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Heroin Purchasing is Income and Price Sensitive

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Abstract

Semi-structured interviews were used to assess behavioral economic drug demand in heroin dependent research volunteers. Findings on drug price, competing purchases, and past 30-day income and consumption, established in a previous study, are replicated. We extended these findings by having participants indicate whether hypothetical environmental changes would alter heroin purchasing. Participants ($n = 109$) reported they would significantly ($p < .005$) decrease heroin daily purchasing amounts (DPA) from past 30-day levels (mean = \$60/day) if: (1) they encountered a 33% decrease in income (DPA = \$34), (2) family/friends no longer paid their living expenses (DPA = \$32), or (3) they faced four-fold greater likelihood of police arrest at their purchasing location (DPA = \$42). Participants in higher income quartiles (who purchase more heroin) show greater DPA reductions (but would still buy more heroin) than those in lower income quartiles. For participants receiving government aid ($n = 31$), heroin purchasing would decrease if those subsidies were eliminated (DPA = \$28). Compared to participants whose urine tested negative for cocaine ($n = 31$), cocaine-positive subjects ($n = 32$) reported more efficient heroin purchasing, i.e., live closer to their primary dealer, more likely to have heroin delivered or walk to obtain it (and less likely to ride the bus), thus reducing purchasing time (52 vs. 31 min, respectively), and purchasing more heroin per episode. These simulation results have treatment and policy implications: Daily heroin users' purchasing repertoire is very cost-effective, more so for those also using cocaine, and only potent environmental changes (income reductions or increased legal sanctions) may impact this behavior.

Keywords

behavioral economics; heroin; injection; opioids; Detroit

In the economic literature, debate continues as to whether drug-addicted individuals are rational consumers (Rogeberg, 2004), the dollar value of the costs and benefits of treatment and prevention (Holder, 1998), and the potential benefits of legalizing drug trade (Grossman, Chaloupka, & Shim, 2002). Although a single survey of self-reports of behavior and economic activity cannot settle these debates, studying entrenched behaviors of drug

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abusers coupled with their economic profiles may help predict unintended side effects of policy and treatment.

Contingent valuation is an economic method for obtaining a consumer's reaction to hypothetical change (Bateman et al., 2002). This method has been used to determine the value of non-market goods or goods where trade is indirect and prices are unobservable (Diener, O'Brien, & Gafani, 1998). Most studies assess willingness to pay (WTP) for non-market benefits or willingness to accept (WTA) the loss of some benefit (expressed in dollars). Specific instances involve assessing WTP for symptom alleviation from the common cold (Yasunaga, Ide, & Ohe, 2006), publically financed health care (Shakley & Donaldson, 2000), and health care services/technologies (Ratcliffe, 2000).

The present study provides quantitative data on heroin consumption among out-of-treatment users, focusing on income generating and spending behaviors. Semi-structured interview methods were used to address three aims. First, we characterized baseline (past 30-day) economic behaviors. Second, contingent valuation was used to assess the impact of prices, arrest rates, transfer incomes and supply availability on purchasing. Third, we examined individual differences. Many variables can simulate price increases and we directly assessed WTA these increases by calculating a difference in daily purchasing amount of heroin.

Methods

Screening Procedures

This investigation was part of two larger studies approved by the local Investigational Review Board (Greenwald & Steinmiller, 2009; Greenwald, 2010). Male and female heroin-dependent volunteers from 18 to 55 years old were recruited by newspaper ads and word-of-mouth. After completing a telephone interview, individuals were invited for in-person screening that included informed consent, demographic data, a complete medical and drug use history, and a semi-structured interview (≈ 20 min) described next. All volunteers reported daily heroin use and provided an opioid-positive urine sample (>300 ng/ml). Participants were paid U.S. \$25 for completing the first screening visit.

Semi-Structured Interview

Participants were asked questions to ascertain past 30-day income, heroin price, all drug and non-drug expenditures, and drug consumption. Subjects then imagined scenarios where income increased/decreased by 33%, subsidies from family/friends or government were eliminated, dealers were unavailable, or arrest rates were higher/lower and how these situations would affect heroin purchasing and consumption. A confidentiality certificate was obtained from the U.S. National Institute on Drug Abuse prior to the study.

Data Analysis

Table 1 lists descriptive characteristics for the entire group and by route of heroin use. Figure 1 breaks income into eight categories; dollar values and participation rates are presented. Figure 2 displays mean expenditures; mean percentages of income and participation rates are reported. Multiple regression analyses were used to evaluate predictors of heroin purchasing and use. A common set of independent variables (leftmost column of Table 2) were used to predict bags consumed per day, number of bags purchased per week, percent of income spent on heroin, and unit purchase amount (columns of Table 2). Table 3 reports the effects of hypothetical variations of income, subsidy, arrest rates and price on the demand variable daily purchasing amount (DPA). These results were examined further by stratifying on group differences in income (Table 4).

Results

Participant Characteristics

This cohort was predominantly African-American, male and about 45 years old with a high school or equivalent education and actively using heroin for a mean of 23 years. Polydrug use was determined through urinalysis and self-report. Urinalysis results revealed 56 positives for cocaine, 27 positives for marijuana and 17 positives for benzodiazepines.

Of the 109 respondents, 72 individuals reported they primarily injected heroin and 37 reported they did not inject (inhaled/snorted). Injection relative to non-injection heroin users reported significantly more time per episode purchasing heroin and consuming more bags of heroin per day. Chi square analysis indicates that route of administration was independent of gender.

Participants reported living close to their primary heroin supplier's transaction location: cumulatively, 46% lived within one mile and 60% within 2 miles. Individuals responded that their primary supplier was reliable: 73% endorsed "never" and 17% endorsed "rarely" (< once/month) failing to purchase heroin (i.e. "busted deal"). Participants reported ease of transportation to their suppliers: 49% primarily walked or rode a bicycle, 13% primarily drove their own vehicle, 21% primarily rode the bus, 13% primarily relied on a friend/family member to drive them, and 4% listed that the dealer delivered heroin to them.

Ninety-two participants (84% of sample) estimated purity of the heroin they purchased: the range varied from 2% to 100% with a mean of 55%. If bag price is stated as product of purity X price, then average bag price is about \$6. When asked about recognition of additives to their heroin, 32% responded they did not know what substances might be added. Participants who suspected additives listed one or more substances, including (total number of mentions): lactose (32); mannitol (17); sedative (17); and vitamins (15). Purity was significantly correlated ($r = .21$) with unit purchase amount, but not with price per unit (possibly due to lack of knowledge about quality at the time of purchase, an economic phenomena referred to as 'asymmetric information').

Modal heroin price was \$10 per bag and modal purchase amount was \$20, i.e., the amount most often purchased was two bags per transaction. Volunteers spent about 40 minutes per purchase, made about 2 purchases per day (14/week), and consumed about 4.7 bags per day.

Income Distribution

Figure 1 identifies sources, amounts and participation in past-month income acquisition. The only significant gender differences involved employment income. Legitimate past-month employment income was \$248 for females and \$587 for males. Hourly wage rate in the most recent job was also significantly lower for females than males, \$10.08 vs. \$13.10. No females reported income from unemployment compensation whereas males' mean unemployment compensation was \$63.80. Females reported higher mean 'other income', e.g., prostitution, than males (\$1161 vs. \$743), but this disparity was not significant.

Expenditure Distribution

Figure 2 reveals common expenses, the mean percentage of income devoted to each category and the participation rate (percent of sample engaging in the behavior). The only significant gender difference was the percent of income spent on alcohol where the mean for males was 0.8% and the mean for females was 0.3%. Females reported spending a higher percentage on shelter/utilities than males (6.7% vs. 4.3%), but this difference was not significant.

On average participants spent 73% of income on purchasing heroin (median = 76.3%). Total income was negatively and significantly correlated ($r = -.26$) with the percentage of income spent on heroin.

Predicting Heroin Purchasing and Consumption

Regression analyses were conducted to predict four dependent measures of heroin purchasing and consumption (rightmost columns of Table 2). The independent variables were identical in each analysis (left column of Table 2).

Higher unit purchase amount was significantly predicted by greater income and fewer suppliers, which accounted for 46% of the variance. Higher percentage of income spent on heroin was significantly predicted by one factor, injection heroin use, which explained 5% of the variance. Frequency of heroin purchases was significantly predicted by higher total monthly income, shorter purchase time, and more suppliers, which explained 23% of the variance. Consuming more daily bags of heroin was significantly predicted by higher total monthly income and lower bag unit cost, which explained 67% of the variance.

Participants were asked how they would vary daily purchasing amount (DPA) of heroin in response to several hypothetical scenarios. Each respondent was instructed to consider how much their DPA would change due to a sudden change in dealer, direct reductions in income or elimination of subsidies, and increased likelihood of arrest. Table 3 presents these data for the overall sample and by gender and route of administration. The impact of income quartile on responses is presented in Table 4. The absolute dollar reduction in heroin expenditure increases within higher income quartiles.

Discussion

This study yielded three primary findings. First, we confirmed and extended results from a previous study (Roddy & Greenwald, 2009) regarding income, expenditure and consumption patterns of heroin dependent, out-of-treatment individuals. Second, we established group differences in contingent valuation of heroin based on hypothetical variations in pricing and policy variables. Third, we discovered some purchasing differences among consumers that might support spatial mismatch or efficiency purchasing.

In our previous study with a similar population (Roddy & Greenwald, 2009), mean monthly income was \$1698, mean daily bags of heroin consumed was 4.43, and median bag price was \$10 ($N=100$). Although mean monthly income in the present sample (\$2155) was higher than the prior study, mean daily bags used (4.7) and median bag price of (\$10) were similar across studies. Both studies establish that the majority of past 30-day income is devoted to heroin consumption (72% vs. 73% respectively). The category of 'other' income once again comprises a majority of mean monthly income. This category includes, but is not limited to, criminal activities such as drug selling and prostitution. Regression results verified factors that we had observed to be significant predictors of drug seeking, purchasing and consumption. The results therefore appear to be reliable. Both studies indicated that more income was related to more purchasing. Higher monthly income was a significant predictor of a higher unit purchase, more purchases per week and greater consumption (bags/day). Higher past-month income did not predict a greater percentage of income devoted to heroin in our recent study and the present one. As explained below, both studies provided some evidence of rational consumption with unit cost and time spent on purchasing significant predictors of purchasing and consumption of heroin.

This study was enhanced with contingent valuation questions that established consumption changes in reaction to pricing and policy variables that contributed to our second primary

finding. Participants were asked to imagine change that might occur in their daily purchasing of heroin brought about by alterations in income including elimination of subsidies, changes in dealer, and changes in arrest rates. There were significant changes in mean daily purchasing amounts due to 33% reduction in income, elimination of food and housing subsidies from family and friends, and a 4X likelihood of arrest rate. Other hypothetical environmental alterations (33% increase in income, a 2X likelihood of arrest rate, a change in dealer) produced non-significant changes in mean purchasing in the prediction direction. Although the change in purchasing due to an increase in income was not significant, it *was* positive.

These responses suggest a forward-looking consumer sensitive to perturbations in the environment. An economist would describe these changes as 'rational' (Becker & Murphy, 1988), yet there is ongoing debate in the economic and psychology literatures about these issues. Some view continued use of addictive substances despite well-known negative consequences as inherently irrational or that results from rational addiction models are fragile (Gruber & Koszegi, 2001). In addition, extreme consumption (i.e., 73% of monthly income devoted to heroin use) may indicate myopia or unusually weighted time preferences for immediate reward (Strotz, 1956; Thaler & Sheffrin, 1981). An extensive account of addiction as a rational response weighing marginal benefits and marginal costs of consumption has been modeled in the economic literature (Stigler & Becker, 1977; Becker & Murphy, 1988; Chaloupka, 1991; Iaccone, 1986). When a reduction in income is anticipated, it is predicted that consumption will decrease. When subsidies are eliminated, the reaction is similar to a decrease in income. When negative consequences of purchasing escalate (greatly), daily purchasing decreases. Rational addiction studies use inter-temporal change as evidence that the consumer considers all time periods in making decisions. Our study did not use this approach; our questionnaire was grounded in the present time. However, our heroin dependent non-treatment seeking volunteers clearly showed capability of considering future hypothetical events and offering consistent responses.

Our study begins to establish the role of hypothetical policy and environmental variables—the direction and relative influences on purchasing and consumption of heroin by those with entrenched habits. Nonetheless, one may question whether the changes that respondent predicted when faced with hypothetical decreases in their income represented choice or constraint. Spending most of their income (73%) on heroin might necessitate a reduction in purchasing when income decreases. Economists usually regard income as a constraint on choices. Microeconomic studies consistently maximize utility subject to a variety of constraints, the most common of which is income. It may be most accurate to label this hypothetical response an instance of *constrained choice*. We also hasten to add that the hypothetical responses of these volunteers were not intended to elicit or represent *long-term* responses to policy changes, i.e., the interviewer asked for localized (30 day) responses. Furthermore, many researchers (e.g., Ida, 2010; Kirby, Petry, & Bickel, 1999; Orphanides & Zervos, 1998) associate addiction with foreshortened time horizons and preferences.

Our third finding resulted from an examination of efficiency purchasing and spatial mismatch. We hypothesized that those with more severe addiction would purchase and consume heroin differently than those whose addiction is less severe. We therefore separated the sample by route of administration and identified differences related to purchasing and consumption (Table 1). Relative to non-injection users (who inhaled/snorted heroin), injection users (proxy for more severe addiction) on average purchased in greater increments, traveled longer for each purchase, and consumed more heroin per day. In addition, the data were examined for evidence of spatial mismatch for heroin purchasing. Detroit's population is predominantly African American and the heroin market resides within the city boundaries. African American heroin users in our study experienced a mean

travel distance of 1.8 miles expending 31 min per purchase on average for 15 purchases per week whereas white users traveled 6.6 miles expending 50 min per purchase on average for 13 purchases per week. The typical mismatch reported in labor market opportunities (Gobillon, Selod, & Zenou, 2007) is thus reversed with African American heroin users in Detroit.

The present study has several limitations. First, the sample may not represent all heroin abusers. These subjects may have responded to the modest incentive of the stipend; thus, dealers or users with significant criminal income may be under-represented. Second, self-report of behaviors may not reflect actual (current) or predicted (contingent valuation) levels. However, self reported use of cigarettes (Hatziaandreu et al., 1989) alcohol (Smith et al., 1990) and drugs (National Drug and Alcohol Research Center, 1998) suggest that self report is highly correlated with variables such as state *per capita* sales and biomarkers and therefore generally considered a reliable estimate of actual use. Furthermore, studies have shown actual consumptive reaction (negative) to price increases in drug, alcohol and cigarette use (Chambers et al., 2009; Becker, Grossman, & Murphy, 1994; Grossman, Chaloupka, & Sirtalan, 1998). Our interview had internal checks to ascertain consistency of the responses. The data reveal that those who purchase small amounts frequently live closer to their dealers than those who purchase larger amounts less frequently. Lastly, a subset ($n = 25$) of our respondents qualified for further laboratory experiments; those in the present study who reported greater purchase times were, in the subsequent lab studies, more willing to 'work' on a computer task to earn the heroin-like opioid hydromorphone instead of money (Greenwald et al., manuscript in preparation). A third limitation is that interview questions required the participant only to consider the past 30 days; therefore the results cannot be extrapolated for long term analysis. Lastly, contingent valuation is a direct method of obtaining responses however the situations presented are necessarily hypothetical. Hypothetical questions yield hypothetical responses. Contingent valuation as a method has been recently reviewed and that review concludes that it is a useful policy formation tool (Smith & Sach, 2009).

The present data suggest that consideration of price and income (arrest rates, subsidies, variability of dealers) and location (measured in time and distance) affects both consumption and purchasing behaviors. Those who face greater travel distance or time per purchase may purchase in larger quantities; those with more severe addiction may purchase more frequently, those who face lower prices will consume more. It also appears that environmental perturbations need to be fairly severe to reduce heroin use behavior. Each policy that potentially influences the variables of income, available to drug users, full price of purchasing, and location of the sale, purchase and consumption of drugs is likely to influence different groups of drug users differently (Chaloupka, 2010). Further research that combines the market variables of pricing and location and examines the group differences in addiction severity, race, gender, income and location is suggested.

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Figure 1. Distribution of past-month income (U.S. dollars; total mean = \$2155) and participation rates (percentage of group) for the aggregate sample ($N = 109$).

Figure 2. Distribution of past-month spending (U.S. dollars) and participation rates (percentage of group) for the aggregate sample ($N = 109$).

Table 1
Descriptive Statistics

	Total Sample Mean	Median (1 st , 3 rd quartile)	Injection Users	Non-injection Users
Sample size (N)	109	NA	72	37
Race (% Black)	60	NA	47	84
Gender (% Male)	76	NA	74	81
Age (years)	45	48 (40,52)	44*	48*
Education (years)	12	12 (12,13)	12	12
Duration heroin use (years)	22.1	25 (10,33)	20	25
Number of heroin suppliers	3.1	3(2,4)	3	3
Distance to supplier (miles)	3.8	1(.5,5)	5*	2*
Walk or ride to primary supplier (%)	48.6%	NA	45.8%	62.2%
Estimated purity	54.6%	60 (40,75)	57	50
Unit purchase amount (\$)	\$31.35	27 (20,35)	\$35*	\$24*
Unit cost (1 bag ≈ 0.1 gm, \$)	\$11.72	\$10 (\$10, \$10)	\$12	\$12
Heroin purchase time (minutes) per episode	39.7 min.	20 min (12.5,45)	46 min*	29 min*
Heroin purchases (#) per week	14.2	14 (10,21)	14	13
Other opiate (#) purchases per week	.2	0 (0,0)	.2	.2
Non-opiate purchases (#) per week	1.6	.25 (0,2)	1.4	2
Heroin consumption pattern (\$10 bags per day)				
0600-1200	1.5	1 (1,2)	1.5	1.4
1200-1800	1.4	1 (1,2)	1.6	1.2
1800-2400	1.5	1 (1,2)	1.7	1.1
0000-0600	.3	0 (0,0)	.4	.2
Total	4.7	4(2.5,5.5)	5.2*	3.9*
Actual current hourly wage (\$)				
Past-Month Income Sources (\$)				
Employment	\$ 722.61	\$ 400 (\$0, \$1100)	\$718.68	\$730.27
Unemployment insurance	\$ 21.61	\$0 (\$0, \$0)	\$27.86	\$9.46
Public assistance	\$ 67.37	\$0 (\$0, \$150)	\$ 67.04	\$68.00
Pension/Social Security	\$ 42.54	\$0 (\$0, \$0)	\$51.51	\$25.08
Family/friends	\$ 296.93	\$50 (\$0, \$300)	\$361.38	\$171.49
Other	\$1004.21	\$ 420 (\$50, \$1425)	\$1013.48	\$986.22
Total	\$2155.28	\$2000 (\$1220, \$2780)	\$2239.95	\$1990.51

Note.

* Means are statistically different at $p < .05$.

Table 2

Regression Results (Four Models)^f

Predicted Variable Sample Mean	Unit purchase \$31.35		Heroin Expenses ÷ Income 73%		Purchases/week 14.2		Consumption 4.7 bags/day	
	<i>B</i> (SE)	<i>t</i>	<i>B</i> (SE)	<i>t</i>	<i>B</i> (SE)	<i>t</i>	<i>B</i> (SE)	<i>t</i>
Constant	8.695 (6.854)	1.269	.692 (.068)	10.184	9.099 (2.074)	4.388	2.100 (.776)	2.706
Primary heroin route (0=non-IV, 1=IV)	5.006 (3.926)	.101	.097 (.039)	2.486	1.295 (1.188)	.103	.759 (.444)	1.707
Distance to dealer (in miles)	.323 (.371)	.075	.005 (.004)	1.482	-.185 (.112)	-.170	.062 (.042)	1.474
Unit cost (\$)	-.328 (.326)	-.078	.002 (.003)	.641	-.104 (.099)	-.099	-.212 (.037)	-5.759
Purchase time (minutes)	.072 (.037)	.165	.000 (.000)	-1.256	-.026 (.011)	-2.385	.001 (.004)	.240
Total income (\$)	.012 (.002)	.626	.000 (.000)	-1.133	.002 (.000)	3.600	.002 (.000)	12.232
Number of suppliers	-2.580 (1.236)	-2.087	.001 (.012)	.047	1.059 (.374)	2.831	-.069 (.140)	-.493
Non-heroin opiates (# weekly purchases)	-.320 (3.063)	-.008	-.033 (.030)	-1.077	.073 (.927)	.008	-.015 (.347)	-.043
Adjusted <i>R</i> ²	0.464		0.051		0.230		0.668	

Note. Bold entries indicate statistically significant ($p < .05$) effects. Relative contributions of predictors are best evaluated with standardized beta values (β^{∞}).

Table 3
Daily Purchasing Amount (DPA) of Heroin: Responses to Hypothetical Scenarios

Mean (Std Error)	DPA total	DPA female	DPA male	DPA injector	DPA non-injector
Present DPA (Baseline)	\$60.88 (\$5.54)	\$79.32 (\$19.09)	\$55.11 (\$4.08)	\$67.68 (\$7.60)	\$47.65 (\$6.54)
33% Reduction in Income	\$33.73* (\$2.24)	\$38.13 (\$5.49)	\$32.33* (\$2.38)	\$37.22* (\$2.94)	\$27.03* (\$3.06)
Friends and Family No Longer Subsidize Living Expenses	\$32.10* (\$2.58)	\$31.37* (\$5.93)	\$32.33* (\$2.86)	\$34.81* (\$3.39)	\$26.89* (\$3.72)
4X More Likelihood Arrest Rate	\$41.95* (\$3.29)	\$43.96 (\$8.80)	\$41.36 (\$3.41)	\$45.36* (\$4.00)	\$35.14 (\$5.68)

Note.

* Means ($\pm$ 1 SEM) are significantly different ($p < .05$) than present DPA

Table 4
Self-reported Mean Reductions in Daily Purchasing Amounts (DPA) of Heroin:
Responses to Hypothetical Scenarios, by Income Quartile

Monthly Income Quartile X Scenario	Quartile 1 \$0 - \$1220	Quartile 2 \$1221-\$2000	Quartile 3 \$2001-\$2780	Quartile 4 \$2781-\$5711
Present DPA (Baseline)	\$27.55 (\$ 2.30)	\$48.90 (\$ 7.19)	\$63.35 (\$ 5.91)	\$104.97 (\$17.26)
Forced Change in Dealer	-\$ 5.77 (\$ 2.83)	-\$13.79 (\$ 6.26)	-\$ 9.44 (\$ 5.73)	-\$23.30 (\$14.26)
33% Reduction in Income	-\$12.07 (\$ 2.34)	-\$22.05 (\$ 6.71)	-\$30.88 (\$ 5.72)	-\$45.43 (\$15.68)
4X More Likelihood Arrest Rate	-\$ 8.39 (\$ 2.24)	-\$20.79 (\$ 6.28)	-\$18.35 (\$ 6.73)	-\$32.06 (\$15.17)