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EDITORIAL

From Lab Bench to Park Bench: How Behavioral Science Affects the Field of Substance Abuse

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In November 2018, the Association for Behavior Analysis International held its first specialty conference on "Substance Use and Addiction" in Washington, DC. The conference featured 16 distinguished speakers and discussants who have contributed to psychopharmacology, behavioral pharmacology, and substance-use treatment and prevention. The conference was attended by 239 registrants and featured 49 posters. The presentations were organized to take the audience through a journey from "lab bench"—the basic science laboratory, to the "park bench"—the development of treatments to address epidemic substance use disorders and poverty. Anthony Biglan delivered the final message to the audience, stating that behavior analysts have opportunity to affect societal drug abuse problems by helping to develop public policy. Our special issue highlights the field in much the same way: including articles from the conference speakers that review the history of the development of behavioral substance-use research, describe the contribution of behavioral mechanisms to substance-use disorder and genetic influence on those mechanisms, detail several effective behavioral treatments for substance-use disorders (SUDs), and finally suggest innovative ways to refine and disseminate our behavioral technologies.

The timeliness of this special issue is apparent: the United States is in the midst of a tragic epidemic of opioid addiction and overdose that is epic in scale and must be considered a fundamental failure of current drug policies and medical practices. The National Institute on Drug Abuse (2019) reports that 130 people a day die from opioid overdoses. It forces us to consider alternatives to the moral/criminal and 12-step disease models that have dominated drug policies and strategies of addiction treatment in the United States. This epidemic is not limited to the United States; as the World Health Organization (WHO, 2018) indicates there were an estimated 27 million people with opiate use disorder in 2016 worldwide. We would argue that the value of behavioral contributions to the understanding and treatment of SUDs has long been

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underappreciated and underutilized. One goal of the conference and this special issue is to increase awareness of these behavioral advances and their potential for affecting drug problems.

Indeed, behavior scientists made critical contributions to understanding and treatment of drug problems from some of the earliest days of the field. B. F. Skinner studied the effects of amphetamine and barbiturates on operant behavior in rats as far back as 1937 (Skinner & Heron, 1937) and his collaboration with pharmacologist Peter Dews in the 1950s marked the beginnings of what is now called behavioral pharmacology (see Dews, 1978; Laties, 2003).

By the early 1960s, James Weeks, Charles Schuster, and Travis Thompson had demonstrated that animals would respond to deliver IV injections of addictive drugs, launching now-classic approaches to self-administration (Thompson & Schuster, 1964; Weeks, 1962). This work was revolutionary both because it so clearly showed the value of the theoretical approach of viewing drugs as reinforcers, and also because the paradigm made it possible to study the impact of biological as well as environment variables on drug taking. Much of what we know about the neurobiology of addiction stems directly from research using these operant drug self-administration procedures.

Once drug-taking was understood as operant behavior, it was not long before the clinical implications of the approach began to be explored. The potential of contingency management strategies to reduce harmful drug use emerged in the 1970s with work from pioneers like Nate Azrin, Maxine Stitzer, and George Bigelow leading the way. Perhaps the first was Azrin's community reinforcement approach for alcoholism (Hunt & Azrin, 1973), which was designed to make vocational, family, and other social reinforcers contingent on sobriety. The reduction in problem drinking observed by Hunt and Azrin has been successfully replicated numerous times over the years (see Smith, Meyers, & Miller, 2001).

Another important breakthrough was the recognition that verbal self-reports about drug use were often controlled by different variables than drug taking itself—self-reports don't always correspond to actual drug use. This understanding led early researchers to target objective measures of drug taking (e.g., urine, breath, or blood samples) in contrast with most previous drug-treatment outcome studies. Pioneering work conducted in methadone maintenance clients by Stitzer, Bigelow, and Liebson (1979) made incentives (e.g., money, take-home methadone) contingent on reduced drug use outside the clinic as assessed by clean urine screens. Although most contemporary contingency management studies have continued to use some type of physiological measure associated with drug taking as the target response, obtaining such measures is often difficult in clinical settings. Some behavior analysts have suggested that requiring such measures is unnecessarily restrictive and that under some circumstances verbal reports of drug use may be effectively used as a proxy (Critchfield & Reed, 2017). We would strongly agree with their points that verbal self-reports are legitimate objects of behavior analytic research in general, and further that many studies show fairly good correlations between self-reported and other measures of alcohol and drug use (e.g., Critchfield, Tucker, & Vuchinich, 1998; Sobell & Sobell, 1990). That being said, we would urge caution with self-reports from individuals with SUDs for several reasons.

As one poignant illustration, most contingency management researchers are familiar with the controversy that developed in the 1980s surrounding a frequently cited study

of controlled drinking in alcoholics. In the original articles, Sobell and Sobell (1973, 1976) reported successful outcomes in most participants in their experimental group after treatment and in a 2-year follow-up largely based on self-reports (along with verbal reports from collateral sources). Years later a follow-up study with the same participants claimed *unsuccessful* outcomes in 19 out of 20 participants even immediately following treatment (Pendery, Maltzman, & West, 1982). Pendery et al. recovered records from 13 of the participants during alcohol-related hospitalizations that occurred within 2 years of the initial treatment study containing self-reports of heavy alcohol consumption made to physicians that conflicted with the Sobells' outcomes. The ensuing controversy included accusations of fraud, an exposé feature on *60 Minutes*, and an investigation that eventually cleared the Sobells of scientific misconduct. The basis for the discrepancies in interpretation may never truly be resolved, but appears to have been due, at least in part, to an overreliance on self-report data on both sides of the debate (see Marlatt, 1983, for a review of the controversy).

The problem with using self-reports as a proxy for actual substance use is that such reports are determined by multiple factors. Critchfield and Reed (2017) recognized this concern and pointed out that the value of such self-reports will depend upon whether the conditions under which they are obtained are favorable to establish correspondence with actual drug use. If one relies solely on self-report, there is a risk for drawing incomplete or false conclusions about the effectiveness of interventions. For example, circumstances in which substantial incentives are contingent on being drug-free may not be an ideal condition for a participant accurately self-reporting that they have used drugs. These problems with validity can also lead to replication failures. In a special issue on psychology's replication crisis in *Perspectives on Behavior Science,* Laraway, Snycerski, Pradhan, and Huitema (2019) note that factors like phrasing of questions, context, and societal changes can all influence outcomes, and therefore whether a study can be replicated. The most effective and replicable behavioral approaches since the Sobell and Sobell controversy have relied on objective measures of drug use, rather than self-reporting.

A few studies illustrate that self-reports are correlated with objective measures of drug use, even in contingency management studies. For example, Petry and Martin (2002) measured correspondence between self-reported use of opioids or cocaine in a contingency management intervention and found that most cases (86%) of drug positive samples were preceded by a self-report of use, but only found a moderate correlation ($r = 0.45$, $p < 0.01$) for overall self-reports and urinalysis results. Aklin et al. (2014) reported that self-reports of cocaine and opiate usage were "virtually identical to the biochemically-confirmed analysis results" in patients providing follow-up data for a workplace contingency management study (p. 332). In both studies, urinalysis was scheduled to be conducted following the self-report, which may have enhanced the correspondence between measures. These conditions characterize the research settings that study correspondence, but it may not be safe to assume that similar correspondence will continue to apply when the checks are not present. One of the authors of this editorial (Donlin Washington) on several occasions has observed participants self-report opiate abstinence, and then argue that there "must be a mistake" once urinalysis tests indicated recent opiate use.

In any case, research using the strategy of providing incentives contingent on clean urine has consistently proven to provide among best treatment outcomes of any

approach to addiction. For example, a classic study by Higgins et al. (1991) invigorated research on contingency management, as evidenced by being cited 640 times, and still stands as a model for incorporating abstinence incentives into substance-abuse treatment. This 12-week study compared a voucher-based abstinence reinforcement intervention for the initiation of cocaine abstinence to traditional 12-step drug counseling. Patients initially earned $1.50 in vouchers for a negative sample, with values escalating by $0.50 for each consecutive negative sample. An additional bonus of $10 was earned for each four consecutive negative samples. The group receiving vouchers was more likely to stay in treatment for the full 12-weeks, more likely to initiate abstinence, and had longer durations of abstinence than the 12-step group.

Contemporary approaches to the behavioral analysis of drug dependence owe much to these early studies. The remainder of this editorial describes the articles included in this special issue that nicely illustrate how the science has evolved and advanced.

Behavioral Mechanisms of Substance Use

Bickel, Snider, and Mellis (this issue) suggest that an experimental medicine approach is needed for the field of substance use and abuse to progress. Following this approach, one should develop experimental questions and interventions based on the behavioral mechanisms controlling behavior (e.g., temporal delay, reinforcer magnitude, competing reinforcers) rather than the topographical features of the behavior (e.g., the consumption of a substance). This article builds upon Bickel's previous work on the importance of delay discounting to the trans-disease process, which is "a process that occurs across a range of disorders, making findings from one disorder relevant to other disorders" (Bickel, Jarmolowicz, Mueller, Koffarnus, & Gatchalian, 2012b, p. 287.) This discounting can lead to a "reinforcer pathology," where preference for a highly reinforcing immediate commodity (e.g., drugs) is exhibited despite negative long-term consequences (Bickel, Jarmolowicz, MacKillop et al., 2012a). The authors argue that understanding temporal control is vital to the development of effective treatment. Increasing the "temporal window," or the period of time over which an individual is sensitive to the accumulation of reinforcement, could shift behavior away from immediate drug reinforcers and towards healthier delayed or uncertain events that are more likely to occur in the absence of substance use (e.g., episodic future thinking).

Critical to the concept of delay discounting as a trans-disease process are findings of stability of individual differences in discounting rates over time. Rung, Peck, Hinnenkamp, Preston, and Madden (this issue) review some of literature supporting this stability (see also Odum, 2011), but make the important point that these trait-like aspects do not mean that delay discounting rates cannot be changed. Their review of an array of behavioral manipulations designed to alter the slope of the discounting function with animals and people in the laboratory reveals many successes. These include brief interventions (e.g., framing, episodic future thinking [see above], nature exposure) as well as more extended approaches (timing training, delay fading, exposure to delays) that may have more durable effects. These promising techniques suggest a rich research agenda with considerable potential for translation to treatment and prevention of the host of problems related to this form of reinforcement pathology.

To the extent that individual differences in delay discounting do show trait-like properties, the source of these differences is an important question. Mitchell (this issue) reviews research that suggests the possibility of a genetic component to delay discounting. She also discusses the relatively large body of research supporting some role for genetic factors in substance use disorder and considers some of the persistent questions that have revolved around exactly what is inherited that might dispose an individual toward alcoholism or other drug problems. Her review also illustrates the multiple and complex ways in which sensitivity to stimulus conditions and reinforcement contingencies may interact with rates of delay discounting and drug taking, and outlines an important role for behavior analytic research to clarify them.

The interpretation and translation of the delay discounting literature depends to some extent on the generality of effects across events. Steep discounting is frequently equated with the lay term "impulsivity" with all the entailments implied by this. In this section's final article, Green and Myerson (this issue) raise important concerns about some of the core assumptions in this field. For example, research from their laboratory (Mejia-Cruz, Green, Myerson, Morales-Chaine, & Nieto, 2016) found that discounting rates of several different delayed reinforcers were correlated with one another, consistent with the idea that discounting shows "transituationality." However, probability discounting of the same reinforcers loaded on a different factor, and discounting of delayed losses was relatively uncorrelated with either one; these findings raise important questions about the transituationality assumption. These and other puzzles reviewed by Green and Myerson reveal that there is still much to learn about delayed and probabilistic discounting and clarification of these issues should be considered a key research priority.

Technology and Treatment Delivery

Dallery et al., (in review) and Kiluk (in review) highlight that a major barrier to the dissemination of behavioral treatments is access. They propose that one way to address this problem is to develop technology that allows remote delivery of contingency management interventions (Dallery et al., in review) and Cognitive Behavioral Therapy (CBT; Kiluk, in review).

Dallery and Glenn (2005) first reported the use of internet-based delivery of contingency management interventions for substance use disorders. In their study, smokers used web cameras to submit breath samples, and could earn vouchers for evidence of recent smoking abstinence. Only 7% of breath samples indicated abstinence in a baseline (no-incentives) condition, compared to 60% samples indicating abstinence in a monetary voucher condition. Dallery's laboratory has refined the method and technology for delivering these interventions since that initial article, which is detailed in his article in this issue. Dallery et al., (in review) also describe how these approaches are addressing other drug use of interest, and exciting new technologies that could allow for continuous monitoring of drug use via watches or tattoos.

Kiluk (in review) describes cognitive-behavioral therapy (CBT) in the treatment of substance use disorders and points out that some variability in success rates might be due to individual differences among clinicians. In this issue, he details the development of a computer-based "skills training machine" of CBT called "CBT4CBT." The

program uses videos, graphics, scenarios, instructions, and exercises to model and allow users to practice skills that target behavior, cognition, and affect. CBT4CBT has been effective an adjunct to *treatment as usual* (TAU) for cocaine and alcohol use. In addition, it has been shown to be more effective as a stand-alone treatment for substance-use disorders when compared to TAU, with better retention, engagement, and substance-use reductions. Kiluk (in review) also describes how this modality of treatment delivery allows for an increase in dissemination and a reduction in cost when compared to in-person CBT sessions.

New Directions in Contingency Management

All of the papers on CM describe refinements of procedures, but also emphasize making CM more accessible and cost effective. Rash and DePhilippis (this issue) target dissemination by describing important features of CM, ways to reduce the effort and cost of using CM in the clinic, and the large-scale implementation of CM by the Department of Veterans Affairs (VA) initiative. As they point out, intermittent reinforcement schedules can be used to address cost barriers to CM delivery. A series of studies by Petry and colleagues (e.g., Petry, Martin, Cooney, & Kranzler, 2000) are described in which abstinence can be reinforced by prize-bowl (or fishbowl) drawings, where only 50% of the tickets "win" a prize. Prize sizes vary indirectly with the probability of winning that prize. The chance at winning a "jumbo" prize worth $100 is small but helps to maintain behavior. This prize-bowl approach was part of "The VA initiative," started in 2011, which sought to increase the delivery of CM for SUDs, and conducted regional training for VA providers. They report that by 2018, most of the programs that had been trained to do so (98%) were delivering CM to increase abstinence or increase treatment attendance. Finally, they describe how to choose patient populations, target behaviors, and arrange incentives to maximize effectiveness for clinicians.

Higgins, Kurti, and Davis (this issue) describe the history and evolution of voucher-based CM interventions, but argue that despite efficacy, the interventions are "underutilized" in SUDs. They state:

> Indeed, if decisions around treatment practices were based on empirical evidence alone, community substance abuse treatment facilities would be the settings where CM would have the greatest presence. . . . In our opinion, there needs to be greater efforts to understand and assist community treatment programs in surmounting barriers to delivering evidence-based treatments, along with holding them accountable for their practices and outcomes . . . this responsibility may fall to professionals in the addictions field.

This statement suggests that researchers need to take on more responsibility by not only refining CM procedures, but helping the community appropriately deliver this evidence-based treatment. Programs like the VA initiative and the Positive Reinforcement Opportunity Project (PROP), are offered as successful models of CM dissemination. Higgins, Kurti, and Davis describe recent efforts to push for adoption of CM strategies into the private sector, Medicaid, and the World Bank.

Silverman, Holtyn, and Toegel (this issue) describe a comprehensive intervention for SUDs that integrates proximal (i.e., abstinence reinforcement) with distal interventions that address poverty, and indirectly may affect the development of SUDs. Silverman has developed a "therapeutic workplace" over a series of studies, which was first introduced by Silverman et al., (2001). This innovative intervention does not directly reinforce drug abstinence with vouchers, but instead allows access to paid work for evidence of abstinence. The participants earn money through attendance and completion of work tasks, but cannot work (or have reduced pay) if they submit samples positive for target drugs. This intervention has also been successful at increasing medication compliance for SUDs as well. The authors also describe how participation in the workplace has targeted job skills acquisition, workplace attendance, and promoting external employment. They end by encouraging behavior analysts to focus on poverty, because there is potential for big impacts.

Conference Dialogue

The conference led to lively discussions, highlighting the strengths, weaknesses, and confusions within the field of substance use research. Discourse of this nature is vital to progress in any field. To summarize the conversation, we will start by addressing three criticisms of behavioral approaches to substance abuse that arose at the conference.

1. Why should someone get incentives for doing something I do for free (i.e., not doing illegal drugs).
2. The effects only last as long as the interventions are present (that is, relapse often occurs after treatment withdrawal).
3. The field hasn't done enough to *prevent* substance abuse in young populations (a criticism noted by one of the invited speakers).

The first point is a familiar one to contingency management practitioners. It addresses fairness, and likely stems from the belief that drug use is a moral issue. Society has often viewed the substance-abuse user as immoral, lacking willpower, and deserving of adverse consequences. It also questions whether effective treatment is warranted. If someone "chooses" to do drugs, are they worth the effort and cost of treatment? More contemporary models of substance use disorder see the user as suffering from a medical disorder that mandates treatment for the benefit of the addict and the society. Because contingency management and CBT have been shown to be some of the most effective at reducing drug use, are we not obligated to deliver these treatments? To be able to deliver these efficacious treatments, we may have to consider making them palatable to the critics. As described in Dallery et al., (in review), deposit contracts reduce costs of delivery by requiring that the individual work towards earning their own money. The Silverman et al. (this issue) approach would also seem to speak to the above concerns, as it may be viewed as a beneficial investment to both the user and to society to reduce poverty and drug use.

The second point questions the effectiveness of the treatment, and is more commonly heard from nonbehavioral scientists and substance-abuse treatment providers. Most would acknowledge that contingency management interventions are effective

while the incentives are available for drug abstinence. The criticism is that once those incentives are ended, many individuals relapse to drug use. Former deputy director of the Office of National Drug Control Policy A. Thomas McLellan and colleagues addressed this concern nicely by comparing SUD treatment to that of other chronic medical problems like diabetes, hypertension, and asthma (McLellan, Lewis, O'Brien, & Kleber, 2000). Cessation of the physician-recommended treatments for those disorders (including SUDs) results in a consistent worsening of symptoms or a "relapse." They suggested a reframing of SUDs as a chronic medical problem rather than viewing it as an acute disorder. Silverman et al. (2019) further argue that "it may not be possible" to deliver irreversible substance-abuse treatment. As they suggest, designing long-term contingency management interventions could be one way to address the problem of relapse. Note that this would be fully consistent with methadone maintenance approach to treatment of opiate addition.

In any event, at the substance abuse conference in November 2018, this question was asked several times, and Stephen Higgins gave an interesting response. In essence, he said that you have to convince people that even moderate periods of abstinence are better than having no periods of abstinence. He stated that one reason he targeted cigarette smoking in pregnant women was that almost everyone could agree that reducing smoking during pregnancy (a relatively short 9-month period) was worth the effort and cost of delivering treatment. Perhaps this procedure generates more acceptance is because the behavior is affecting the fetus as well as helping the mother amend unhealthy behaviors. Some other populations also are afforded more support, and it could also be argued that society is less judgmental of military veterans with SUDs than those in the general population, because many can see drug use as related to deployment stress and combat experiences. This may explain why the VA initiative (Rash & DePhilippis, this issue) has been more successfully than similar programs for different populations. Perhaps the devastating consequences of the current opiate addiction crisis will force critics to become more accepting of the idea that those with substance-use disorders are worth the cost and effort.

Finally, Biglan and Van Rysen (this issue) challenge us to address the prevention of substance-use disorders. The aphorism that "an ounce of prevention is worth a pound of cure" has often been applied to SUDs, but drug prevention programs have had a checkered history. For example, research on one of the most widely applied programs (Drug Abuse Resistance Education [DARE]) has generally shown little or no enduring effects on preventing drug use (Maisto, Galizio, & Connors, 2019) and some studies have shown that participation in the program may actually increase intake of alcohol and other drugs (Lillenfeld, 2007). Biglan and Van Rysen make the case that drug-prevention strategies based on behavioral principles may be more effective, but as with behavioral approaches to treatment, they have not been widely applied. Indeed, they also note that in contrast with the growing literature on behavioral treatments, behavior analysts have done little prevention research.

There are doubtless a variety of reasons for this neglect, but one that Biglan and Van Rysen focus on is the reliance on self-reported drug use that has characterized most prevention research. Although findings based exclusively on self-reported drug use do raise a caution flag (see above), we certainly agree with Biglan and Van Rysen that this history should not discourage behavior analysts from engaging in prevention work. Indeed, the developing technology (discussed in this issue) that can provide cheap and

practical measures of physiological traces of substance use may provide a roadmap for future prevention research (e.g., Dallery et al., in review).

The positive discourse of the conference far outweighed the criticisms outlined. Indeed, much of the discussion focused on how to better refine and disseminate effective treatments. We hope that readers of the articles in this special issue will experience some of the excitement and optimism shared at the conference. The value of behavioral approaches to understanding, treating, and preventing substance use problems is clear. There is much work to do.

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