Published in final edited form as:

Subst Use Misuse. 2011 ; 46(1): 4–9. doi:10.3109/10826084.2011.521066.

A Review of Computer-Based Interventions Used in the Assessment, Treatment, and Research of Drug Addiction

Warren K. Bickel¹, Darren R. Christensen¹, and Lisa A. Marsch²

¹ Center for Addiction Research, Department of Psychiatry, University of Arkansas for Medical Sciences, Little Rock, Arkansas, USA

² Center for Technology and Health, National Development and Research Institutes, Inc., New York, New York, USA

Abstract

Computer-based interventions are cost-efficient methods that may result in greater access to drug addiction treatment. We review recent findings from our laboratory where computer-based interventions have produced outcomes that are comparable to therapist-delivered interventions. We also examine how computer-based interventions targeting substance abuse disorders relate to cognitive functioning. This review will suggest that not only are computer-based interventions cost-efficient and accessible but that they are also effective methods for the motivation, engagement, and treatment of drug-dependent individuals. Moreover, computer-based interventions are compatible with a recently proposed biological mechanism implicated as the basis for drug addiction.

Keywords

drug dependence; discounting; temporal discounting; computer-based programs; technologies; neuroimaging; functional magnetic resonance imaging (fMRI); substance abuse

INTRODUCTION

The use and misuse of drugs is a serious public health problem that has been estimated to cost the United States approximately 180 billion dollars (Office of National Drug Control Policy, 2004) and account for approximately one in five deaths per year (Mokdad, Marks, Stroup, & Gerberding, 2004). To address this problem, drug addiction research has grown in multiple directions including the assessment of temporal effects, brain activity, and skill acquisition (Leshner, 2007). This growth has been concurrent with developments in scientific and computational technologies, such as computer-based instructional design and brain imaging.

Nonetheless, the health challenges persist. In particular, the high demand, limited availability of services, difficulties maintaining consistent treatment, and low adoption of evidence-based research impede widespread health change (Bickel & McLellan, 1996;

Copyright © 2011 Informa Healthcare USA, Inc.

Address correspondence to Warren K. Bickel, Center for Addiction Research, Department of Psychiatry, University of Arkansas for Medical Sciences, 4301 West Markham Street, Slot #843, Little Rock, AR 72205; WBickel@uams.edu.

Declaration of Interest

In addition to their affiliations listed above, Drs. Bickel and Marsch are affiliated with Health Sim, LLC, a health –promotion software development organization. The authors have worked extensively with their institutions to manage any potential conflict of interest.

McLellan, Carise, & Kleber, 2003). Consequently, researchers have suggested that a substantive change in the delivery of addiction treatment is required to achieve better treatment and prevention outcomes (Bickel & Marsch, 2007; McLellan et al., 2003).

To meet these issues, we present several findings from our own and colleagues' laboratories that examine recent computer-based interventions in the areas of drug addiction assessment, treatment, and research. We begin by reviewing the recent scientific literature on computer-based interventions for drug addiction and then discuss how computer-based interventions may address a recent putative neurological mechanism underlying drug addiction.

Information Technologies as the Medium of Treatment Delivery

Although computer-based programs have been effectively used in various therapeutic contexts (Murphy & Mitchell, 1998; Newman, Consoli, & Taylor, 1997; Selmi, Klein, Greist, Sorrell, & Erdman, 1990), very few controlled clinical trials have examined the efficacy of interactive computer-delivered therapy for the treatment of addictive disorders. One notable exception was a study undertaken by Marsch and Bickel (2004) that used a fluency-based computer program to facilitate the acquisition of HIV/AIDS knowledge by opioid users. Fluency-based programs have been shown to promote skill mastery by developing the accurate and fast responses associated with competent performance (Binder, 1996) while improving the short- and long-term retention of knowledge (Binder, 1996; Dougherty & Johnson, 1996). With the fluency approach to treatment, participants progress at their own speed and acquire skills of self-evaluation that enable them to monitor their progress and achievement (Lieberman & Lynn, 1991). Importantly, fluent behavior maintains high performance under challenging circumstances such as when distracters that challenge self-control are present, a situation that a drug-dependent individual often experiences (Binder, 1984; Brownell, Marlatt, Lichenstein, & Watson, 1986; Hubbard & Mardsen, 1986; Washton, 1986).

Marsch and Bickel (2004) randomly assigned opioid-dependent injection drug users to either a fluency-based computer HIV/AIDS education program or a standard therapist-based counseling HIV/AIDS intervention. At the three monthly follow-ups, participants who experienced the computer-based program learned significantly more information about HIV/AIDS, enjoyed the teaching method, and requested additional information with greater frequency than therapist-based counseling. The authors suggested that the greater retention of information was due to the fluency approach and interactive nature of the computer program. Coupled with the evidence that computer-based programs have been shown to be as valid and reliable as or more valid and reliable than face-to-face interviews (Kobak, Greist, Jefferson, & Katzelnick, 1996), this result suggests that computer-based programs offer substantial benefits to opioid-dependent injection drug users.

The efficacy of computer-delivered interventions is also supported in studies that have examined the drug use of new mothers. For example, one session of computer-delivered motivational interventions for postpartum women resulted in improvements in the motivation of participants to engage in treatment and challenge their substance abuse¹ behavior (Ondersma, Chase, Svikis, & Schuster, 2005). In a similar study, a single session of computer-delivered motivational intervention combined with mailings and a voucher-based reward for attendance was found to significantly lower drug use for all substances except marijuana for postpartum women (Ondersma, Svikis, & Schuster, 2007).

¹The journal's style utilizes the category *substance abuse* as a diagnostic category. Substances are used or misused; living organisms are and can be *abused*. Editor's note.

Recently, two novel studies have examined the effects of information-based technologies as a delivery medium for the treatment of drug addiction. One comparative study randomly assigned opioid-dependent out-patients from a university-based research clinic into a fluency-based computer-delivered behavioral therapy program, a therapist-based delivery of the same program, or a standard treatment for opioid-dependent individuals (Bickel, Marsch, Buchhalter, & Badger, 2008). Both the computer- and therapist-based treatment programs included a contingency reinforcement system that rewarded drug abstinence using a point system worth small monetary amounts. The computer-based approach required the participants to respond to the treatment content that consisted of 49 modules that addressed self-management planning, drug-refusal training, time management skills, etc. The authors found that the computer- and therapy-based presentations produced similar total number of abstinent weeks and longer continuous abstinence than the standard treatment. Importantly, the computer-based treatment required substantially less therapist intervention time compared with the therapist-led treatments, making this program more cost-efficient. In addition, the authors found there was no difference between the three treatments when assessed by the helping alliance questionnaire. Bickel et al. (2008) suggested that these results indicated that computer-based approaches could be introduced into new therapeutic settings without jeopardizing clinically important alliances between clients and staff. Bickel et al. (2008) proposed that computer-based approaches could be an important alternative to group therapy for individuals with social phobias and anxiety.

Shortly after the publication by Bickel et al. (2008), Carroll and colleagues (2008) published a similar study. Carroll et al. (2008) assigned substance-dependent individuals to either a standard therapist-facilitated cognitive behavioral treatment or a standard treatment plus a six-module computer-based cognitive behavioral training program. Both groups experienced 8 weeks of treatment and were matched for primary substance use, gender, and ethnicity. The computer content was based on a cognitive behavioral treatment manual published by the National Institute on Drug Abuse (Carroll, 1998). The modules used a variety of multimedia elements to explain key concepts, provided examples of drug-refusal language and behavior, required active participation, and provided “homework” on the module taught in that session. Self-reports and urine samples were also taken at every assessment period: before treatment, twice a week during treatment, and at the end of treatment. Participants assigned to the computer-based treatment submitted significantly more negative urine screens for any type of drug and tended to have longer continuous periods of abstinence during treatment than the other therapies. Moreover, participants stayed in treatment longer and evaluated the computer-based program more positively than the standard treatment. Carroll et al. (2008) suggested that their computer-based therapy would be an effective adjunct for outpatient treatment for substance dependence, because of its ability. The authors hypothesized that because the delivery of the treatment are more likely to be completed, controlled computer-based treatments could be used to assess specific mediators for addiction with greater precision than therapist-facilitated treatments. The Carroll et al. (2008) study illustrates the typical finding from computer-based treatments: greater engagement with the program, longer periods of abstinence, and greater client enjoyment than standard therapist-based treatments.

In summary, new technologies of drug addiction assessment, treatment, and research, such as computer-based methodologies, appear to be cost-effective, efficacious, and accessible. For example, drug-dependent individuals reported being more responsive to a computer-based HIV/AIDS information program than a standard counselor-led intervention. Computer-based interventions were also found to increase new mothers’ motivation for abstinence and have similar levels of alliance building as therapist interventions. However, it needs to be noted that computer-based therapies may not be suited to all patients; some may prefer and respond better to an interaction with a therapist who is in the same room, while

others may not be used to computer-based technologies which may cause them to focus on the operation and delivery of the treatment and be less engaged with the program's content (Magura, 2000). Another consideration is whether the present circumstances of the patient require an immediate intervention by the therapist, for example, when they are an immediate danger to themselves or to others. In these situations the physical presence of the therapist would be more appropriate.

Competing Neurobehavioral Decision Systems Hypothesis of Addiction: A New Focus of Information Technological Approaches to Treatment

Neuroscience technologies have been used to find the putative neural systems involved in impulsive and self-controlled choice behaviors. Brain-imaging techniques such as functional magnetic resonance imaging (fMRI) have been used to determine areas of relative brain activation in temporal discounting tasks (discounting the value of delayed rewards). The functional magnetic resonance imaging process measures the different levels of magnetism of oxygen- and non-oxygen-carrying hemoglobin in the brain. Bickel et al. (2007) reviewed behavioral economic and neuroeconomic research that investigated the influence of addiction on temporal discounting. They concluded that suboptimal decision-making, such as impulsive choices and steep temporal discounting, may be the result of the more impulsive brain system dominating the executive brain system (e.g., planning, memory, self-control; Bechara, 2005; Jentsch & Taylor, 1999).

Indeed, studies that have examined decision-making by individuals with lesions in the brain areas presumed to control executive functions, that is, roughly the prefrontal cortex, show the individuals' inability to behave in their long-term self-interest (Bechara, Damasio, & Damasio, 2003). Bickel et al. (2007) suggested that excessive discounting of the future exhibited by drug-dependent individuals (see Bickel & Marsch, 2001, and Yi, Mitchell, & Bickel, 2009, for a review) may be explained by the shift in the balance of overall control from brain regions that are associated with self-control to those associated with impulsivity (McClure, York, & Montague, 2004). Bickel et al. (2007) proposed that if this hypothesis is confirmed, it may radically alter the understanding and treatment of drug addiction. One treatment implication is that it suggests a new target for treatment efforts (Bickel & Yi, 2008). Specifically, if cognitive functions associated with the executive system can be rehabilitated, the likelihood of self-controlled behavior may increase. This hypothesis is supported from research where ex-drug-dependent individuals discounted delayed money less than drug-dependent individuals and similar to nondrug users (Bickel, Odum, & Madden, 1999). Therefore, therapies designed to develop brain regions associated with self-control could prompt less impulsive decisions. Therapies designed to improve executive function could be delivered through the use of computer-based approaches and, coupled with their high program consistency and participant enjoyment, appear to be a logical choice for repairing cognitive dysfunction. For example, strengthening cognitive function through neurocognitive rehabilitation, perhaps using a fluency paradigm via computer interaction, could reestablish decision-making and planning skills associated with making better choices such as abstaining from drug taking (Bickel et al., 2007).

Initial evidence using computer-based neurocognitive rehabilitation already exists. Specifically, researchers trained a group of 18 heterogeneous substance-dependent adults, using an executive skills training program, and compared their treatment outcomes with three other treatment groups (relaxation training, typing training, and no active treatment) in a residential program (Fals-Stewart & Lucente, 1994). The results indicated that patients in the cognitive rehabilitation group demonstrated faster recovery on measures of cognition and were rated by staff as participating more in treatment activities. Thus, computer-based treatment programs appear to offer the potential to impact executive function via the hypothesized responsible brain systems.

Implications: Barriers and Bridges

However, before the benefits of applying computer technologies to the treatment of drug dependence are achieved, a computer-based treatment program needs to be implemented. Often this occurs within an existing treatment center where institutional practices and staff perceptions are different from the proposed implementation and therefore require the organization to make some changes for a successful transition to occur (Wisdom, Gabriel, Edmundson, Bielavitz, & Hromco, 2008). Research examining the transfer of new technologies suggests that these barriers are often challenging for an organization and typically result in an incomplete implementation despite strenuous efforts by the change agents. For instance, in a review of 172 US drug treatment programs, researchers found that even after extensive on-site training, 72% of all programs failed to implement the full protocol (Hall, Sorensen, & Loeb, 1988; Sorensen et al., 1988). Consequently, the criteria necessary for organizational engagement have become a focus in the implementation of new treatments approaches (Backer, 1995; Gustafson et al., 2003). Notably, Simpson (2002) identified four conditions needed for effective technology transfer: (1) the appropriate innovations need to be brought to the attention of the organization and made accessible for dissemination; (2) evidence must show the innovation to be feasible and effective; (3) available resources must be adequate; and (4) interventions must encourage organizations and people to change. While other researchers have specifically indicated the need for the organization's leadership to direct, supervise, support the process, set goals, understand the challenges, and give the process a sense of urgency (Kavanagh et al., 2002; Spouse, 2001; Wisdom et al., 2008), other commentators suggest that successful technological implementation also needs to have a broad focus, and engage all groups the treatment center has a relationship with (e.g., funding organizations), as multiple shareholders appear to have an impact on the treatment process (Brown, 1995, 2000; Roman & Johnson, 2002). Ultimately, the success of implementation of new technologies appears to rely on the engagement of the treatment center and its important shareholders with the change process.

CONCLUSION

New technologies appear to produce better or similar results in detecting, informing, and educating individuals with substance use disorders relative to traditional counselor-facilitated methods. New hypotheses and therapies for drug addiction have grown from using these technologies, offering further solutions for drug-dependent individuals, their families, and society. Indeed, the efforts to stop use or reduce harm will also lead to benefits to the user and society and possibly inform other issues relating to impulse control such as sexually transmitted diseases and criminality. Embracing new technologies will lead to discoveries about addiction and ultimately to better preventative measures and treatments. The recent research from our laboratory contributes to this effort, offering further possibilities for the assessment, treatment, and research of drug addiction.

Acknowledgments

This research was supported by the National Institute on Drug Abuse grants R01 DA 11692, R01 DA 022386, R01 DA 12997; Wilbur Mills Chair Endowment; and in part by the Arkansas Biosciences Institute, a partnership of scientists from Arkansas Children's Hospital, Arkansas State University, the University of Arkansas's Division of Agriculture, the University of Arkansas, Fayetteville, and the University of Arkansas for Medical Sciences. The Arkansas Biosciences Institute is the major research component of the Tobacco Settlement Proceeds Act of 2000.

GLOSSARY

<i>Computer-delivered therapy</i>	Computer-delivered therapy is a computer-based media that provides users with information designed to supply therapeutic treatment
<i>The executive system</i>	The executive system is a theorized cognitive system that controls and manages other cognitive processes. It is thought to be involved in processes such as planning, cognitive flexibility, abstract thinking, rule acquisition, initiating appropriate actions and inhibiting inappropriate actions, and selecting relevant sensory information
<i>Functional magnetic resonance imaging (fMRI)</i>	Functional magnetic resonance imaging is a type of specialized magnetic resonance imaging scan. It measures the haemodynamic response related to neural activity in the brain or spinal cord of humans or other animals
<i>Information technology</i>	Information technology is computer-based information systems, particularly software applications and computer hardware
<i>Neurocognitive rehabilitation</i>	Neurocognitive rehabilitation is a therapeutic effort to achieve functional changes by (1) reinforcing, strengthening, or reestablishing patterns of behavior or (2) establishing new patterns of cognitive activity or compensatory mechanisms for impaired neurological systems
<i>Neuroscience</i>	Neuroscience is the field devoted to the scientific study of the nervous system. This ranges from the biochemical and genetic analysis of dynamics of individual nerve cells and their molecular constituents to imaging representations of perceptual and motor tasks in the brain
<i>Prefrontal cortex</i>	The prefrontal cortex is the anterior part of the frontal lobes of the brain found in humans and higher mammals

References

- Backer, TE. Assessing and enhancing readiness for change: Implications for technology transfer. In: Backer, TE.; David, SL.; Soucy, G., editors. Reviewing the behavioral science knowledge base on technology transfer. NIDA Research Monograph 155, NIH Publication No. 95-4035. Rockville, MD: National Institute on Drug Abuse; 1995. p. 21-44.
- Bechara A. Decision making, impulse control, and loss of willpower to resist drugs: A neurocognitive perspective. *Nature Neuroscience*. 2005; 8:1458–1463.
- Bechara A, Damasio H, Damasio AR. Role of the amygdala in decision-making. *Annals of New York Academy of Sciences*. 2003; 985:356–369.
- Bickel WK, Marsch LA. Toward a behavioral economic understanding of drug dependence: Delay discounting processes. *Addiction*. 2001; 96:73–86. [PubMed: 11177521]
- Bickel, WK.; Marsch, LA. A future for the prevention and treatment of drug abuse: Applications of computer-based interactive technology. In: Henningfield, JE.; Santora, PB.; Bickel, WK., editors. *Addiction treatment: Science and policy for the twenty-first century*. Baltimore: John Hopkins University Press; 2007. p. 35-44.
- Bickel WK, Marsch LA, Buchhalter AR, Badger GJ. Computerized behavior therapy for opioid-dependent outpatients: A randomized controlled trial. *Experimental and Clinical Psychopharmacology*. 2008; 16:132–143. [PubMed: 18489017]
- Bickel WK, McLellan AT. Can management by outcome invigorate substance abuse treatment? *American Journal on Addictions*. 1996; 5:281–291.

- Bickel WK, Miller ML, Yi R, Kowal BP, Lindquist DM, Pitcock JA. Behavioral and neuroeconomics of drug addiction: Competing neural systems and temporal discounting processes. *Drug and Alcohol Dependence*. 2007; 90S:S85–S91. [PubMed: 17101239]
- Bickel WK, Odum AL, Madden GJ. Impulsivity and cigarette smoking: Delay discounting in current, never, and ex-smokers. *Psychopharmacology*. 1999; 146:447–454. [PubMed: 10550495]
- Bickel, WK.; Yi, R. Temporal discounting as a measure of executive function: Insights from the competing neurobehavioral decision system hypothesis of addiction. In: Houser, D.; McCabe, K., editors. *Neuroeconomics: Advances in health economics and health services research*. Bingley, UK: Emerald; 2008. p. 289-310.
- Binder, C. Unpublished doctoral dissertation. Columbia Pacific University; San Rafael, CA: 1984. The effects of explicit timing and performance duration on academic performance in elementary school children.
- Binder C. Behavioral fluency: Evolution of a new paradigm. *The Behavior Analyst*. 1996; 19:163–197.
- Brown, BS. Reducing impediments to technology transfer in drug abuse programming. In: Backer, TE.; David, SL.; Soucy, G., editors. *Reviewing the behavioral science base on technology transfer*. NIDA Research Monograph 155, NIH Publication No. 95-4035. Rockville, MD: National Institute on Drug Abuse; 1995. p. 169-185.
- Brown, BS. From research to practice: The bridge is out and the water's rising. In: Levy, JA.; Stephens, RC.; McBride, DC., editors. *Emergent issues in the field of drug abuse: Advances in medical sociology*. Vol. 7. Stamford, CT: JAI; 2000. p. 345-365.
- Brownell KD, Marlatt GA, Lichenstein E, Watson GT. Understanding and preventing relapse. *American Psychologist*. 1986; 41:765–782. [PubMed: 3527003]
- Carroll, KM. A cognitive-behavioral approach: Treating cocaine addiction. Rockville, MD: National Institute on Drug Abuse; 1998.
- Carroll KM, Ball SA, Martino S, Nich C, Babuscio TA, Nuro KF, et al. Computer-assisted delivery of cognitive-behavioral therapy for addiction: A randomized trial of CBT4CBT. *American Journal of Psychiatry*. 2008; 165(7):881–888. [PubMed: 18450927]
- Dougherty KM, Johnson JM. Overlearning, fluency, and automaticity. *The Behavior Analyst*. 1996; 19:289–292.
- Fals-Stewart W, Lucente S. The effect of cognitive rehabilitation on the neuropsychological status of patients in drug abuse treatment who display neurocognitive impairment. *Rehabilitation Psychology*. 1994; 39(2):75–94.
- Gustafson DH, Sainfort F, Eichler M, Adams L, Bisognano M, Steudel H. Developing and testing a model to predict outcomes of organizational change. *Health Services Research*. 2003; 38:751–776. [PubMed: 12785571]
- Hall, SM.; Sorensen, JL.; Loeb, PC. Development and diffusion of a skills-training intervention. In: Baker, TG.; Cannon, DS., editors. *Assessment and treatment of addictive disorders*. New York: Praeger; 1988. p. 180-204.
- Hubbard, RL.; Mardsen, ME. NIDA Research Monograph. Vol. 72. Rockville, MD: National Institute on Drug Abuse; 1986. Relapse to use of heroin, cocaine, and other drugs in the first year after treatment.
- Jentsch JD, Taylor JR. Impulsivity resulting from frontostriatal dysfunction in drug abuse: Implications for the control of behavior by reward-related stimuli. *Psychopharmacology*. 1999; 146:373–390. [PubMed: 10550488]
- Kavanagh DJ, Spence SH, Wilson J, Crow N. Achieving effective supervision. *Drug and Alcohol Review*. 2002; 21:247–252. [PubMed: 12270075]
- Kobak KA, Greist JH, Jefferson JW, Katzelnick DJ. Computer-administered clinical rating scales: A review. *Psychopharmacology*. 1996; 127:291–301. [PubMed: 8923563]
- Leshner, AI. Advancing the science base for the treatment of addiction. In: Henningfield, JE.; Santora, PB.; Bickel, WK., editors. *Addiction treatment: Science and policy for the twenty-first century*. Baltimore: John Hopkins University Press; 2007. p. 137-141.
- Lieberman DC, Lynn MC. Learning to learn revisited: Computers and the development of self directed skills. *Journal of Research on Computing in Education*. 1991; 231:375–395.

- Magura S. Introduction: Program quality in substance dependency treatment. *Substance Use and Misuse*. 2000; 35:1617–1627. [PubMed: 11138701]
- Marsch LA, Bickel WK. The efficacy of computer-based HIV/AIDS education for injection drug users. *American Journal of Health Behavior*. 2004; 28:316–327. [PubMed: 15228968]
- McClure SM, York MK, Montague PR. The neural substrates of reward processing in humans: The model role of fMRI. *Neuroscientist*. 2004; 10:260–268. [PubMed: 15155064]
- McLellan AT, Carise D, Kleber HD. Can the national addiction treatment infrastructure support the public's demand for quality care? *Journal of Substance Abuse Treatment*. 2003; 25:117–121. [PubMed: 14680015]
- Mokdad AH, Marks JS, Stroup DF, Gerberding JL. Actual causes of death in the United States 2000. *Journal of the American Medical Association*. 2004; 291:1238–1245. [PubMed: 15010446]
- Murphy L, Mitchell DL. When writing helps to heal: Email as therapy. *British Journal of Guidance and Counseling*. 1998; 26:21–32.
- Newman MG, Consoli S, Taylor CB. Computers in assessment and cognitive behavioral treatments of clinical disorders: Anxiety as a case in point. *Behavior Therapy*. 1997; 28:211–235.
- Office of National Drug Control Policy. Publication no. 207303. Washington, DC: Executive office of the President; 2004. The economic costs of drug abuse in the United States, 1992–2002.
- Undersma SJ, Chase SK, Svikis DS, Schuster CR. Computer-based brief motivational intervention for peri-natal drug use. *Journal of Substance Abuse Treatment*. 2005; 28:305–313. [PubMed: 15925264]
- Undersma SJ, Svikis DS, Schuster CR. Computer-based brief intervention: A randomized trial with postpartum women. *American Journal of Preventive Medicine*. 2007; 32:231–238. [PubMed: 17236741]
- Roman PM, Johnson JA. Adoption and implementation of new technologies in substance abuse treatment. *Journal of Substance Abuse Treatment*. 2002; 22:211–218. [PubMed: 12072165]
- Selmi PM, Klein MH, Greist JH, Sorrell SP, Erdman HP. Computer-administered cognitive-behavioral therapy for depression. *American Journal of Psychiatry*. 1990; 147:51–56. [PubMed: 2403473]
- Simpson DD. A conceptual framework for transferring research to practice. *Journal of Substance Abuse Treatment*. 2002; 22:171–182. [PubMed: 12072162]
- Sorensen JL, Hall SM, Loeb P, Allen T, Glaser EM, Greenberg PD. Dissemination of a job seekers' workshop to drug treatment programs. *Behavior Therapy*. 1988; 19:143–155.
- Spouse J. Bridging theory and practice in supervisory relationship: A sociocultural perspective. *Journal of Advanced Nursing*. 2001; 33:512–522. [PubMed: 11251739]
- Washton AM. Women and cocaine. *Medical Aspects of Human Sexuality*. 1986; 20:57.
- Wisdom J, Gabriel R, Edmundson E, Bielavitz S, Hromco J. Challenges substance abuse treatment agencies faced in adoption of computer-based technology to improve assessment. *The Journal of Behavioral Health Services & Research*. 2008; 35:158–169.
- Yi, R.; Mitchell, SH.; Bickel, WK. Delay discounting and substance abuse-dependence. In: Madden, G.; Bickel, WK., editors. *Impulsivity: The behavioral and neurological science of discounting*. Washington, DC: American Psychological Association; 2009. p. 191–211.

Biographies

Warren K. Bickel, Ph.D., is the Wilbur D. Mills Chair of Alcoholism and Drug Abuse Prevention, Professor of psychiatry, and Director of the Center for Addiction Research, University of Arkansas for Medical Sciences (UAMS), Little Rock, Arkansas. Dr. Bickel also serves as Director of College of Public Health's Center for the Study of Tobacco Addiction at the UAMS. He has been continuously funded as Principal Investigator with several concurrent grants since 1988. His recent research includes the application of behavioral economics and neuroeconomics to drug dependence with an emphasis on the discounting of the future and the use of information technologies to deliver science-based prevention and treatment. He is the recipient of numerous awards and honors including the Joseph Cochin Young Investigator Award from the College on Problems of Drug Dependence, the Young Psychopharmacologist Award from the Division of Psychopharmacology and Substance Abuse of the American Psychological Association, a National Institutes of Health MERIT Award from the National Institute on Drug Abuse, and Researcher of the Year from the Arkansas Psychological Association's Honors for Outstanding Contribution. He served as President of the Division of Psychopharmacology and Substance Abuse, American Psychological Association, and as President of the College on Problems of Drug Dependence. He was editor of the journal *Experimental and Clinical Psychopharmacology*, has coedited five books, and has published over 250 papers.

Darren R. Christensen, Ph.D., Postdoctoral Research Fellow, Center for Addiction Research, UAMS. Dr. Christensen completed his Ph.D. in psychology at the University of Canterbury, New Zealand, where he studied quantitative models of choice and decision-making under Associate Professor Dr. Randolph Grace. His Ph.D. thesis culminated in an extended model of decision-making that describes both the acquisition and the steady state of nonhuman choice behavior and found a hitherto unknown phenomenon when the initial-link duration is increased and terminal-link delays are constant. Moreover, the extended model exhibited parameter invariance qualities when an archival data set was examined. His research interests are, broadly speaking, the quantification of decision-making and choice behavior including drug addiction and the neurological bases of behavior.

Lisa A. Marsch, Ph.D., is the Director of the Center for Technology and Health at National Development and Research Institutes, Inc., New York, New York. She has conducted numerous research studies focused on examining how technology can be used to enhance the reach of science-based prevention and treatment interventions. She has directed several projects focused on developing and evaluating interactive, computer-based systems that deliver evidence-based interventions using effective learning and informational technologies, including computer-based behavioral therapy for individuals with substance use disorders, HIV prevention for injection drug users, HIV and STI prevention for young drug users, and substance abuse prevention for children and adolescents. This research has provided novel empirical information regarding the role that technology may play in improving substance abuse prevention and treatment in a manner that is cost-effective, ensures fidelity, and enables the rapid diffusion and widespread adoption of science-based interventions. She serves as a scientific reviewer for the National Institute on Drug Abuse, the National Institute on Alcohol Abuse and Alcoholism, and the National Institute on Mental Health. Dr. Marsch is also on the editorial boards for the *Journal of Child and Adolescent Substance Abuse*, *Substance Use and Misuse*, and *Experimental and Clinical Psychopharmacology*.