSM)
Sexual Delay Discounting Related to Drug Use



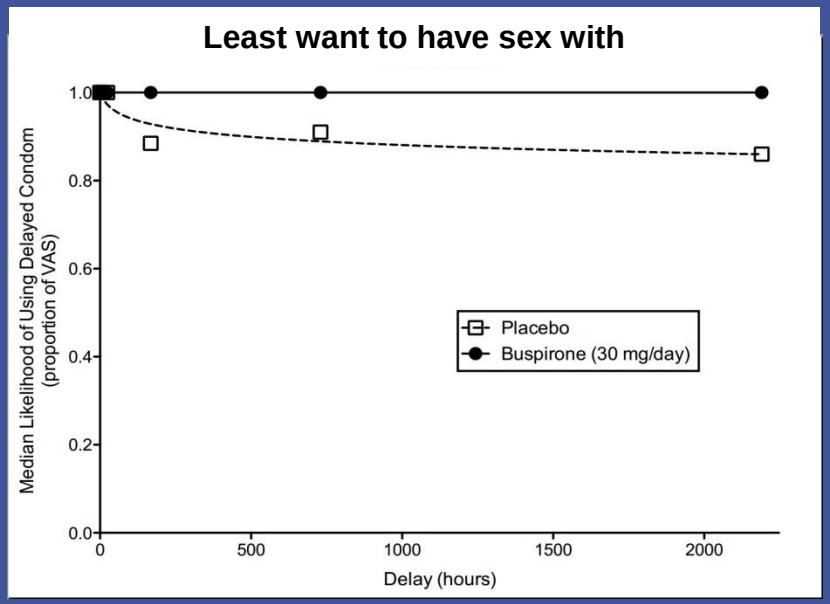
Cocaine Dependent vs. Controls
Sexual Delay Discounting

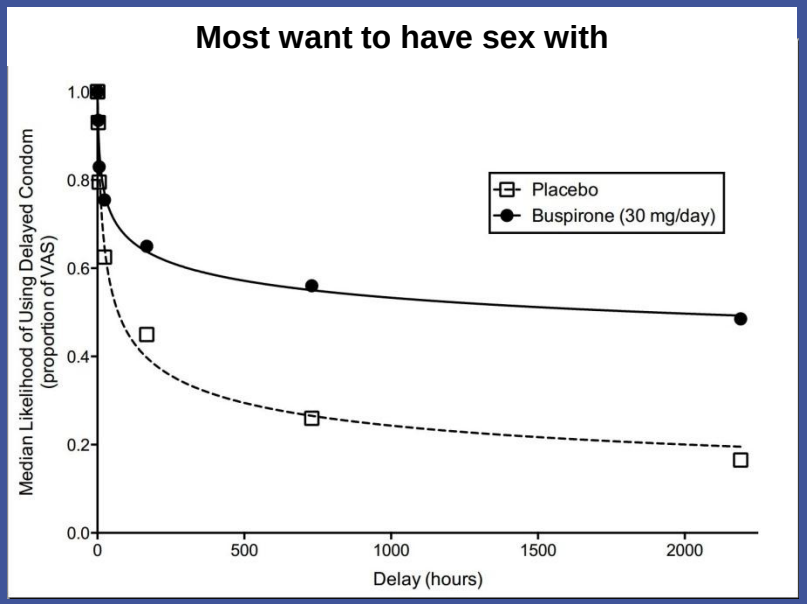


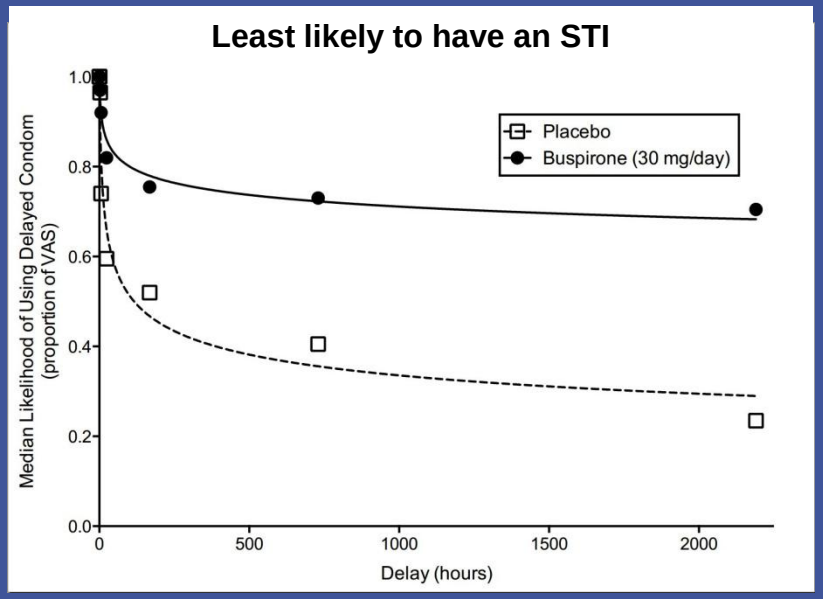
Cocaine Dependent vs. Controls
Sexual Probability Discounting

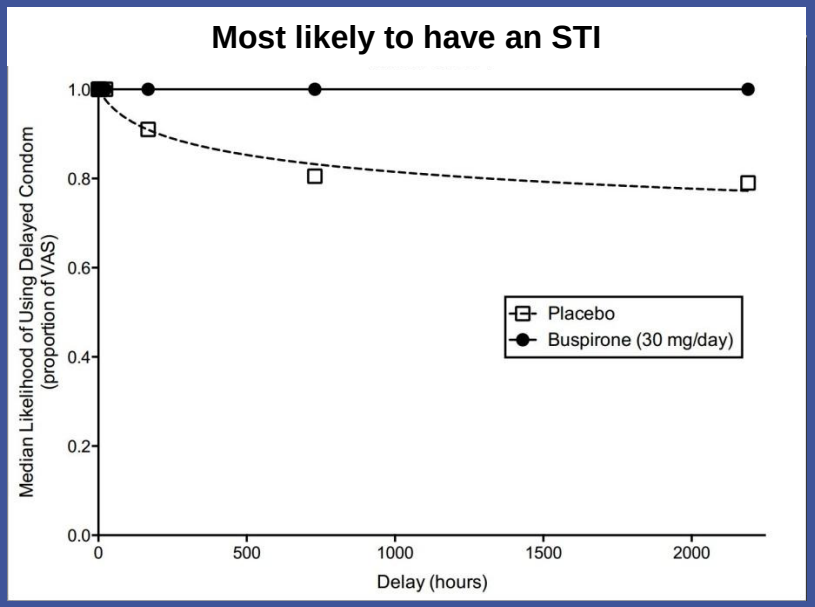


Effects of Buspirone – Stoops, Univ. of Kentucky

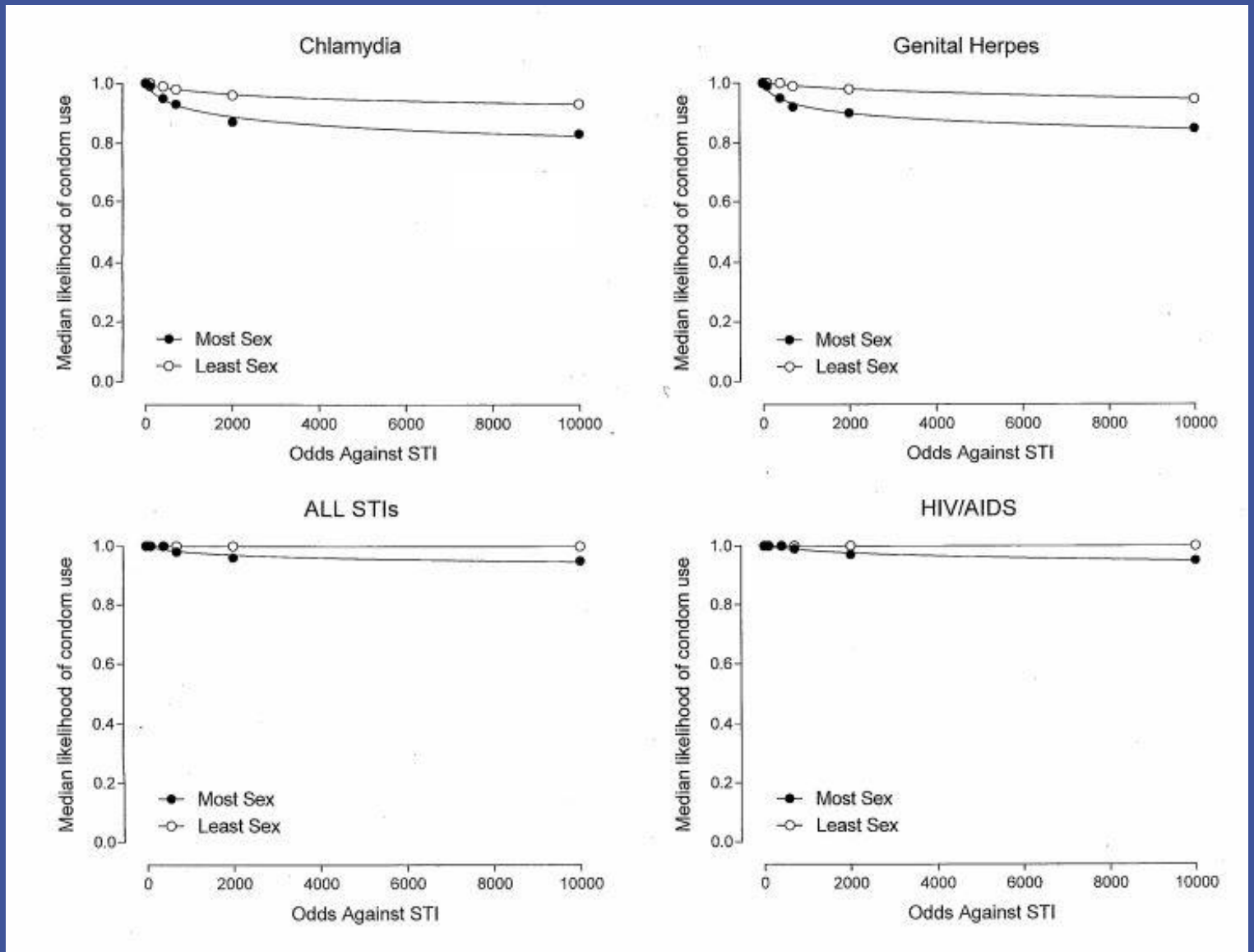




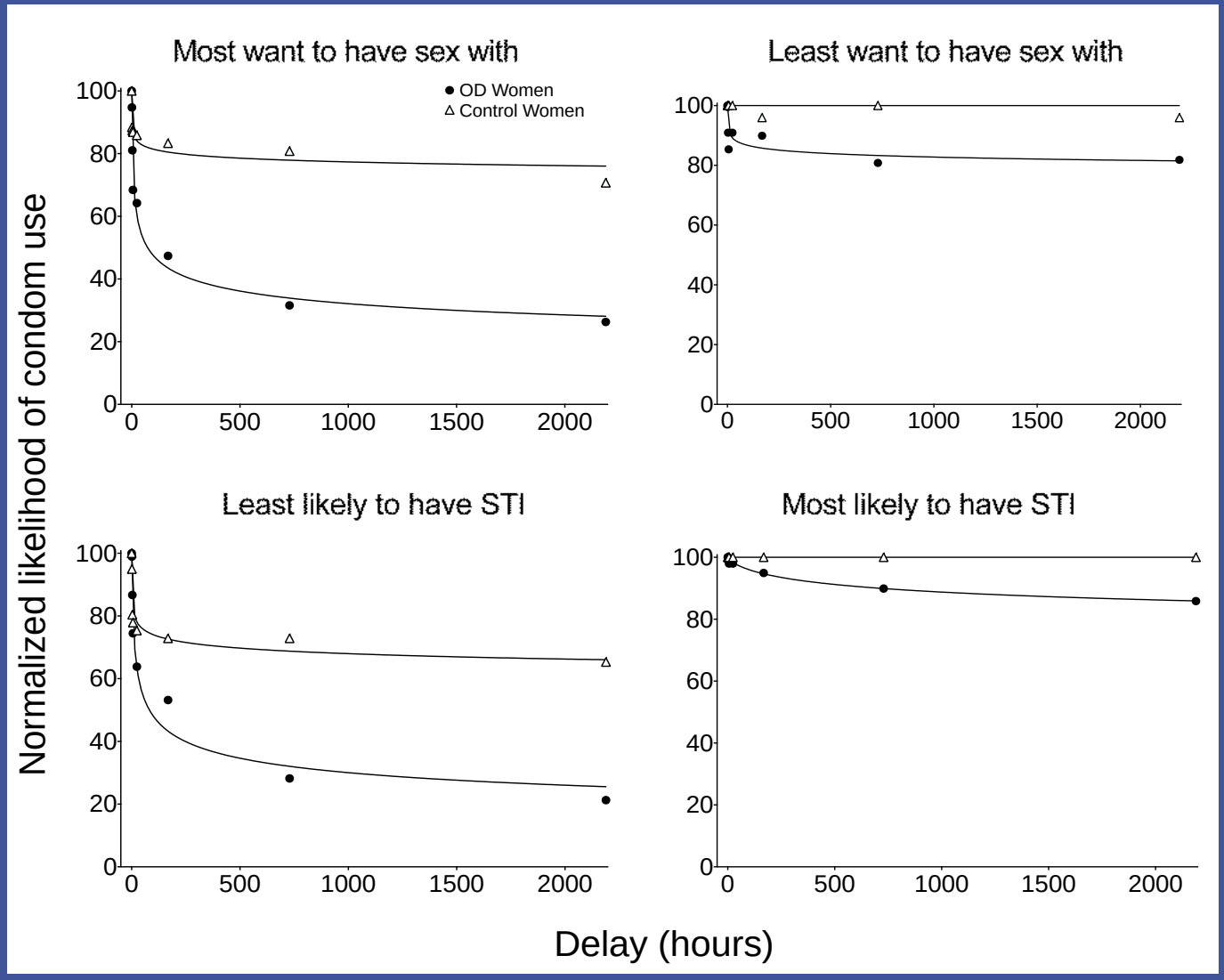




Sexual Probability Discounting in Undergrads (N=58)
Collaboration with Richard Yi

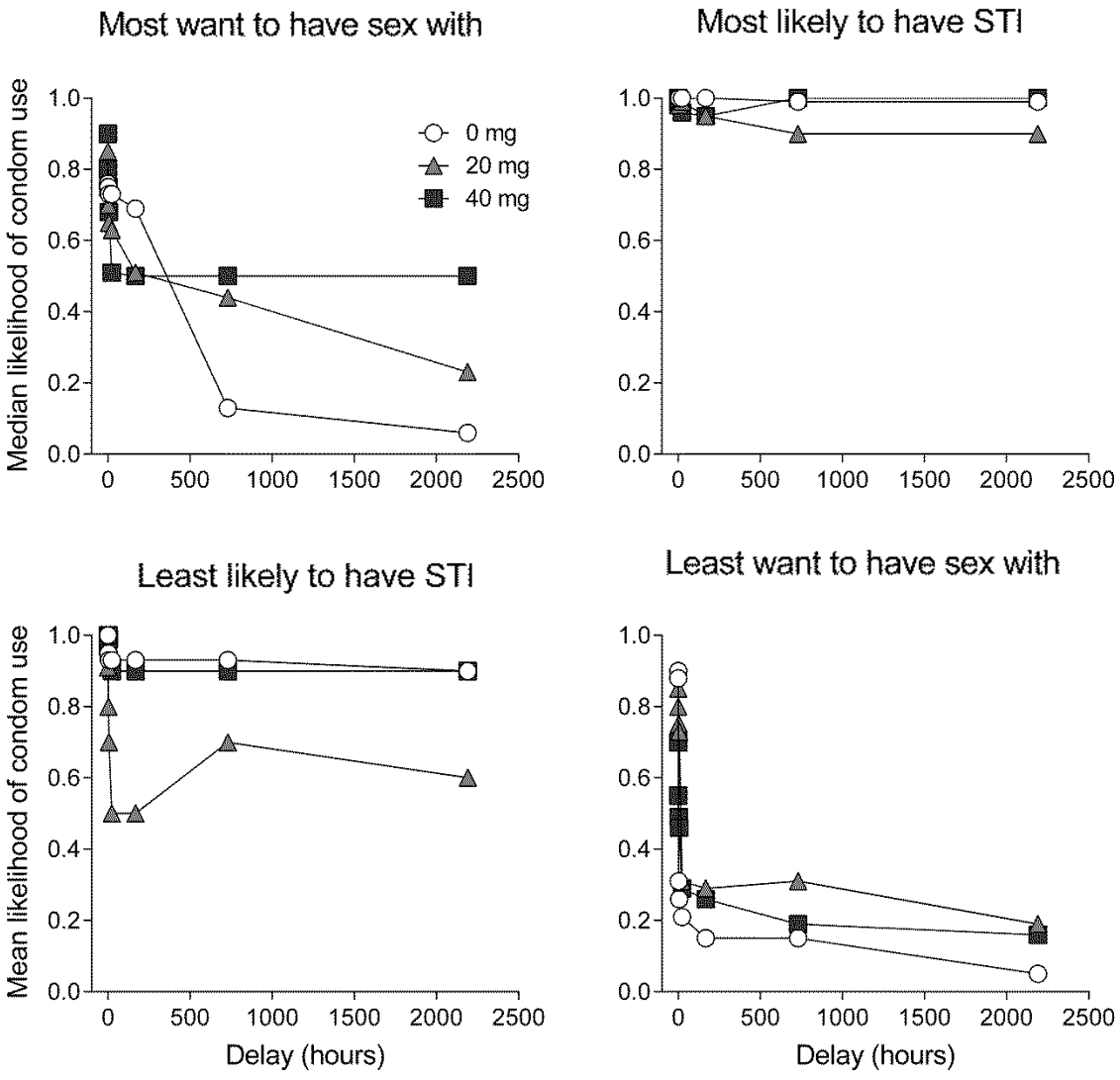


Opioid Dependent Women (N=27) vs. Controls (N=33) with Sarah Heil Laboratory

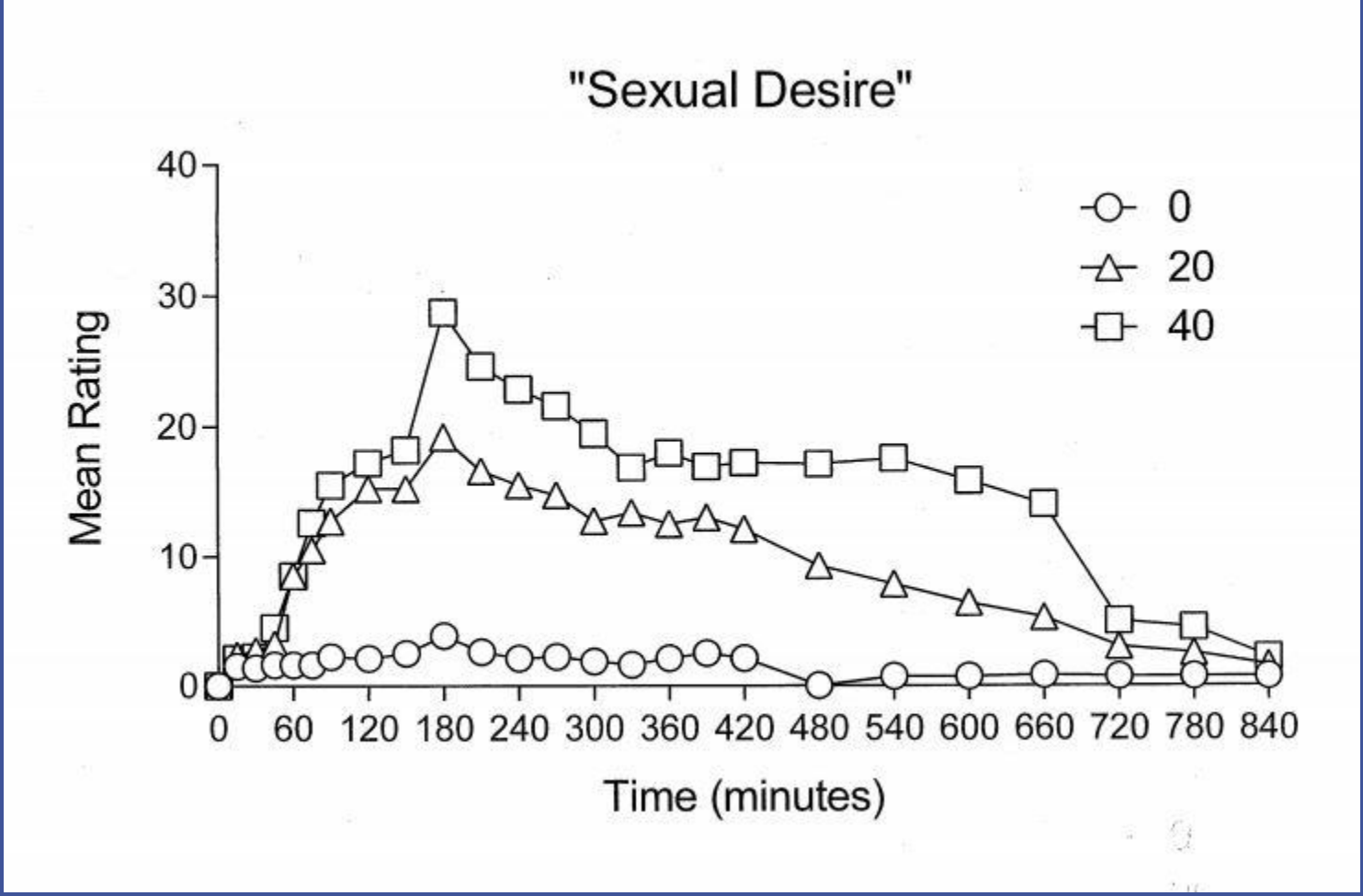


Acute Drug Effects on Sexual Discounting

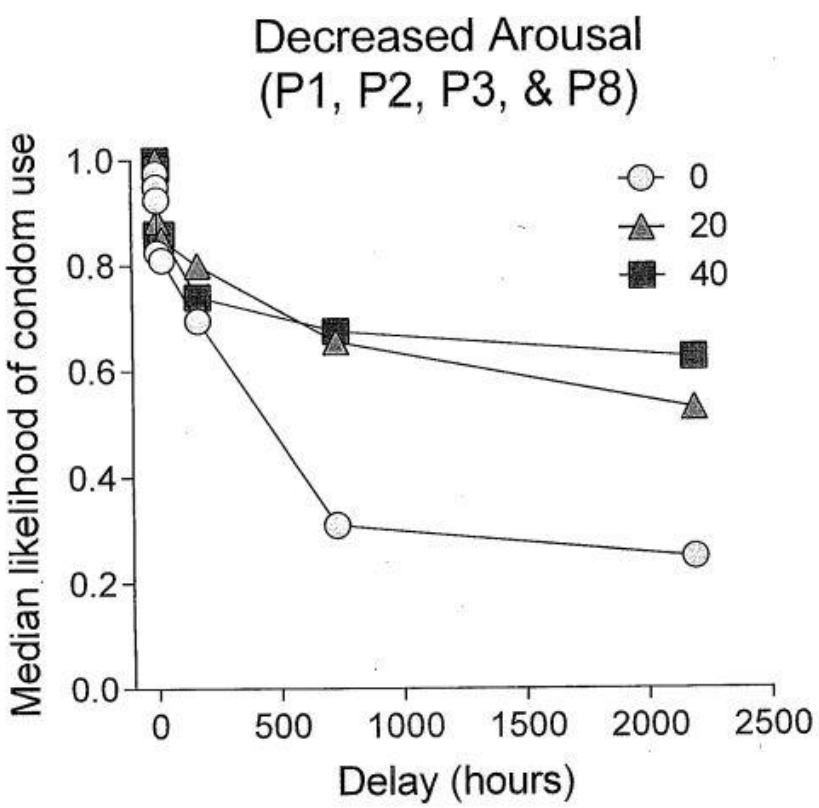
Dose Effects of Methamphetamine (N=11)

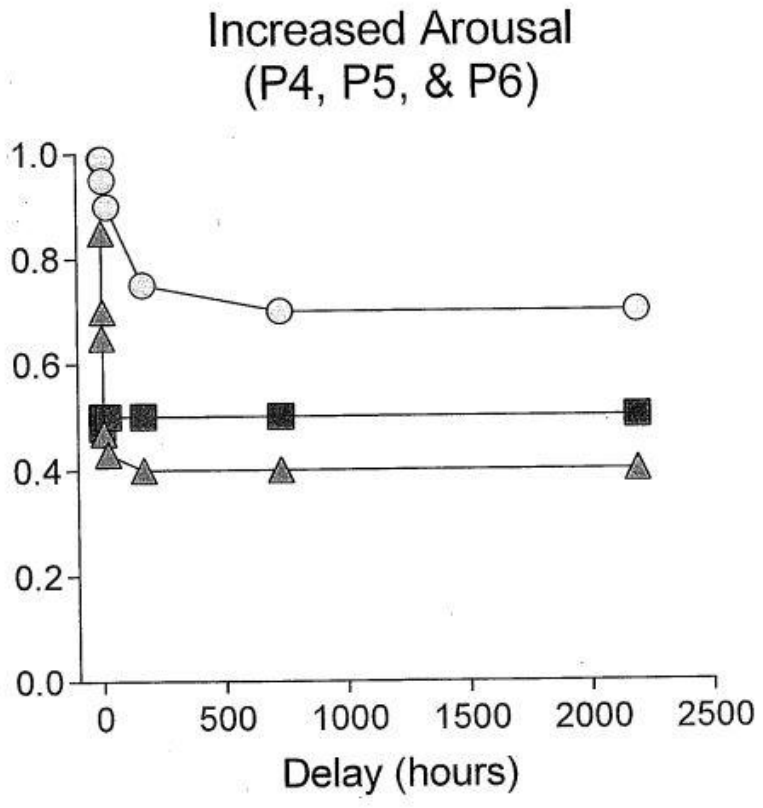


Dose- and Time-Related Effects of Methamphetamine on Sexual Desire

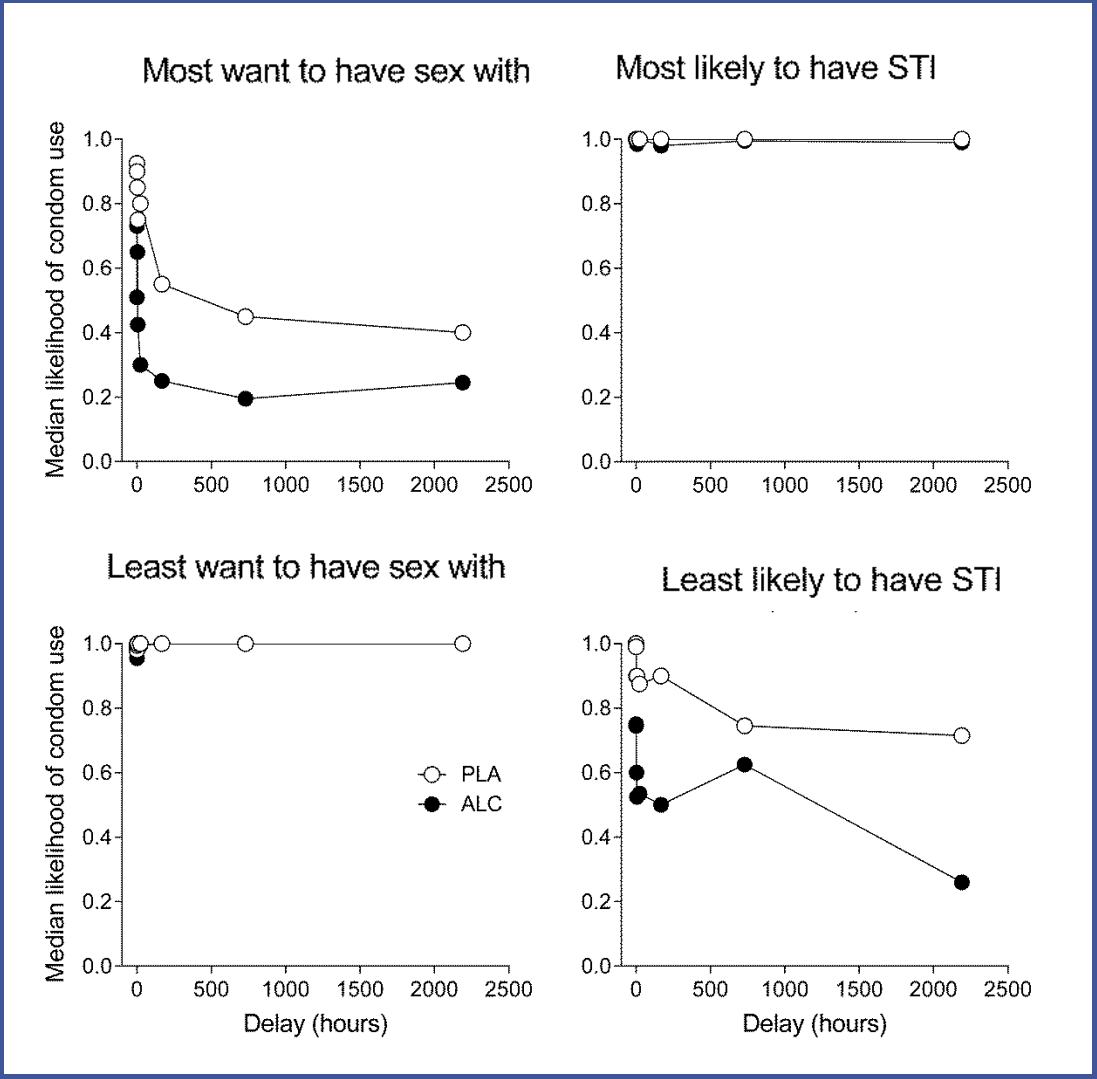


Effect Of Methamphetamine on Sexual Discounting Depends on Sexual Desire

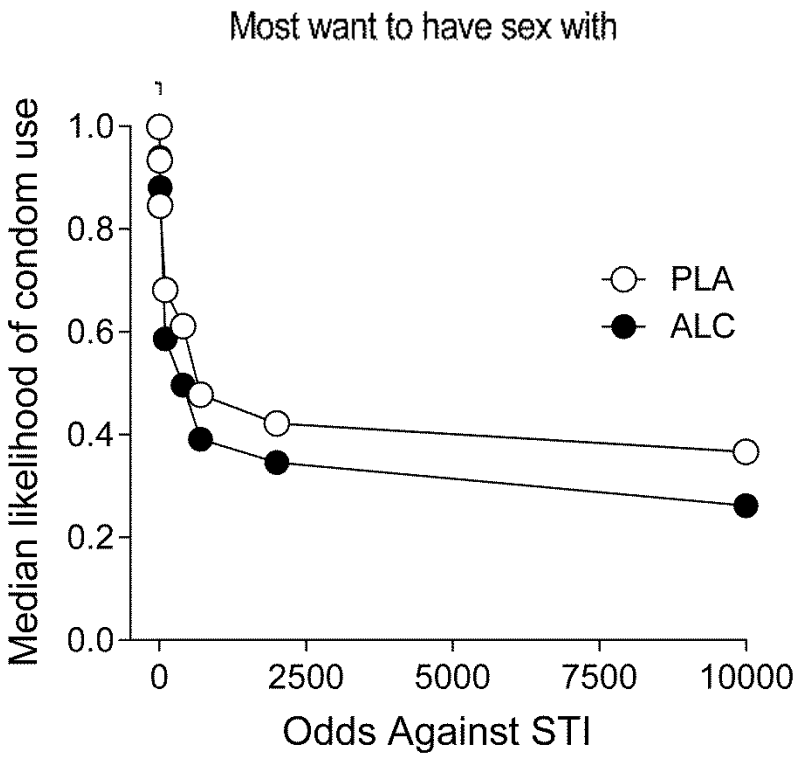


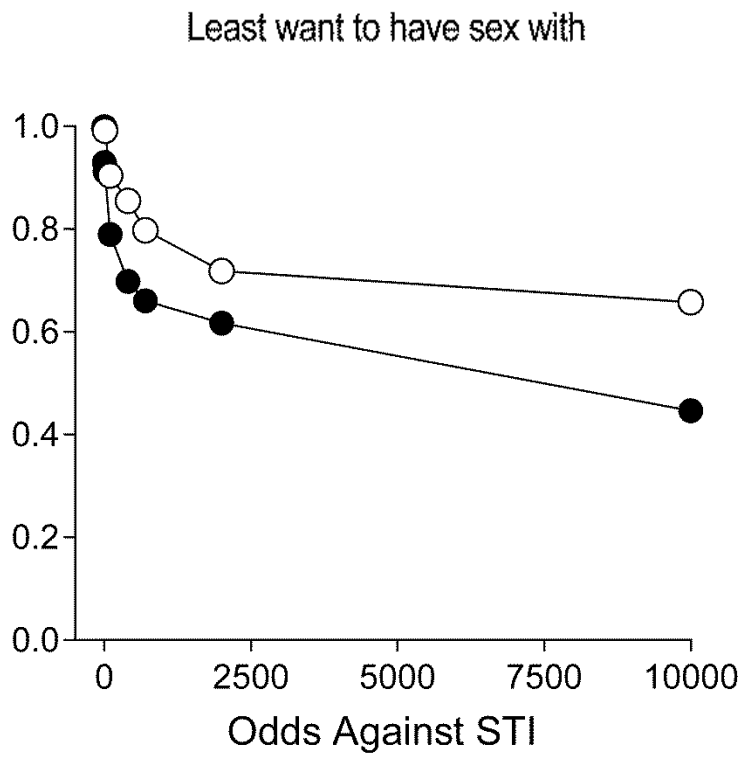


Effects of Alcohol (1 g/kg) on Sexual Delay Discounting (N=14)

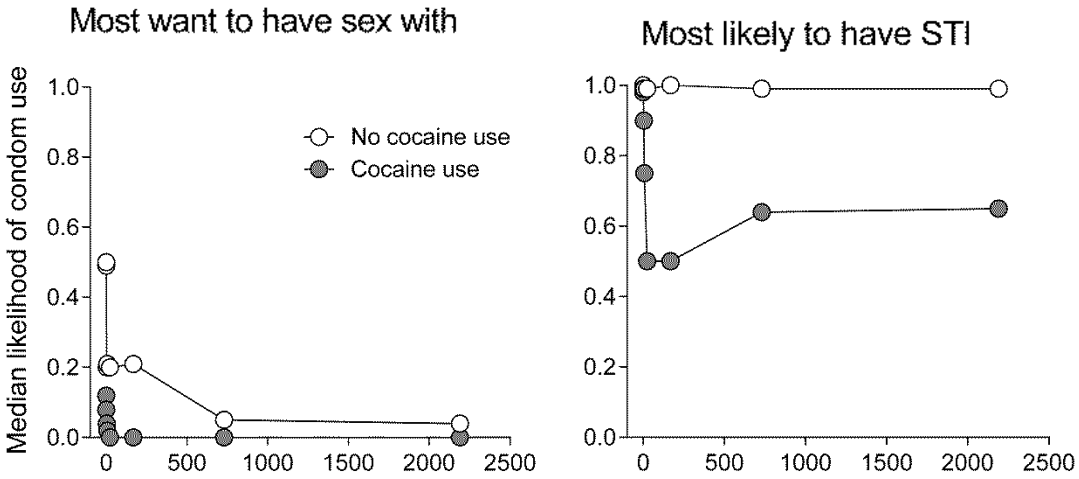


Effects of Alcohol (1 g/kg) on Sexual Probability Discounting (N=14)





Effects of Hypothetical Cocaine Use on Sexual Discounting (N=11)



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

- Warren Bickel, Ph.D. (VA Tech)
- Sarah Heil, Ph.D. (UVM)
- Todd Korthuis. M.D., M.P.H. (OHSU)
- Eliot Gardner, Ph.D. (NIDA IRP)
- Jacinda Dariotis, Ph.D. (Johns Hopkins Public Health)
- Sherecce Fields, Ph.D. (Texas A&M)
- Richard Yi, Ph.D. (Univ. of Maryland, College Park)
- Margaret Zeller, Ph.D. (Univ. of Cincinnati College of Medicine)
- William Horan, Ph.D. (UCLA)

Acknowledgments

- Patrick S. Johnson, Ph.D.
- Natalie R. Bruner, Ph.D.
- Evan Herrmann, Ph.D.
- Warren Bickel, Ph.D.
- Jacinda Dariotis, Ph.D.
- Bill Stoops, Ph.D.
- Sarah Heil, PhD.
- Crystal Barnhouser
- Eric Jackson
- Katie Buckheit
- Nana Emezienna
- Grant Glatfelter
- Eric Strain, M.D.
- Annie Umbricht, M.D.
- Leticia Nanda, N.P.
- BPRU nursing
- National Institute on Drug Abuse Grants
  - R01 DA035277
  - R01 DA032363
  - R21 DA026967
  - R21 DA032717
  - R03 DA026523