Altered States: Addicts Underestimate Future Drug Preferences

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Abstract

To determine whether addicts, when opiate satiated, accurately predict the effects of their own future drug deprivation, addicts receiving opioid agonist treatment (buprenorphine) chose between extra buprenorphine and cash under four conditions defined by whether they were opioid deprived or satiated, and whether their choices applied immediately or following a delay. Based on prior research showing that people underestimate the motivational influence of states they are not currently experiencing, we predicted that addicts would place higher monetary on buprenorphine when deprived than when satiated, even when outcomes were delayed. Based on prior time discounting research, we predicted addicts would value immediate buprenorphine more than delayed buprenorphine. Both predictions were supported.

One of the central questions in the literature on drug abuse and addiction is why people take addictive drugs in the first place. As Avrum Goldstein (1994) queries in his seminal book *Addiction*,

> "If you know that a certain addictive drug may give you temporary pleasure but will, in the long run, kill you, damage your health seriously, cause harm to others, and bring you into conflict with the law, the rational response would be to avoid that drug. Why then, do we have a drug addiction problem at all? In our information-rich society, no addict can claim ignorance of the consequences."

Several lines of research have addressed this riddle. Some have argued that the addict's decision is, in fact, rational – that the discounted benefits of addiction outweigh its costs (Becker & Murphy, 1988). Rational addiction implies that the future consequences of current and past behavior are given due consideration when making drug consumption decisions. Conversely, others have posited that addicts are in fact ignorant of the consequences because the development of drug-dependence is so gradual (Herrnstein & Prelec, 1992; Heyman, 1996). Still others have found positive support for a variety of additional causal factors, such as steep time discounting (Bickel & Marsch, 2001; Giordano, 2002), genetics (Crabbe, 2002), and peer influences (Niaura, 2000; Westermeyer, 1999).

While acknowledging the importance of these factors, we test for the operation of an additional possible factor that may influence decisions to take addictive drugs: People may underestimate the motivating effects of states such as deprivation on their own future behavior. As a result, they may initiate taking drugs with an unrealistic view of how easy it will be to quit once they have begun.

Prior research has not addressed this issue directly. There is some research showing that young cigarette smokers significantly underestimate their own risk of becoming addicted (Slovic,

2001). For example, only 15% of high school students who smoked less than one cigarette per day predicted they might be smoking in 5 years when in fact 43% were still smoking 5 years later (Johnston, O'Malley, Bachman, 1993). However, there are many reasons why they may have not predicted their own subsequent behavior other than underestimating the effects of drug deprivation.

There is also considerable evidence, for a wide range of non-drug-related drive states – e.g., hunger, thirst, fear, sexual arousal and pain -- that people who are not experiencing these states tend to underestimate their motivational force (Loewenstein & Angner, 2003). In one study, water deprived subjects who had just exercised and water satiated subjects preparing to exercise, read a description of hikers who got lost in the woods and rated whether they thought the hikers would prefer to receive food or water, as well as which subjects would prefer if they were in the hiker's position (Van Boven & Loewenstein, 2003). Consistent with the idea that it is easier to imagine being water deprived when one actually is water deprived, subjects who had just exercised were more likely to predict that the hikers, and they themselves, would prefer to receive water than those preparing to exercise.

The design of the current study follows closely that of an earlier study, which demonstrated underappreciation of food deprivation (Read & van Leeuwen, 1998). Subjects chose whether to eat healthy but unsatisfying snacks or unhealthy but filling snacks on a future day when they could either expect to be food deprived (in the late afternoon) or food satiated (right after lunch). They made these choices either in the late afternoon or right after lunch. Supporting the idea that food deprivation is easy to imagine when one is food deprived, choices were affected not only by the time when the snack would be received, but also by the time of day, and hence level of deprivation, when subjects made the decision.

The idea that drug addiction would fit such a pattern is intuitively plausible. Although drug addiction can produce all sorts of horrendous behaviors, when one is not addicted it is difficult to imagine *any* force that could induce one to take the actions that drug addiction is notorious for motivating. However, empirically documenting under-appreciation of the effects of drug

deprivation is difficult because, unlike water and food deprivation, which most people experience routinely and can be easily induced experimentally, the biopsychosocial effects of drug deprivation are only experienced when one is addicted to a drug. Clearly, it would be unethical to expose non-drug-users to drugs to see if they fully appreciate how powerful the effects of drug deprivation will be once they are addicted.

It is, however, possible to address a closely related issue: whether people who are already addicted to drugs but are currently drug satiated can appreciate the motivational force of their own future drug deprivation. Most long-term addicts have experienced repeated intense drug deprivation, so one would expect addicts, if anyone, to appreciate the force of drug deprivation. Testing whether drug satiated addicts can predict the future effect of their own drug deprivation, therefore, provides a conservative test of whether people more generally underestimate the force of drug deprivation.[1]

Testing whether addicts' valuations of future drugs are affected by their current state of deprivation also tests the fundamental tenet of rational choice theory that decisions should be based on the consequences of alternative courses of action. Clearly, whether an addict is currently craving a drug as a result of whether they are about to, or have just completed, treatment has nothing to do with their future desire for a drug. Hence, a finding that transient changes in deprivation-states affect valuations of future drugs would pose a fundamental challenge to rational choice theory, at least insofar as it has been applied to the decisions of drug-abusers.

Overview of Study

To determine whether addicts, when they are drug satiated, under-appreciate the motivating effects of their own future drug deprivation, we gave heroin addicts real choices between receiving an extra dose of opioid agonist medication or 12 money amounts. Similar to the previously reviewed studies of water and food deprivation, addicts made half the choices when

[1]It is possible that addicts become addicts specifically because they cannot appreciate the force of craving, but this would simply underline the importance of such underappreciation for understanding the phenomenon of addiction.

experiencing drug satiation 2-hours after receiving a maintenance dose of buprenorphine (BUP), and made half when experiencing drug deprivation because they had not received any opioids, including BUP for 5 days. Crossed with this manipulation, for half the decisions the money or extra drug resulting from their choices was delivered after 5-days, and for the other half the outcome was almost immediate. (See "supplementary information" for details.)

If addicts can appreciate the force of their own future drug deprivation even when they are satiated then neither of these choices – i.e., involving immediate BUP, or BUP delayed by 5 days -- should be affected by their current level of drug deprivation. If they underappreciate the force of their own future drug deprivation, however, then they should place a higher money value on drugs when they are currently experiencing the effects of drug deprivation than when they are not. This is the central prediction that we tested in our study.

Methods

Thirteen adults in treatment for opioid dependence at the University of Vermont Substance Abuse Treatment Center (SATC) participated in the study. Eight of the research participants were male, and five were female. Participants' mean age was 37.5 years (SD=7.6 years). All met DSM-IV criteria for opioid dependence and FDA criteria for methadone maintenance. Subjects reported an average of 11.9 years of opioid dependence (SD = 8.7 years), and used an average of five bags of heroin intravenously per day (SD = 3.4 bags).

To ensure compliance with the opioid abstinence criterion, subjects provided urine samples on days when they were scheduled to receive buprenorphine. Submission of an opioid positive urine sample resulted in discontinuation from the study until their next opioid-negative urine sample. A second positive test resulted in ejection from the study. Figure 1 shows the cycle of dosing and 8 buprenorphine-money choice sessions during the 8-week study period. Note, the choice task was administered *before* BUP dosing on Days 5 & 10 for *deprived* (D) conditions, administered *2-hours after* dosing for *satiated* (S) conditions. During the study period, each subject experienced eight choice sessions over eight weeks. To ensure that subjects carefully

considered each choice on Day 5 they were told that they would receive a randomly selected outcome of the choice (BUP/$) they make on Day 5 and Day 10 at the end of the session on Day 10. Four choice sessions were conducted when the subject was opioid deprived (i.e., he made choices 5-days after receiving buprenorphine) and four choice sessions were conducted when the subject was opioid satiated (i.e., she made choices 2-hours after receiving buprenorphine).[2] Therefore, for each pair of choice sessions (on Day 5 & Day 10), subjects chose among outcomes delayed by 5 days during the first session (on Day 5), and choose among outcomes which were delivered relatively immediately in the second choice session (on Day 10). Although the arrangement of choice sessions and delivery of outcomes was consistent across subjects, the sequence of deprived and satiated conditions was randomized for each subject.

We told subjects the purpose of this study was to determine preferences for buprenorphine and money, and that they could choose between an extra maintenance dose of buprenorphine and ascending amounts of money. We explained that we would assess preference for BUP or money on Days 5 and 10, and sometimes they would make choices before getting their maintenance dose when feeling drug deprived, but that they would only receive the outcome on Day 10. Thus, on Day 5 we told the participants that they were choosing among outcomes that they would receive five days later. The value of an extra maintenance dose of buprenorphine was assessed by asking subjects to choose between 12 amounts of money ($5, $10, $15, $20, $25, $30, $35, $40, $50, $60, $75 & $100) and an additional maintenance dose of buprenorphine (a constant drug dose). The study's main dependent measure was the lowest dollar value at which money was preferred to buprenorphine. To ensure that subjects carefully considered these choices, we told them they would receive the outcome of one of their choices randomly selected

[2]Buprenorphine doses were determined according to procedures successfully used and previously described in the literature (Bickel & Amass, 1995; Johnson, Cone, Henningfield & Fudala (1989). Each subject's maintenance dose was determined during the first week of participation. Under less-than-daily dosing conditions, subjects were administered multiple doses (i.e., one daily maintenance dose for each day of the inter-dosing interval). For example, under quintuple dosing, five daily maintenance doses were administered sequentially over a period of 25 minutes.

from the first or second session in each pair of choice sessions. This is a common procedure for eliciting valuations from subjects (Loewenstein & Adler, 1995).

In addition to this main dependent measure, we took measures of opioid agonist and withdrawal effects. Pupil radius assessments (i.e., an objective, physiologic index of opioid agonist/withdrawal effects), and subjective reports of opioid agonist and withdrawal symptoms were completed at the beginning, middle, and end of each choice session. The opioid agonist assessment consisted of a five item (e.g., high, drug effect, good effect, bad effect, & like) visual analogue scale that subjects responded to along a 100mm line from none (0) to severe (100). The opioid withdrawal symptoms assessment consisted of 15 items (muscle cramps, painful joints, yawning, hot/cold flashes, upset stomach, irritable, runny nose, sweating, restless, watery eyes, abdominal cramps, chills/gooseflesh, backache, bothered by noises, skin clammy & damp, nausea), which subjects responded to on a 10-point Likert scale from none (0) to severe (9). Mean scores were calculated for pupil radii, opioid agonist, and opioid withdrawal across subjects, in deprived and satiated conditions.

Results

Analyzing the within-session opioid agonist ratings, opioid withdrawal ratings and pupil radii (manipulation checks for the effects of the deprivation) revealed differences in these measures that were consistent with the intent of the deprivation manipulation. Opioid withdrawal ratings at the time of assessments were significantly increased ($\underline{F}_{1,12} = 7.02$, $\underline{p}=.02$) when subjects were opioid deprived ($\underline{M} = 3.6$, $\underline{SD} = 1.8$) compared to when subjects were opioid satiated ($\underline{M} = 2.4$, $\underline{SD} = 0.9$). Similarly, pupil radii were significantly increased ($\underline{F}_{1,12} = 76.5$, $\underline{p}<.001$) when subjects were opioid deprived ($\underline{M} = 5.8$, $\underline{SD} = 0.7$) compared to when they were opioid satiated ($\underline{M} = 5.0$, $\underline{SD} = 0.7$). Consistent with the experimental conditions, opioid agonist ratings were significantly increased ($\underline{F}_{1,12} = 10.6$, $\underline{p}=.007$) when subjects were opioid satiated ($\underline{M} = 1.4$, $\underline{SD} = 1.3$) compared to when they were opioid deprived ($\underline{M} = 0.9$, $\underline{SD} = 1.1$).

We used a nonparametric, repeated measures analysis of variance based on ranks to test for differences in the money value of an extra maintenance dose of buprenorphine across treatment

conditions. This analysis is a generalized version of Friedman's Rank test applied to data with a 2x2 factorial structure, i.e., deprivation level (satiated & deprived) and delay (immediate & delayed 5-days). This nonparametric rank analysis was preferred to parametric analysis for several reasons. First, the interval between successive choices presented to the subject was not constant across magnitude. Secondly, the distribution of responses was non-normal. Lastly, five subjects chose buprenorphine exclusively in at least one of the eight choice sessions (i.e., they preferred it at an unknown amount greater than $100). Though their exact monetary value was not determined, we could readily rank their responses relative to their other choices.

Figure 2 shows the median lowest dollar amount preferred to an extra maintenance dose of buprenorphine when the outcomes of choices were immediate, delayed 5 days, and when subjects were opioid deprived and satiated. Confirming our central hypothesis, the nonparametric repeated measures analysis of variance revealed a main effect of immediate deprivation on choice ($F_{1,12} = 23.12$, $p = .0001$). The median monetary amount preferred to an extra dose of buprenorphine was greater when subjects were opioid deprived (immediate = $75, delayed = $60) compared to when they were satiated (immediate = $50, delayed = $35).

Consistent with a large body of research examining the effects of time delay on value, the median lowest dollar amount preferred to buprenorphine was significantly greater ($F_{1,12} = 6.45$, $p = .016$) when outcomes of choices were immediate (deprived = $75, satiated = $50) versus when they were delayed (deprived = $60, satiated = $35).

Contrary to our expectation that opioid deprivation would increase the value of immediate drug relative to delayed drug, there was no evidence of an interaction between delay to outcomes of choice and opioid deprivation ($F_{2,12} = 0.0$, $p = 1.0$). Immediately experiencing the effects of drug deprivation seems to enhance one's ability to predict the effects of future deprivation whether it will occur immediately or five days later.

Conclusions

This is the first study, to our knowledge, that has examined the ability of addicts to anticipate the effects of their own future drug deprivation. Our results suggest that addicts underappreciate the effects of deprivation when they are not actually deprived. These results provide evidence that contradict the predictions made be the theory of rational addiction (Becker & Murphy, 1988; Chaloupka, 1996), which stipulates that addicted individuals are rational or farsighted in the sense that they anticipate accurately the expected future consequences of their current actions.

Although we obtained our results with addicts, it is likely that they apply, perhaps even more strongly, to people who are not addicted. Due to the inconsistent availability of drugs and money, and the illicit nature of drug addiction, most heroin addicts have had ample experience with episodes of drug deprivation, giving them the opportunity to learn not only about its subjective intensity, but also to experience its motivating effects first-hand. In contrast, those who are not addicted can at best gain such experience vicariously. Therefore, combined with the human tendency toward overconfidence (Dougherty, 2001; Polivy & Herman, 2002), we believe our study provides strong support for the idea that people who are not addicted are likely to underestimate the effects of their own future drug deprivation.

Underappreciation of future deprivation can produce a pattern of preference reversal that is very similar to that demonstrated with hyperbolic time discounting. If people fail to anticipate the force of their own future deprivation, they are likely to make a different choice – to be more likely to indulge in drug use – than they originally anticipated, when they subsequently confront such deprivation (Loewenstein, 1999). In the context of a counseling session when an addict underestimates the effects of future deprivation associated with abstinence, he might report a desire to quit and genuine confidence that he will be successful in quitting. When the opportunity to use drugs occurs, however, the client will likely choose to use drugs because, as a result of underestimating the impact of deprivation, he values the immediate consequences of drug use (e.g., relieving withdrawal) more than anticipated. In fact, one of the most efficacious

treatments for preventing relapse to drug use involves teaching addicts to anticipate, recognize and cope with "high risk" situations such as craving, which are said to serve as cues to use drugs (Marlatt, 1988).

Addiction certainly has many causes. Our study suggests that underappreciation of future drug deprivation is one factor that deserves further attention.

References and Notes

Becker, G. & Murphy, K (1988). A theory of rational addiction. Journal of Political Economy, 96(4), 675-700

Bickel, W. K., Marsch, L. A. (2001). Toward a behavioral economic understanding of drug dependence: Delay discounting processes. Addiction, 96(1), 73-86.

Bickel, W.K. & Amass, L. (1995). Buprenorphine treatment of opioid dependence. A review. Experimental & Clinical Psychopharmacology, 3(4), 477-489.

Chaloupka, F.J. (1996). A review of economic models of habitual and addictive behavior and their empirical applications to cigarette smoking. In *Advances in behavioral economics,* L. Green, & J.H. Kagel, eds., Norwood, NJ: Ablex Publishing Corporation, pp. 183-206.

Crabbe, J. C. (2002). Genetic contributions to addiction. Annual Review of Psychology, 53(1), 435-462.

Dougherty, M. R. (2001). Integration of the ecological and error models of overconfidence using a multiple-trace memory model. Journal of Experimental Psychology, General, 130(4) 579-599 (2001).

Giordano, L. A, Bickel, W. K., Loewenstein, G., Jacobs, E. A., Marsch, L. & Badger, G. J. (2002). Mild opioid deprivation increases the degree that opioid-dependent outpatients discount delayed heroin and money. Psychopharmacology, 163(2), 174-182.

Goldstein, A (1994). Addiction: From biology to drug policy (p. 12). New York: Freeman.

Herrnstein, R. & Prelec, D. (1992). A theory of Addiction. In G. Loewenstein & J. Elster (eds.), Choice over time (pp. 331-360). New York: Russell Sage Foundation.

Heyman, G. M. (1996). Resolving the contradictions of addiction. Behavior & Brian Sciences, 19(4), 561-610.

Johnson, R. E., Cone, E. J., Henningfield, J.E. & Fudala, P.J. (1989). Use of buprenorphine in the treatment of opiate addiction. I. Physiologic and behavioral effects during a rapid dose induction. Clinical pharmacology and therapeutics, 46(3), 335-343.

Johnston, L., OMalley, P., & Bachman, J. (1993). National survey results on drug use from the Monitoring the Future study, No. 933598. Rockville, MD: National Institute on Drug Abuse.

Loewenstein, G. & Adler, D. (1995). A bias in the prediction of tastes. Economic Journal, 105, 929-937.

Loewenstein, G. & Angner, E. (2003). Predicting and indulging changing preferences. In G. Loewenstein, D. Read, & R. Baumeister (eds.), Time and decision: Economic and psychological perspectives on intertemporal choice (pp. 351-391). New York: Russell Sage Foundation Press.

Loewenstein, G. (1999). A visceral account of addiction. In Elster, Jon and Skog, Ole-Jørgen (Eds.) Getting Hooked: Rationality and Addiction (pp. 235-264). Cambridge, England: Cambridge University Press.

Marlatt, A. G. (1985). Relapse Prevention: Maintenance Strategies in the Treatment of Addictive Behaviors.

Niaura, R. (2000). Cognitive social learning and related perspectives on drug craving. Addiction, 95(Suppl 2), S155-S163.

Polivy, J. & Herman, C. P. (2002). If at first you don't succeed. False hopes of self-change. American Psychologist, 57(9), 677-689.

Read, D. & van Leeuwen, B. (1998). Predicting hunger: The effects of appetite and delay on choice. Organizational Behavior & Human Decision Processes, 76(2), 189-205.

Slovic, P. (2001). Smoking: risk, perception & policy. Thousand Oaks, CA: Sage Publications.

Van Boven, L. and Loewenstein, G. (2003). Social Projection of Transient Visceral Feelings. Personality and Social Psychology Bulletin, 29(09), 1159-1168.

Vuchinich, R. E.; & Simpson, C. A. (1998). Hyperbolic Temporal Discounting in Social Drinkers and Problem Drinkers. Experimental and Clinical Psychopharmacology, 6(3), 292–305.

Westermeyer, J. (1999). The role of cultural and social factors in the cause of addictive disorders. Psychiatric Clinics of North America, 22(2), 253-273.

Figure 1

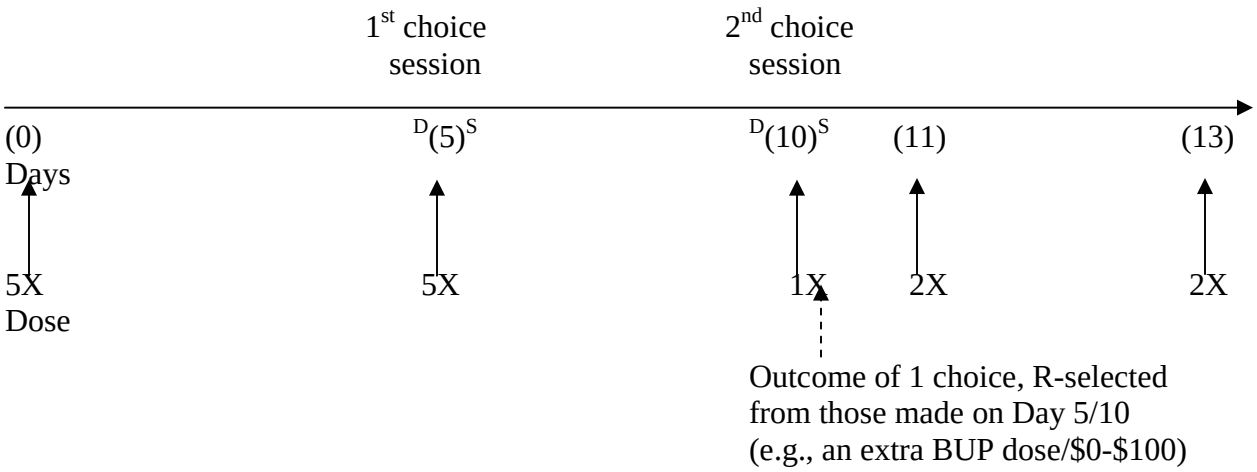
1st choice session
2nd choice session
(0) Days
D(5)S
D(10)S
(11)
(13)
5X Dose
5X
1X
2X
2X
Outcome of 1 choice, R-selected from those made on Day 5/10 (e.g., an extra BUP dose/$0-$100)

Figure 2. Median lowest dollar amount attributed to an extra dose buprenorphine.