An Experimental Analysis of Consumption?
A Review of *Advances in Behavioral Economics*:
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edited by L. Green and J. H. Kagel

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It follows that the main datum to be measured in the study of the dynamic laws of an operant is the length of time elapsing between a response and the response immediately preceding it or, in other words, the rate of responding. (Skinner, 1938, p. 58)

With these words, Skinner identified the primary dependent variable that has been employed in the experimental analysis of behavior over the last 60 years. Although Skinner argued that the dynamic properties of operant responding could be captured best with the cumulative record, this measure has increasingly been replaced by average rates of responding over molar time intervals. The latter, perhaps owing to Herrnstein's (1970) important work with concurrent schedules, has nonetheless retained rate of response as the primary dependent variable in the study of operant behavior.

Like behavioral scientists, economists have been interested in response rate, but their primary measure of responding has been *production*, an outcome measure of responding. A second primary dependent measure used within economics, but not typically studied in the behavioral sciences, is *consumption*. Consumption refers to the total goods and services purchased within a temporal interval (e.g., annual gross domestic spending). At the level of individual organisms, consumption sim-

ply refers to the obtained reinforcement rate (e.g., 20 reinforcers per hour) multiplied by the reinforcer magnitude (e.g., $20 \times \$0.25 = \5). Although obtained reinforcement rates are measured and reported in some basic and applied research conducted within a behavioral framework (e.g., concurrent schedules of reinforcement), obtained reinforcement rate is more often an independent variable than a dependent variable in this literature.

Behavioral economics represents an integration of various microeconomic concepts and measures with methodologies, concepts, and measures employed within the experimental analysis of behavior. Among these integrations, an experimental analysis and measurement of both response rate and consumption are among the many advances in Green and Kagel's *Advances in Behavioral Economics* (Vol. 3). Behavioral measures of response rate and economic measures of consumption are particularly well suited to the topics in this text—substance use and abuse—because response rate and consumption appear to capture the primary behaviors and outcomes of interest: drug seeking and drug taking, respectively. As several of the authors in this text note, interventions and public policies that effectively decrease drug consumption may not be accompanied by corresponding decreases in drug seeking. That is, if one exclusively focuses on decreasing drug consumption, one will miss increments in rate of undesirable drug-seeking behaviors. Likewise, if exclusively measuring rates of drug seeking, one will overlook in-

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roads being made in combating drug consumption despite increasing rates of criminal activities associated with drug seeking. This point will be discussed further below.

The text is composed of a short introduction and nine chapters that summarize recent advances within behavioral economic research and theory published in or emanating from the substance abuse literature over the last decade. The book may be grossly dissected into the following three subject areas (although the chapters are not arranged strictly according to these subjects): (a) behavioral economic analyses of laboratory drug taking, (b) behavioral economic theoretical analyses of the determinants of drug use and abuse, and (c) contemporary economic models of drug abuse.

Behavioral Economics of Laboratory Drug Taking

An opening chapter by DeGrandpre and Bickel concisely defines and empirically illustrates some of the implications of economic theories, concepts, and measures for understanding substance abuse. The central implication is that drug use and abuse may be conceptualized as consumer demand for a drug, with *consumer demand* defined as the amount of drug that will be consumed at a given price. By interpreting drug consumption as consumer demand, the economic demand law may be applied to the problem of substance abuse. The demand law holds that consumption of a good tends to decrease as the price of that good increases, all else being equal (Samuelson & Nordhaus, 1985). Consistent with the demand law, empirical evidence is provided in this chapter, and throughout the text, illustrating that price increases tend to decrease human and nonhuman drug consumption in the laboratory and in the natural economy. However, the story is not as bright for the effects of price increases on drug seeking. DeGrandpre and Bickel provide empirical evidence illustrating that although

drug taking may decrease when price increases, response rates (i.e., drug-seeking responses) may increase substantially.

This inverse relation between response rate and consumption is further explored in terms of public policy in a second chapter by Bickel and DeGrandpre. The policy initiatives modeled in their experiments include drug legalization, increased drug interdiction, pharmacotherapies (e.g., agonist and antagonist medications), employment initiatives, and recreation programs designed to provide an alternative to drug taking (e.g., midnight basketball). The authors' laboratory results with human subjects suggest that greater drug interdiction can reduce drug consumption by decreasing the availability of drugs and increasing the work required to obtain a unit of drug (i.e., increase the price at which drugs are available). Across the vast majority of price increases conducted in their laboratory, however, rates of drug seeking increase with each price increase. In the natural economy, these increases may translate into increased criminal activities maintained by money or access to drugs. These results suggest that only when drug prices are increased substantially will demand shift from inelastic to elastic: the point at which both drug taking and drug seeking are decreased. The increase in price necessary to produce these beneficial outcomes, however, may be difficult or impossible to realistically implement through drug interdiction. Likewise, the experiments summarized in this chapter suggest that reducing the cost of obtaining drugs through legalization is likely to increase drug consumption in current drug users. The effects of legalization on the initiation of drug use by nonusers are not addressed by the data presented in this chapter.

Heyman provides a chapter that examines the effects of the price at which alcohol may be purchased and its relation to alcohol consumption. In the first half of the chapter, Heyman ex-

amines epidemiological data and the correlation between alcohol price, alcohol consumption, and cirrhosis of the liver. The relation between these measures is striking: Consistent with the demand law, alcohol price decreases are closely mirrored by parallel increases in alcohol consumption and cases of death due to liver cirrhosis. In the second half of the chapter, Heyman examines the relation between price increases and alcohol consumption in rats with histories of heavy drinking. Two of his experiments show that the relation between price increases and consumption decreases do not mirror the increases in alcohol consumption produced by price decreases. Heyman hypothesizes from these data that price decreases may increase the initiation of drinking and per capita alcohol consumption at the population level, but price increases may be less effective in curbing drinking in populations of heavy drinkers.

A second tenet of the economic demand law holds that price increases yield larger decreases in consumption of Good X if a substitute Good Y is available. To take a nondrug example, increasing the price of movie theater tickets will produce a larger decrease in ticket sales if videocassette recorder rentals are readily available than if they are unavailable. Supporting evidence for this prediction is provided with human subjects by Bickel and DeGrandpre and with nonhumans in the chapter by Carroll. Carroll's chapter summarizes the empirical work on substitute relations between drug and alternative nondrug reinforcers. Laboratory data illustrate how alternative nondrug reinforcers can inhibit nonhuman acquisition of drug self-administration, decrease drug intake during drug maintenance, and reduce motivational deficits produced by drug withdrawal. Further, evidence illustrates that alternative reinforcers can reduce the severity of relapse or the number of animal subjects that experience relapse to drug use. The data summarized by Carroll, much of it her own,

are some of the most exciting advances in understanding the conditions under which drug acquisition occurs, is maintained, and, importantly, can be reduced through behavioral interventions designed to increase the availability of alternative nondrug reinforcers. Clinical research has already impressively demonstrated the ability of alternative nondrug reinforcers to decrease drug taking in human substance abusers outside the laboratory (e.g., Higgins et al., 1995; Silverman et al., 1996; Stitzer & Bigelow, 1983).

To round out the laboratory behavioral economics portion of the text, Johanson, Schuster, and Woolverton—three leading behavioral pharmacologists who describe themselves as relative outsiders to the area of behavioral economics—comment on the potential strengths and weaknesses of the behavioral economic model. For example, although the economic concept of unit price may potentially simplify our understanding of the cost-benefit interactions that affect drug use, few animal studies have been conducted to assess unit price predictions, and those that have been conducted have nearly exclusively employed fixed-ratio schedules of drug self-administration. Further, Johanson and colleagues note several enduring questions within behavioral pharmacology to which a behavioral economic analysis has yet to be applied (e.g., relative reinforcer efficacy) and raise several empirical findings that appear to be difficult to reconcile with a behavioral economic account of substance abuse (e.g., Nader, Hedeker, & Woolverton, 1993).

*Theoretical Analyses of the
Determinants of
Drug Use and Abuse*

Vuchinich and Tucker's chapter contrasts molecular and molar theories of choice, and discusses the implications of these differences for the study of alcohol abuse (although their analysis appears to be equally applicable to understanding abuse of other substances

as well). Molecular accounts of alcohol abuse focus on the immediate antecedent conditions that are responsible for each episode of alcohol consumption. Because the immediate, observable, antecedent causes of drinking are difficult to identify, some molecular accounts (e.g., cognitive social learning theory) have speculated about cognitive events that increase the momentary probability of drinking. From this theoretical position, short-term therapeutic interventions focus on changing the cognitive covariates of drinking episodes (e.g., improving self-efficacy). Vuchinich and Tucker (and Fisher in a later chapter) contrast this position with a molar choice account of behavior based on behavioral theories of choice (e.g., the matching law, Herrnstein, 1970; and maximization theories, e.g., Rachlin, Battalio, Kagel, & Green, 1981). A molar choice account of alcohol abuse seeks to explain temporally extended patterns of drinking in terms of the temporally extended environmental context in which drinking occurs.

Economic variables that affect the temporally extended (i.e., molar) context responsible for alcohol abuse provide the link between Vuchinich and Tucker's molar choice account of alcohol abuse and behavioral economics. The authors provide data illustrating their ongoing attempts to measure temporally extended patterns of alcohol consumption and other behaviors that may interact with drinking. The authors also review their work correlating changes in the availability of significant alternative sources of reinforcement (e.g., intimate, family, and social relations) with patterns of drinking. The results, albeit correlational, support the molar choice conceptualization of the determinants of alcohol abuse. Further, the results complement those obtained in human and animal laboratory experiments in which drugs are self-administered with and without alternative sources of reinforcement (summarized in chapters by Bickel &

DeGrandpre, Carroll, and DeGrandpre & Bickel).

In a related chapter, Fisher applies the molar choice perspective to understanding cigarette smoking. Like Vuchinich and Tucker, Fisher focuses on how the availability of alternative reinforcers affects molar patterns of smoking. Specifically, Fisher holds that "social support" may be conceptualized as a commodity that may serve as an economic substitute for many of the reinforcing effects of cigarette smoking. Unfortunately, Fisher never provides an operational definition of social support as a substitute commodity beyond classifying it as a "good thing" or a "reinforcer" (although what behavior is being reinforced in Fisher's analysis is unclear). Fisher notes that nicotine produces anxiety-reducing, antidepressant, stimulant, and euphoric effects that, he suggests, mirror the benefits of social support on mood and task performance (empirical evidence for the latter is provided in the chapter). Given the common cluster of beneficial consequences for both nicotine and social support, Fisher suggests that the two commodities may substitute for one another. Evidence supporting this substitute relation is based on self-reports of cigarette smoking rates following widowhood (i.e., a loss of social support).

The data collection techniques, predictions, and theoretical analyses summarized in the chapters by Vuchinich and Tucker and by Fisher appear to be derived from Herrnstein's (1970) empirical analysis of choice as much as they are from the behavioral economic concepts of open and closed economies (see Hursh & Bauman, 1987) or other microeconomic models. For example, because Fisher holds that nicotine and social support are substitute commodities, his theory and predictions appear to fall directly from Herrnstein's matching law. However, because the matching law describes choice between qualitatively identical reinforcers (i.e., perfect substitutes), its generality to nonidentical reinforcers may not al-

ways hold (see Kagel, Battalio, & Green, 1995). Indeed, the relation between alcohol and a variety of alternative reinforcers (as discussed by Vuchinich & Tucker) is unlikely to be a perfect substitute relation. If this is true, then the qualitative predictions provided by Vuchinich and Tucker and by Fisher are unlikely to be followed by quantitative predictions about drug seeking or drug consumption. Pragmatically, this may not be a problem given that the broad goal of these authors' work is to reduce substance abuse. Nonetheless, a complete understanding of choice between qualitatively different reinforcers is necessary before quantitative predictions can be made. Interestingly, economists have studied the relations between nonidentical goods for some time and have classified these relations along a continuum from substitutes to complements (see chapters by Carroll and DeGrandpre & Bickel; Vuchinich & Tucker, 1988). This classification scheme may prove to be beneficial to behavior analysts who are interested in quantitative theories of choice (cf. Rachlin et al., 1981).

Contemporary Economic Models of Drug Abuse

Two chapters of the text are provided by leading economists whose work concerns models of substance abuse. In the first, Brito and Strain develop a quantitative utility-maximizing model of alcohol abuse that factors into the price of alcohol, among other things, money lost due to work missed. To take a simplified example, if the cost of another in a series of drinks is \$3.00, but having this drink causes the individual to miss an hour of work at \$5.00 an hour, then the real cost of the drink is \$8.00. Brito and Strain argue that for many drinkers the money lost due to missed work is likely to be a substantially larger component of the real price of a drink than the money spent to obtain a drink. Thus, changing the latter price of alcohol (via excise tax

increases) is unlikely to affect alcohol consumption in populations of problem drinkers. Indeed, the authors briefly review the econometric evidence suggesting that alcohol consumption is little affected by price increases. From their model, the authors argue that loss of employment leads to increased alcohol consumption not because of the resulting loss of alternative sources of nondrug reinforcement (as argued by Vuchinich & Tucker and by Fisher in their respective chapters) but because lost wages no longer factor into the real price of alcohol, resulting in a decrease in the real price at which alcohol may be consumed. This conflicting interpretation of the effects of a job loss will require a laboratory experimental analysis.

The chapter by Chaloupka provides a historical overview of economic theories and models leading up to the rational theory of addiction (Becker & Murphy, 1988), the dominant economic account of drug abuse. Chaloupka provides an excellent comparison of myopic and rational accounts of demand for addictive goods. Although both represent utility-maximizing models of drug abuse, myopic models hold that drug demand is affected by past consumption (i.e., a reinforcement effect) and current drug price. Expectation of future drug prices and the future consequences of current drug use do not play a role in myopic models of drug abuse. By contrast, rational theories of addiction hold that current drug consumption is affected by past drug consumption, current drug prices, the anticipated price of drugs in the future, and consequences of current drug consumption. As is true for behavioral models of delayed consequences (e.g., Mazur, 1987), future consequences in the rational addiction theory are discounted to some degree. According to the theory, then, drug abusers rationally consider the future in their maximizing equation, although they may discount the value of future consequences at a higher rate than do those who do not use drugs (e.g., Chaloupka,

1991; Madden, Petry, Badger, & Bickel, 1997). Chaloupka provides a wealth of population-level econometric data that support the rational addiction theory's contention that drug consumption is supported by past drug use, current prices, expectations of future pricing, and consequences of drug use.

Although behavior-analytic readers are likely to cringe at some of the language used by Chaloupka regarding the effects of expectancies on current drug use, the translation to behavioral variables is seemingly not difficult (e.g., the effects of expectancies about future consequences may be read as "effects of past exposure to informative stimuli describing consequences"). Because the rational theory of addiction has increasingly been discussed in the substance abuse literature, has generated laboratory research, and has been influential in informing public policy makers, understanding this economic account of substance abuse would well serve behavior analysts interested in drug abuse. Therefore, Chaloupka's summary of the theory and literature review are an important resource.

Summary

Because substance abuse can have long-term detrimental physiological, societal, and behavioral effects, it is important to assess the effects of experimental manipulations and treatment variables on both drug seeking (i.e., response rate) and drug consumption. For example, a considerable amount of research has been directed toward the development of putatively therapeutic drug-abuse medications (e.g., agonists, antagonists). Assessment of the effects of these medications has generally focused on changes in the rate of drug self-administration to the exclusion of drug consumption (see, e.g., Katz, 1989). Under a range of drug doses, rates of drug self-administration by humans and nonhumans generally conform to an inverted U-shaped dose-response function (i.e.,

low doses maintain low response rates, moderate doses maintain relatively high rates, and high doses maintain low rates of drug self-administration). Antagonist drugs typically shift this dose-response curve to the right, indicating that the antagonist has blocked the reinforcing effect of the drug until sufficiently high doses are available that, when self-administered, overcome the effects of the antagonist medication. Because response rates are reduced or eliminated by the antagonist medication across a large portion of the baseline dose-response curve, this effect of antagonist medications is generally viewed as therapeutic. However, when the effects of the prototypic antagonist on drug consumption are examined, we find that the medication substantially *increases* drug consumption when the drug is available in high doses, that is, at low prices (Madden, Bickel, & DeGrandpre, 1996). Thus, the therapeutic efficacy of antagonist medications may be confined to environments in which drugs are not readily available. If the drug may be purchased at high doses or at a low cost, however, a behavioral economic analysis focusing on drug consumption suggests that the antagonist medication will increase drug consumption (thereby increasing physiological harm to the user) and rates of drug seeking. To the extent that the latter involves illegal activities, antagonist medications may increase harm to others as well.

Certainly Skinner's (1938) suggestion that free-operant response rate should serve as the primary dependent variable in the experimental analysis of behavior has led to a plethora of research questions and discoveries. Among its other beneficial conceptualizations, manipulations, and measures, the behavioral economic approach adds to Skinner's suggestion a focus on the outcome of operant responding: consumption. The contents of Green and Kagel's volume illustrate how a focus on drug seeking and drug taking, when combined with an analysis of the economic variables that af-

fect these behaviors, may advance our understanding of the determinants of substance abuse. Behavior analysts who are interested in better understanding substance abuse or in gaining a more thorough understanding of behavioral economics will benefit from reading this volume.

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