Chapter 6
Virtual Environments for Substance Abuse Assessment and Treatment

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Introduction

I am on my way to a party and cannot stop thinking about having a beer, and then of course, about avoiding drinking beer. I feel the familiar tension and craving rising as a result of wanting a drink. I have rehearsed this in my head a thousand times, "I will not drink, I will ask for a soda or bottled water". I think about how I may escape the situation if I am unable to fight off the urge to drink. I repeat to myself over and over, "I will make it through this evening. I will not fail again."

I am now 1 week sober and ready to give-up, realizing that I can't stop drinking. I am now on my way to a party where I know there will be plenty of alcohol and everyone will be drinking. I need to clear my mind. "Just relax" I think as my car stops on the street in front of the house. Suddenly the demons I inevitably struggle with hit me again. Self-doubt creeps in as I walk toward the front door, with my eyes fixed on the cracks in the sidewalk. I keep my head down but can't avoid noticing a man and a woman laughing and enjoying themselves just inside the entryway.

"Dammit," I think as I lose focus on the sidewalk. I am immediately fixated on the beer in their hands. I feel the anxiety of not having a drink in my hand and the intense craving that follows it. My mind starts racing, and my chest feels that familiar tightness. I take another

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> deep breath and say hello to the couple on my way in, hoping that my ever-rising desire to drink will magically disappear with each step forward. As I enter the kitchen, it feels as if a bomb of anxiety has just exploded inside me. My chest is heavy, I'm screaming inside my head, as I feel the intense urge to drink when I smell pizza, cigarette smoke, and beer. I see the six packs, too numerous to fit in the fridge, bottles of liquor and mixers and red plastic cups all sitting peacefully on the table. I have but one thought, "I need a drink now or I have to get the hell out of here."

The previous scenario is based on a first-person recollection of attending a party that was developed into a virtual reality scenario by Dr. Bordnick at the Virtual Reality Clinical Research Lab. This scenario was used to construct a virtual reality platform to assess and eventually decrease alcohol craving, offering a novel approach to substance abuse treatment.

For centuries, people have consumed substances, specifically, drugs and alcohol in various forms for a multitude of reasons. These include religious ceremonies, recreation, or coping with physical pain or psychological distress. As of 2014, it was estimated that approximately 21.5 million Americans ages 12 and older met the criteria for a substance use disorder within the last year (Center for Behavioral Health Statistics and Quality 2015). Substance misuse is a significant public health concern that costs our nation over $600 billion annually, including costs directly associated with substance abuse treatment, as well as indirect costs such as lost productivity, and involvement in public systems like child welfare and the legal system (Substance Abuse Mental Health Services Administration 2013; National Institute on Drug Abuse 2012). Vast resources have been allocated to investigate the mechanisms of substance abuse, reasons for relapse, and the development of evidenced based therapies. Although billions of dollars are spent each year on drug and alcohol treatment, most interventions have had limited success (Lopez-Quintero et al. 2011; McLellan et al. 2000). Given the high rates of relapse (McLellan et al. 2000), increasing prevalence rates, and mortality associated with substance use and abuse (Rockett et al. 2012), innovative treatment and assessment approaches must be developed to increase abstinence and reduce relapse.

Virtual Reality (VR) is an innovative technology that has the potential to advance substance abuse research and treatment far beyond where we are today. Since the first reported use of VR for substance abuse issues in 2001 (Kuntze et al. 2001), clinical uses of VR have gained momentum and have been employed for the assessment and treatment of drug and alcohol use disorders (Bohil et al. 2011; Gorrindo and Groves 2009; Bordnick et al. 2012; Fleming et al. 2009). Virtual reality software applications based on cue exposure and reactivity are extensions of the key behavioral principles of conditioning, reinforcement, and extinction (Rescorla and Wagner 1972), which have shown real promise in the treatment of addictions. This chapter presents an overview of advances in virtual reality and their applications related to substance abuse assessment and treatment. We will review the theory behind drug craving and highlight advances for using VR environments to augment traditional treatment methods. Finally, we will offer suggestions for future research and applications of this novel technology to improve client outcomes.

Current Substance Abuse Treatment Methods and Associated Challenges

There is a wide variety of current treatment methods for drug and alcohol abuse. Most approaches focus on total abstinence. Typically, they require the user to spend time in a secure environment where he or she can go through the detoxification process and receive medical attention if necessary, followed usually by 30–90 days in a controlled living environment. During this time recovering users participate in individual and group therapy, from either a psychodynamic, interpersonal process or cognitive behavioral perspective in the hopes of remediating acute stressors and identifying problematic situations or "triggers" for substance use. Outpatient aftercare focuses on the development of adaptive coping skills and emphasize the importance of group support as ways of decreasing the possibility of relapse. Many current treatment paradigms also incorporate a strong spiritual component, encouraging clients to accept the fact that they are powerless over their addiction(s) and will always be an alcoholic or drug addict (Alcoholics Anonymous World Services I 2001).

Unfortunately with each of these approaches, high relapse rates remain (McLellan et al. 2000). The most obvious limitation of traditional treatment approaches is that they usually involve removing clients from their typical social environments (Marlatt et al. 2011). This approach continually reinforces avoidance of social and contextual cues and other craving inducing stimuli as a preferred coping method, rather than attempting to extinguish them (Gorrindo and Groves 2009; van Dam et al. 2012). Thus, from a practical standpoint typical treatment approaches often fall short. Substance users in recovery cannot continually live in a controlled environment, devoid of access to drugs and alcohol and apart from any cues that may stimulate craving and urges to use. This is especially important in light of the fact that the majority of social and cultural events in the United States often incorporate alcohol as a component of the function (Peele and Grant 2013); thus avoidance is not as easy as one would hope. Many drugs of abuse are no further away from one's medicine cabinet down the hall or in the local neighborhood. Similarly, since alcohol and cigarettes are readily available at every grocery and corner store (Babor 2010), individuals in recovery attempting to avoid these cues all together would potentially never be able to leave their homes. This is especially problematic in the case of traditional age college students (Larimer and Cronce 2002; Knight et al. 2002) who are often in environments where substance use and abuse are the norm, rather than the exception.

Inpatient treatment and intensive outpatient treatment for substance abuse is expensive, costing on average from $7000 per month for those with Medicare or Medicaid coverage to an average of $20,000 Lee (2011) per month for those with private insurance for a typical, non-luxury facility, leaving many in need of treatment priced out of the opportunity to access. Prior to implementation of the Affordable Care Act, approximately 27.5% of adults with substance abuse disorders were currently uninsured (Donohue et al. 2010), and paying for inpatient treatment

is virtually impossible for many without health insurance coverage. Although access to treatment may be improved by the expansion of health care coverage under the Affordable Care Act (Buck 2011), this type of treatment is still quite costly. Furthermore, higher coverage rates may lead to increased utilization but decreased availability of treatment due to demand far outpacing the availability of beds in currently existing treatment facilities.

Even if one is able to pay for inpatient treatment and extended aftercare, there is a high level of stigma associated with hospitalization and substance abuse treatment (Keyes et al. 2010; Schomerus et al. 2011; Livingston et al. 2012). Furthermore, those opting for long term inpatient treatment may be at risk of losing employment or may leave loved one's without the necessary financial support due to loss of income during that time (Beck et al. 2011). Individuals in treatment are separated from their primary support structures (Beck et al. 2011) while working on addiction issues, which may further complicate long term client outcomes. Similarly, if familial or interpersonal difficulties are contributing factors for continued use or relapse, separation from one's family only prevents the user from addressing these contextually relevant cue and dynamics in recovery.

Other complications arise from typical treatment paradigms. Therapies reinforcing one's belief that he or she is powerless in their addiction can also be problematic and do not assist in building the self-efficacy needed to tolerate distress associated with craving (Bandura 1989; Burling et al. 1989). These approaches have limited utility in relation to the development and refinement of the negotiation and communication skills necessary to keep one's self on track when exposed to people or environments in which one would normally engage in substance use. Some treatment paradigms assert that it is necessary for a client to engage in treatment indefinitely to retain his or her sobriety, and that if not, he or she will most certainly relapse, leaving some clients overwhelmed at the prospect of life long treatment.

Methods that allow the client to feel as if he or she can affect change in relation to his or her drug and alcohol use is essential for successful long term, continuing treatment success (Warren et al. 2007; Burleson and Kaminer 2005). Traditional cognitive behavioral/relapse prevention (CBT/RP) therapies have shown efficacy for decreasing use and promoting abstinence (Witkiewitz and Marlatt 2004; Barrett et al. 2001). One key component in CBT/RP is the incorporation of coping strategies with the goal of equipping the client with skills to prevent use and relapse (Marlatt and Witkiewitz 2002; Marlatt and Donovan 2005). Traditional CBT/RP uses role-playing in an office or lab setting to practice and rehearse these skills. The role-playing context (office or lab setting) and the use of live actors are limiting factors, artificial, and lack congruence with real world use situations and interactions. The client is expected to imagine or suspend critical judgment in a clinical setting that lacks meaningful cues and contexts. We believe skills training conducted in laboratory or office based environments will result in less than optimal transfer or generalization of skills in the real world. Ideally, the most effective intervention would bring real world cues and contexts into the lab or clinical setting; however this has been logistically difficult to achieve (Bordnick et al. 2013).

Cues, Craving, and Extinction Related to Substance Abuse

Craving is defined as an intense desire, or want to consume. It is believed to consist of both behavioral and biological processes working in concert often leading from initial use to continued misuse and dependence. Craving is elicited by a trigger, also known as a cue, which prompts or signals the craving episode. The most recent edition of the Diagnostic and Statistical Manual of Mental Disorders, DSM5, associates craving with changes in brain neuro-circuitry that are linked to relapse when one is exposed to drug-related stimuli (Association AP 2013). Accordingly, substance craving has been added as one of the criterion necessary for the diagnosis of a DSM substance use disorder, a criterion that was not required in the prior editions of DSM (Association AP 2000), reinforcing the continued importance of the relationship among cues, craving, and substance abuse.

There are two primary types of cues related to craving: proximal and contextual. Proximal cues are defined as objects directly related to, or in close proximity to a substance such as the alcohol or drug itself, bar ware, or drug use paraphernalia such as pipes, syringes, spoons, or razor blades. Contextual cues are more indirectly related to the substance and are defined as the settings or social contexts in which the substances are used such as a bar, party, shooting gallery, or any other place in which one may use. "Complex" cues,(Traylor et al. 2011) resulting from the integration of both proximal and contextual cues most closely approximate real world environments and are thought to become conditioned via repeated paring with substance ingestion. After repeated pairing these cues become generalized and result in the strengthening of the physical or psychological response produced by consuming the substance even in the absence of the actual substance itself. Consider an example of craving based on cues that most Americans can relate to– the craving for french fries. This craving is related not only to the fries themselves, but also to their smell, to the way they look in advertisements, or to seeing a sign for your favorite restaurant. You see a commercial on TV for the fries, you crave fries. You go into a restaurant planning on not eating fries, and then smell the fries, you crave fries. There is a good chance that you will end up ordering fries because of these cues.

Substance craving works much in the same way. For example, when someone is trying to quit smoking, craving may be induced by cues such as seeing or touching cigarettes, but it can also be triggered by the smell of cigarette smoke, seeing others smoking, pictures of cigarettes in magazines, or just being in a place where one used to smoke. The craving resulting from these cues may lead to relapse. Unfortunately, cue reactivity is not only limited to the duration for which one actually consumed the substances, but has been reported to occur from weeks to years after abstaining from use (Gawin and Kleber 1986; Manschreck 1993; Prakash and Das 1993), making it one of the most prominent and difficult withdrawal symptoms to manage.

These conditioned associations triggering craving are at the heart of VR exposure treatment for substance abuse. Treatment via VR focuses on the situational and contextual cues associated with substance use. Cue exposure methodologies for investigation of drug craving for alcohol, nicotine, and cocaine have been extensively

discussed in the substance abuse literature. Cue exposure is a method used to repeatedly expose a person to drug or alcohol related cues to extinguish the paired associations between the reinforcing properties of the substances and the context/cues (Marlatt and Witkiewitz 2002; Collins and Brandon 2002; Conklin and Tiffany 2002; Hammersley et al. 1992). The process of cue exposure requires the identification of which proximal, contextual, and complex cues trigger craving, then exposing the user to these cues without the drug to extinguish the craving sensation associated with those cues. How sensitive one is to cues, and how many cues trigger craving is thought to be related to the abuse liability of a substance and relapse potential.

Basic Cue Exposure Studies

Traditionally, laboratory based cue-exposure studies have involved exposure to cues via imagined scripts, actual substances and/or paraphernalia, or multimedia rather than recreation of environments. Typically, sessions are conducted in a non-descript laboratory to avoid any potential triggering from outside sources. Participants are exposed to cues in a laboratory environment where physiology, self-reported mood state, and craving responses are recorded. Studies related to smokers suggest that when smokers are exposed to visual, auditory, olfactory, and tactile smoking cues, there is an increase in physiological arousal and associated craving and urges to smoke when compared to neutral (non-smoking related) cues.

Research has also been conducted on proximal cues in relation to the use of alcohol. Multiple studies (Cooney et al. 1997; Glautier and Drummond 1994; Drummond and Glautier 1994; Hutchison et al. 2001; Szegedi et al. 2000; Monti et al. 1993) suggested that visual, auditory, olfactory, and tactile drinking cues increase physiological arousal and subjective reports of craving in both moderate and heavy drinkers. These findings are consistent with (Wikler 1973) and colleagues' early (1973) assertion that presentation of proximal alcohol cues in a laboratory setting will result in increased physiological reactivity in chronic alcoholics. These studies have provided a framework for research on conditioned responses to alcohol. Zironi & colleagues also found that a context that was previously paired with drinking was shown to induce relapse in laboratory animals (Zironi et al. 2006), providing further evidence supporting environmental context as a conditioned stimuli.

(Carter and Tiffany 1999) conducted a meta-analysis spanning the literature from 1976–1996 comparing the cue reactivity of nicotine, cocaine, heroin, and alcohol. They found that although presentation of proximal alcohol cues consistently leads to increased craving, effect sizes reported for the alcohol studies (+0.53) were significantly lower than those found for the other substances (+1.1 and higher) indicating that this may be due to decreased cue reactivity exposure for alcohol conducted in artificial settings such as a lab. It is hypothesized that lab settings are insufficient to bring about significant changes in craving and long term use due to a lack of environmental/contextual cues that seem to be key in craving and use for all drugs,

but especially for alcohol. Furthermore, it is frequently suggested that conducting exposures to proximal cues in real world environments or simulated real world context would better approximate actual use settings and would lead to increased effects and increased ecological validity (Conklin and Tiffany 2002; Bordnick et al. 2008; Ludwig 1986; Ludwig et al. 1974).

To date, cue exposure therapies offered apart from the context in which one usually consumed drugs or alcohol have failed to offer robust results in reducing incidences of relapse. This could be explained by renewal reinstatement, spontaneous recovery and reacquisition as suggested by (Conklin 2006). Renewal is a key factor to success in extinction trials, as it results in the reinstatement of an extinguished behavior that was conditioned in a different context. Conklin found that smokers had increased craving to proximal smoking cues but also to smoking environments, even when presented separately (Conklin 2006), further supporting the belief that environmental context is a key factor in craving and must be addressed to decrease renewal effects and potential relapse (Thewissen et al. 2006). Other factors such as spontaneous recovery (Conklin 2006; Bouton 1993; Pavlov 1927), generalization of training cues and attentional bias (Field et al. 2004; Field and Cox 2008), individual differences, reward salience, reward value (Rose and Behm 2004), timing, and length of extinction sessions could also partially explain these results, as conditioned behaviors in general may be subject to differences in these factors. Although context may not be the only factor influencing the limited success in prior lab based extinction studies based on cue reactivity research, it is important to consider.

Contextual Cue Exposure Studies

Environmental context is defined as the social atmosphere and setting in which substance use occurs. Over time substance administration becomes paired not only with proximal cues but with the environmental contexts in which ingestion of the substance occurs. Thus, it can be hypothesized that the reactivity to substance cues extends beyond the presentation of proximal cues to include the entire context or situation. Extinction studies in humans involve extinguishing craving to proximal cues and have been easy to execute. However, extinguishing craving related to context of the drug or alcohol use behavior has been more difficult to execute due to logistical issues (Collins and Brandon 2002; Conklin 2006; Thewissen et al. 2006).

Previous studies focusing on proximal cues have lacked the incorporation of cues presented in congruent environmental contexts, thus offering an artificial exposure situation for participants (Bordnick et al. 2008; Ludwig 1986; Ludwig et al. 1974; Bordnick et al. 2004a). In studies of exposure to physical context related to drinking, increased craving and reactivity have been reported (Zironi et al. 2006; McCusker and Brown 1990). Prior studies also indicate that alcohol is consumed at higher levels in congruent drinking contexts compared to laboratory (low congruence) settings (Wall et al. 2000, 2001; Wigmore and Hinson 1991). Conditioned reactivity to environmental contexts previously associated with use without proximal

cues present may trigger alcohol or drug seeking behaviors in users who are in abstinent resulting in relapse (Drummond et al. 1990; O'Brien et al. 1998). Similarly, the importance of environmental context is further supported in conditioned place preference (CPP) studies in animals (Biala and Budzynska 2006; Gremel et al. 2006; Le Foll and Goldberg 2005; Tzschentke 1998). In CPP studies, the rewarding effects of addictive substances are tested in environments where use/administration has occurred. The organism associates the context (distinct cage or contextual setting) and stimuli with the drug. Thus, the cage or contextual setting serves as a cue, itself capable of triggering craving and reactivity. Context becoming a strong stimulus is not difficult to comprehend since many addicted persons report specific places (e.g., bar, party, at home) in which they have formerly used leads to craving and urges to use.

While the mechanism of craving is not fully understood, it has been hypothesized that drug craving is a response conditioned through direct drug use, and elicited by environmental cues related to the individual's past substance use (Prakash and Das 1993; Childress et al. 1993; O'Brien et al. 1993; Satel 1992; Wallace 1989; Obuchowsky 1987). Research has demonstrated that exposure to conditioned cues can lead to physiological arousal and craving, suggesting that cue exposure and evaluation of cue reactivity should be an important element in the treatment of addiction (Szegedi et al. 2000; Childress et al. 1993; Drummond 2001; Johnson et al. 1998; Rohsenow et al. 1991; Tiffany and Hakenewerth 1991). Drug craving and exposure to cues in nicotine, alcohol, and cocaine dependent populations have been reported as factors related to drug use and have been implicated as antecedents to relapse (Miller 1991; Gawin 1991). In fact, Smith and Frawley (1993) contend that craving or urge to use is the most powerful predictor of abstinence loss. This contention is supported by additional research with cocaine dependent individuals indicating that craving may be a factor initiating relapse (Bordnick and Schmitz 1998). Measures of craving and drug use during hospitalization, outpatient treatment, and subsequent follow-up indicate that context is also important to craving. While in a controlled environment where they had limited exposure to drug related cues respondents reported low levels of craving. However upon discharge to an outpatient setting with far fewer restrictions on drug related cues, respondents experienced a significantly higher levels of drug craving (Johnson et al. 1998; Bordnick and Schmitz 1998), a contention that is supported by most substance abuse treatment professionals. Overall, these findings indicate that there is an interaction between drug cues and one's immediate social environment which may lead to actual substance use resulting in relapse.

Complex Cue Exposure Studies

Cue exposure and cue reactivity research would be extended if more research was conducted *in vivo* in a variety of contexts such as a bar, a party, or at home, and included the social interactions associated with these contexts coupled with

real-time evaluation methods. Studies support greater cue reactivity being elicited in cases where complex cues are presented, in relation to those using proximal or contextual cues alone (Traylor et al. 2011; Bordnick et al. 2008). This has important implications when utilizing cue reactivity and exposure to extinguish substance use behaviors. Advances in exposure based therapies have yielded encouraging results in relation to the treatment of addictions (Conklin and Tiffany 2002; Marissen et al. 2007; Coffey et al. 2005; Lee et al. 2007). However, there are confidentiality and safety concerns associated with in-vivo exposures for therapists and clients alike in relation to individuals who are purchasing and consuming substances in unsafe environments such as heroin shooting galleries and crack houses. Thus, while in-vivo exposure is usually the preferred method of exposure therapy, it is not always feasible and often may be inadvisable (Carvalho et al. 2010; Pallavicini et al. 2013).

To address these limitations, a novel virtual reality based system which provides exposures in a simulated context (such as a virtual party) that approximates real world use environments, but still maintains experimental control, has the ability to manipulate complex cues as well as environmental context, and can collect real-time data on cues and craving would be ideal for conducting this type of research.

VR Offers Promise to Extend Cue Reactivity Research and Address Shortcomings of Traditional Approaches to Substance Abuse Treatment

Although the application of VR for treatment of substance abuse disorders is relatively new, the principles behind VR based exposure therapy have been around since the late nineteenth century (Schwartz et al. 2002; Higgins et al. 2008). From the times of Pavlov, Watson, and Skinner, principles of behaviorism have been successfully applied to the treatment of psychological disorders. VR employs active behaviorally based strategies built on the principles of exposure, extinction, and skills acquisition.

Virtual reality has the potential to transcend traditional methods of assessment and treatment of substance abuse, blurring the lines between reality and virtual worlds, allowing significant advances in addiction research and treatment. VR incorporates a human-computer interaction providing active participation within a three dimensional virtual world designed to immerse the user. It involves the use of a head-mounted display and tracking systems which respond to user movement by changing the scenes being displayed in real-time as if one was looking around. Directional audio (stereo), graphics, microphones, vibration platforms, tactile (hand grasp), and scent cues all add to the fully interactive VR experience. VR systems can present complex cues that engage all five senses under full control of the experimenter (Bordnick et al. 2008, 2004a; Baber et al. 1992; Bordnick and Graap 2004; Bordnick et al. 2004b). For example, the user can enter a bar, hear music, and observe a person being served a drink. The user then could order a drink for him or

herself and pay for it. Upon the drink being served, the user can smell the beverage scent (e.g., whiskey) and pick up the drink providing a real-time, realistic experience similar to one's local bar.

When considering the use of virtual reality, questions arise on how learning in virtual environments translates or generalizes to the real world (Kozak et al. 1993). Several studies have addressed this, and support the contention that clinical gains (e.g. treatment effects) made in VR generalize to the real world (Anderson et al. 2003; Rothbaum et al. 1999; Rothbaum 2006; Gallagher et al. 2005; Garcia-Palacios et al. 2006). Numerous studies demonstrating successful treatment in VR leading to real world benefits in patients have been reported for fear of flying (Rothbaum et al. 2006), stroke rehabilitation (Lam et al. 2006), social anxiety disorder and public speaking (Anderson et al. 2003, 2013; Parsons and Rizzo 2008), post-traumatic stress disorder (Rothbaum et al. 1999; Kenny et al. 2008; Gerardi et al. 2008), organic brain damage (Rose et al. 2005), eating disorders (Ferrer-Garcia et al. 2013; Ferrer and Gutiérrez-Maldonado 2011; Engel and Wonderlich 2010), and attention deficit hyperactivity disorder (Parsons et al. 2007; Schultheis and Rizzo 2001). These studies support the assertion that the effects of VR for substance abuse treatment will translate into real world environments as well.

The key feature distinguishing VR from a traditional multimedia experience, videogame, or interactive computer graphic display, is the sense of presence that the users report. It is critical that VR environments for use in behavioral health are not video games resembling fantasy. Virtual environments must be realistic representations of real world contexts and social interactions if they are to be useful for assessment and treatment. In as much, developmental progression is key and involves the follow iterative process: (1) Review of the current literature, (2) Consultation of experts in the respective areas of study, (3) Field research, (4) Collaborative development process between scientists and programmers, and (5) Real world pilot testing.

Virtual reality based therapy is a flexible and innovative approach that addresses many of the shortcomings of traditional treatments with an individualized, yet systematic approach through the use of exposure and skill acquisition. Since VR therapy is highly individualized, treatment via virtual reality can be tailored to the specific substance of abuse, and assist with the completion of exposures in virtual environments that are unique to each client's individual needs. Due to the immersive nature of VR, clients do not get the sterile "feel" of a lab or the overly controlled calmness of a therapists office, both of which may be so far removed from the client's actual substance use environments that these settings may have less than optimal impact skill acquisition and transfer (Bordnick et al. 2013). Assessment and treatment are conducted in VR environments (e.g., party, bar, crack house) that are congruent with past drug use rather than a clinical setting. VR based treatment does not require a hospital stay, nor does it require an individual to commit to long periods of time away from friends and family, thus minimizing the economic and emotional impact on one's family that often results from extended inpatient treatment. Sessions can be conducted in both inpatient or outpatient settings, thus increasing access to effective treatment.

VR Improves Upon Traditional Cue Exposure Treatment and In-Vivo Exposures

Prior research has led us down a clear path in support of using cue exposure to proximal, environmental, and complex cues as an evidence-based alternative to traditional substance abuse treatment methods. However, why VR is the preferred method of cue exposure treatment rather than simply using traditional lab based interventions or true in-vivo treatments warrants additional discussion. Although many studies support the use of in-vivo exposure as a way of decreasing reactivity to environmental cues through the processes of exposure and extinction, it is often difficult (Coffey et al. 2005; McNally 2007) to encourage the client to engage in these types of real world exposures. Many in-vivo exposures are contraindicated for a client to engage in on his/her own, especially early on in treatment (Foa et al. 2007). Thus, someone trained must be available to accompany the client on these exposures. It is costly to have a mental health professional leave the office and accompany his/her client on multiple exposures to the environments in which he or she was engaging in substance use. Often the substance use is occurring during the evenings and weekends, making logistical issues even more of a concern.

Safety and confidentiality concerns are paramount when doing exposure therapy (Foa et al. 2007), and safety and confidentiality of both the client and the mental health professional can be severely compromised when exposures are related to the people and places that the client encounters when he or she is using substances. This is especially problematic when the client is using illegal drugs versus alcohol or nicotine.

There is also a serious issue with lack of control of one's environment in in-vivo exposures (Carvalho et al. 2010; Maltby et al. 2002; Powers and Emmelkamp 2008), especially in places where most people in the immediate vicinity are under the influence, the context can change at a moment's notice. In addition, clients engaging in in-vivo exposures in these types of environments may not have an easy way to end the exposure (exit the situation) once they are in the substance use environment. If the exposure gets to be too much, panic can set in and increase the clients urge to use following the exposure. This may also decrease the client's motivation to participate in subsequent exposure sessions (Huppert et al. 2006; Otto et al. 2004), and potentially lead to dropout (Hembree et al. 2003).

VR cue exposure treatment improves upon traditional lab based treatments in the following ways. First, treatment is done in a virtual environment, rather than a lab which is decorated to look like places that one would use, there is an exponential increase in the amount of detail and realism that the client will experience in relation to the environmental context. In fact, many places where individuals actually use drugs and alcohol are extremely difficult to recreate in a traditional lab-based setting, (Traylor et al. 2011; Bordnick et al. 2008) especially if these places are outside or in settings other than a bar or a house. Thus, VR can provide true recreations of contexts specific to substance use situations beyond just those associated with alcohol and nicotine (Saladin et al. 2006; Culbertson et al. 2010).

As mentioned, numerous studies have supported the use of VR for treatment of alcohol or nicotine dependent using individuals, which could extend to other substances of abuse.

VR Beyond Alcohol and Nicotine

Looking toward the future, it is exciting to note, that after 15 plus years of VR development and research in substance abuse, Dr. Bordnick's work continues with the development of VR based substance use assessment and treatment scenarios for both desktop and smartphone based systems at Tulane University School of Social Work (https://tssw.tulane.edu/). Going forward, VR platforms can be developed to recreate heroin shooting galleries, abandoned buildings, public restrooms, and clubs where opiates and stimulants are often consumed. Although still in the nascent stages, there is an emerging body of literature that supports the utility of VR based interventions to the treatment of opiates and stimulants. In 2015, while at the University of Houston, VR treatment scenarios for both heroin injection drug users (IDU) and non-injection drug users (NON-IDU) were created under the direction of Dr. Bordnick. An emerging body of evidence also supports the use of VR as a viable treatment for stimulants of abuse such as cocaine (Saladin et al. 2006) and methamphetamine (Culbertson et al. 2010) based on the craving research related to these substances. Saladin and colleagues found that craving was significantly elevated in individuals exposed to a virtual crack cocaine environment than those exposed to a virtual aquatic (neutral) environment, and that craving was at its highest for individuals immersed in scenes depicting active cocaine use. Similarly, Culbertson and colleagues(Culbertson et al. 2010) reported eliciting higher levels of craving and physiological arousal in non-treatment seeking methamphetamine users who were exposed to VR methamphetamine environments in comparison to those exposed to video based methamphetamine scenarios or neutral VR or video-based scenarios, indicating that craving for stimulants can be effectively elicited in virtual environments. Additional research concerning the ability of virtual stimulant environments to extinguish craving for these substances is still in the developmental stages. Further extension of this research to prescription stimulants of abuse could potentially revolutionize interventions with teens and young adults who are particularly prone to abusing these substances (Wilens et al. 2008; Compton and Volkow 2006; White et al. 2006; Setlik et al. 2009).

Virtual environments offer the ability to provide exposures to simple, complex, and environmental cues all working in concert to trigger craving and maintain substance use patterns. Clients can be exposed to a multitude of cues or "triggers" at once, making VR exposures potentially more efficient than those done in traditional laboratory setting. Since problematic substance use behaviors are conducted in a variety of settings, they are maintained by complex cues occurring in more than one context (Conklin and Tiffany 2002; Havermans and Jansen 2003). Many former addicts report being able to maintain sobriety in certain situations but not in others

differing significantly from those where the lab based exposure therapy occurred. The technology of VR exposures eliminates this problem by allowing cue exposure to occur across a variety of contexts, leading to increased generalization across different areas of one's life. An additional advantage that VR has over laboratory based exposure treatment is that participants can experience multiple contexts during one exposure session simply with the click of a mouse, an option that is completely unavailable in traditional clinical or lab settings.

Social interactions are key cues involved in drug and alcohol use. VR exposures can contain a few or many virtual humans as indicated for social interactions related to use. This is especially important when attempting to recreate scenes at a busy club or circuit party for the treatment of stimulant drugs such as cocaine and methamphetamine. Cues in VR exposures can be changed with each exposure experience and they can be recreated exactly time and time again depending on the needs of the client, much the same way as is done when doing prolonged exposures for posttraumatic stress (van Dam et al. 2012; Foa et al. 2007). The predictability of VR also increases the safety of the exposure and the control that the experimenter has over the exposure experiences. Finally, VR exposures allow communication between mental health professionals and the participant in real time, allowing the professional to integrate other proven cognitive and behavioral techniques into the virtual scenario without losing client immersion (Robillard et al. 2003; Pausch et al. 1997). The client is still fully involved in the virtual scene, attending to all the cues he or she is surrounded by, in addition to being able to communicate with the mental health professional and practice coping skills.

Examples of Virtual Reality Environments for Drugs and Alcohol

VR environments have been fully developed for assessment and treatment protocols for nicotine, alcohol, and heroin. Each will be summarized with supporting literature and a description of the environments. All environments are currently available for research and treatment purposes.

Nicotine

Over 15 years ago, the first immersive VR environment for smoking was developed. This simple environment based upon traditional cue reactivity exposure and consisted of three rooms. The first room was a neutral cue that contained digital artwork of fish aquariums that served as a non-smoking related control condition. The second room contained proximal smoking cues only and no social interactions. The third and final room contained complex cues consisting of both proximal and contextual stimuli along with social interactions culminating in an offer to smoke by

another party goer. Testing of this environment provided the first empirical evidence that VR smoking cues can elicit craving in smokers (Bordnick et al. 2004a). Seeking to progress beyond simple cue assessment, Dr. Bordnick was funded by National Institute on Drug Abuse (NIDA) to develop the first VR treatment for nicotine dependence. Two years of development and testing yielded seven immersive nicotine specific exposure environments including: a social party, a convenience store, an airport smoking lounge, a car/parking garage, outside of office courtyard with smoking areas, and a restaurant. Screenshots of VR smoking environments are depicted below (see Fig. 6.1). All environments included embedded videos to engage users in social interactions featuring peer pressure. A clinical treatment trial followed using cognitive behavioral relapse prevention (CBT/RP) techniques to augment exposure in the VR environments. During the clinical sessions, therapists taught coping skills in real time while the participants were immersed in the VR environments. This clinical trial demonstrated that CBT/RP augmented with VR cue significant reduces nicotine craving and lead to high rates of cessation compared to traditional nicotine patch therapy (Bordnick et al. 2012) and offered the first successful use of VR serving as a platform to teach coping skills in drug dependence.

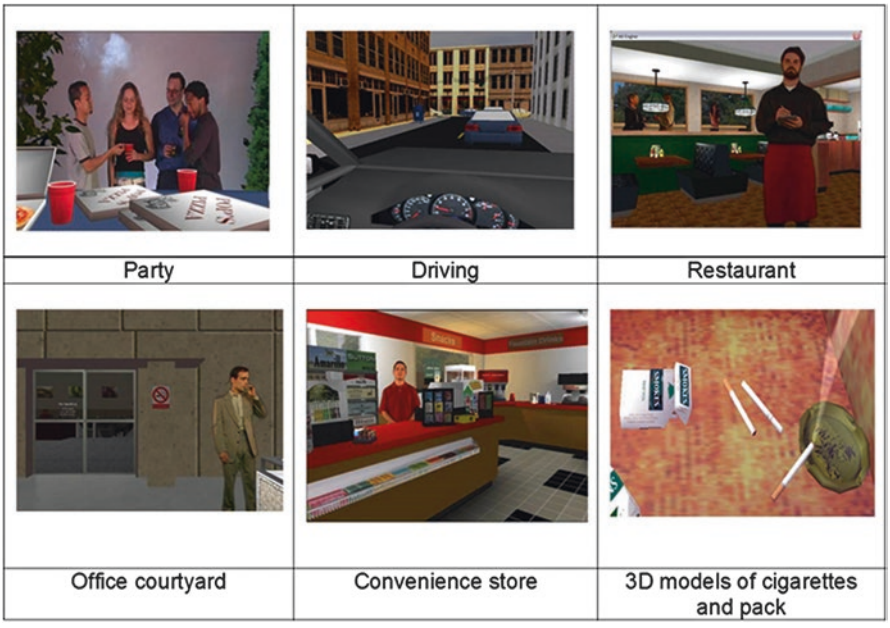

Fig. 6.1 Smoking VR environments

Alcohol

In 2005, the first VR immersive alcohol cue reactivity environment was developed. Building upon previous smoking platforms, these VR environments focused on alcohol as the primary cues and the basis for social interactions. Development for alcohol followed the same systematic process as nicotine, first beginning with the development of proximal cues and then progressing to interactive environments with social exchanges involving drinking. To improve realism related to total sensory input, scent was incorporated during the development of these platforms using a USB enabled sent device. This device provided both specific (beer, pizza, whiskey) and contextual (smoking filled bar, food in a restaurant) scents. The biggest hurdle during the developmental phase was creating detailed alcohol drinks with ice, garnishes, and realistic liquids, as well as alcohol related items such as beer cans and wine or liquor bottles. After months of trial and error computer graphic artists created an entire bar of high resolution realistic 3D drinking proximal cues. VR drinks are depicted in Fig. 6.2. The first VR alcohol environment was tested for cue reactivity comparing neutral cues to alcohol cues in a sample of heavy drinkers. Result clearly demonstrated that VR based alcohol proximal and social cues significantly increase craving compared to neutral cues (Bordnick et al. 2008). Building upon this success, VR environments were created to provide exposure to alcohol based proximal cues and social interactions across a variety of real world contexts. Seeking to improve upon the social interactions depicted in our virtual environments, Dr. Bordnick and his team decided to move from video social interactions to more advanced high definition avatars (Fig. 6.3), which allow for additional flexibility and realism. Various VR based alcohol environment are depicted in Fig. 6.4.

Fig. 6.2 VR alcohol drinks

Fig. 6.3 High definition avatar

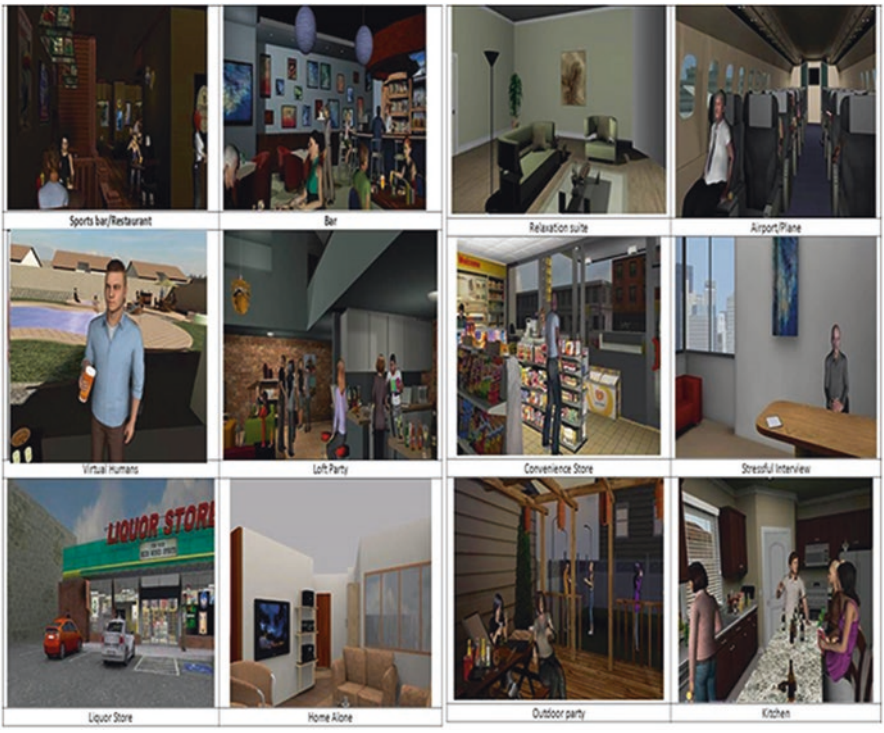

Fig. 6.4 VR alcohol environments

Environments range from a social party to a liquor store and are currently being used to teach coping skills in real prevention studies for alcohol dependence. Using current technologies, these alcohol environments offer several advances including text to speech and real time serving of drinks. For example, a client can order their drink of choice and the bartender will serve them their drink complete with accompanying scent. Another unique feature of the alcohol environments includes: text to speech which allows the therapist to personalize exposure and interaction in real time. For example, the avatars can address the clients by their name and have personal discussions during an exposure session.

Opiates/Heroin

In 2012, building upon our expertise in VR and ongoing studies with Mexican-American heroin users, our team developed two heroin use scenarios to assess craving and provide exposures to extinguish craving and urges to use. Two scenarios were proposed, one for older injection drug users (IDU's) and one for younger non-injecting heroin users (NON-IDU). The non-IDU environment consists of a home in an urban neighborhood where young adults are having a party. The party is populated with both users and non-drug users. Inside the house people are drinking, and in one of the bathrooms, two young men are cutting and snorting heroin off the sink (Fig. 6.5). The IDU VR environment consists of a row house where older men are hanging out on the front yard drinking beer, while inside two men are high, and one fixes and injects heroin. The outside of the shotgun house is depicted in Fig. 6.6.

Fig. 6.5 VR avatar snorting heroin (Non-injection scenario)

Fig. 6.6 VR heroin (Injection scenario) Shooting gallery house

These environments were developed based on photographs, input from former users, and field workers with experience conducting interviews in shoot houses (a.k.a. shooting galleries). Since VR heroin environments had not previously existed, the team had to create everything from the ground up. The avatars injecting and snorting heroin were based on videos of a former user simulating injecting and snorting behaviors to include all nuances of these actions such as tying off, taping the arm, and cooking the heroin in a spoon. These videos then served as the basis for a motion captured actor who would perform the injecting and snorting behaviors. The resulting animation was then added to high definition avatars.

The avatars offered the greatest challenge since they needed to accurately depict Mexican American users, without being canned or stereotypical. For example, the avatars needed to have realistic tattoos that represented gang membership, traditional art, and local themes, such as the 713 area code on arm or fingers or Houston sports team logos prominently displayed (Fig. 6.7). Focus groups were convened during the development process to provide input across all detail areas from clothing to gestures. The final IDU and NON-IDU VR environments are accurate scenarios that represent state-of the-art assessment tools combining expertise from behavioral and computer science disciplines, along with input from our field team members.

Fig. 6.7 Avatar with tattoos

Additional Applications of VR and Next Steps for Substance Use Prevention and Treatment

There is an ever expanding body of literature supporting the use of virtual reality in clinical and educational settings (Fleming et al. 2009; Kenny et al. 2007; Parsons et al. 2008; Cook et al. 2010). Numerous medical schools world-wide use virtual reality and other simulation based training methods for students to learn procedural skills, practice assessment and diagnosis, and improve interpersonal communication (Cook et al. 2010, 2011, 2012). As technological advances continue to evolve, the potential uses of VR in the realm of substance abuse treatment continue to evolve as well. In terms of client education, VR could be used immediately following detoxification or during the early stages of treatment to simulate how a particular substance may affect the body and brain of the user, as well as provide simulations related to the short and long term psychological and physiological consequences of substance use.

Cognitive and behaviorally based treatment protocols for co-occurring mental disorders in dual diagnosis clients would be enhanced through concurrent treatment via VR for both substance abuse and mental health issues. Within the virtual world, clients could engage in multiple forms of virtual exposures for a variety of issues related to their substance use and abuse, treating not only the symptoms of substance abuse but also the underlying anxiety depression and/or post-traumatic stress that tends to maintain it (Gorrindo and Groves 2009; Foa et al. 2007). Concurrent VR treatment may be an efficient, cost effective way to increase treatment gains through the integration of a substance use component into already established VR platforms such as Virtual Iraq/ Virtual Afghanistan (Gerardi et al. 2008; Rizzo et al. 2010; Kim 2005). The introduction of substance abuse components into existing platforms could also extend to the treatment of co-occurring eating disorders (Ferrer-Garcia et al. 2013; Ferrer and Gutiérrez-Maldonado 2011), and recurrent self- injury. Laptop based virtual environments may present a novel approach to the treatment of internet addiction, shaping the user's behavior away from technology

for cruising or watching pornography Philaretou et al. (2005) to using it for treatment and adaptive management of emotional states (Riva 2005; Glanz et al. 2003).

Public health gains could be augmented by the use of virtual environments developed for individuals who were active in the "party and play" scene to assist with development of skills for safer sex practices and for engaging in sexual behaviors without ingesting methamphetamine, thus reducing risk of HIV transmission (Halkitis et al. 2001). These platforms could also be modified to assist in the treatment of co-occurring sex addition (Döring 2009). Other education based scenarios may be used to assist the client in learning about safer injection practices and other HIV/HCV risk reduction techniques. Existing VR platforms may be adapted to assist with medication adherence which is often problematic for individuals who have cyclical sobriety and relapse patterns, and could be especially helpful in the prevention of the transmission of sexually transmitted infections in those who are abusing substances.

As mentioned before, a key element of VR exposure treatment is skills building for relapse prevention. VR platforms have the potential to help build client efficacy concerning negotiation and communication skills. For example, a client could practice how to turn down substances when offered, and practice this repeatedly with a variety of potential outcomes and responses from those in the virtual social environment. Virtual environments provide clients with safe, controlled opportunities to try out newly acquired skills sets, and get immediate feedback concerning performance.

Finally VR, virtual environments and virtual patients have the potential to improve mental health professionals' assessment and diagnostic skills in relation to substance use disorders (Riva 2005, 2009; Gregg and Tarrier 2007). For example, students may use virtual environments to practice and refine therapeutic skills used with clients having substance abuse disorders. This is an especially promising approach for novice clinicians (Beutler and Harwood 2004) who may not have adequate opportunities to practice with this population unless they are working in inpatient treatment settings. Given that substance abuse issues affect such a large percentage of the US population (Center for Behavioral Health Statistics and Quality 2015; National Institute on Drug Abuse 2012), it is imperative that all mental health professionals and primary care physicians are well versed in the assessment and treatment of substance use disorders.

VR therapy is emerging as an effective evidence-based treatment strategy for numerous mental health disorders (Parsons and Rizzo 2008; Powers and Emmelkamp 2008), including substance abuse. However, as with any technology, there must be more research concerning how virtual environments can be used to assist in the assessment and treatment of substance use disorders. It is important to extend the current body of research concerning the efficacy of VR treatment when it is paired with medication for management for substance abuse issues, much in the same way prior studies investigated the efficacy of anti-depressant and anti-anxiolytic medications in combination with CBT for treatment of mood and anxiety disorders (Butler et al. 2006). Future studies may not only investigate the additive effects of VR plus

medication in relation to mood management, but also investigate if VR is a moderator in relation to the efficacy of stimulant and opiate antagonist medications.

VR could also be used for "virtual therapy" for individual interventions (Rothbaum 2006; Parsons and Rizzo 2008; Riva 2005). The popularity of technology based counseling is currently on the rise due to its privacy, and increased accessibility. Sessions with a virtual therapist trained in the treatment of substance use disorders within the VR lab could provide a unique alternative to traditional outpatient treatment. Individuals could participate in "virtual groups" delivering specialized treatment interventions well suited to substance abuse treatment such as dialectical behavior therapy (Harned et al. 2010; Becker and Zayfert 2001) (DBT) in areas where trained DBT therapists are unavailable or for those who do not have access to live DBT based program in the area. VR sessions could be paired to and interfaced with other forms of technology such as smart phone or tablet apps to assist clients by reinforcing concepts presented during VR exposure and skills training sessions, facilitating clients' real time trigger management and the associated craving and urge to use.

Challenges for Widespread Use of VR for Substance Abuse Treatment

The business of substance abuse treatment is a multi-billion-dollar industry often resulting from repeat business. As previously mentioned, substance use disorders in the US cost the government, private and community based organizations, and individual tax payers *billions* of dollars annually. Thus, the development of effective treatments is ultimately cost effective. VR has numerous advantages over other traditional forms of substance abuse treatment interventions. That is not to say, however, that VR is without it drawbacks.

One of the most commonly cited concern about the widespread use of VR for treatment or education in general is the cost associated with the equipment and the development of virtual environments (Cook and Triola 2009). Although cost effective overall, setting up a VR lab requires substantial start-up costs in both equipment and in training related to the proper use of the equipment and treatment protocols. As with any technology, cost decreases as a function of increased use and adaptation. For example, in 2000, an entry level head mounted display cost $6000 alone. Currently, an entry level complete VR system begins at $3500 including the head mounted display (HMD), tracker, and computer system. This decrease makes VR more affordable and ready for prime-time dissemination by clinics, hospitals, and groups of private practitioners.

Similarly, the development of the virtual environment scenarios such as a bar, shooting gallery, or frat house is also quite costly. However, as our technological acumen expands, so do the possibilities for cost containment and widespread use of VR. One of the easiest ways of addressing this concern is to focus on development

of basic, common VR platforms and use them as a basis for a variety of virtual environments by adding specific details and types of interactions. For example, a VR party environment for social anxiety disorder could be modified for use in drug and alcohol treatment to teach coping skills by adding alcohol cues and social interactions related to drinking. Another logical way to contain cost is through sharing of virtual environments between departments within one University as well as between Universities world-wide. If a University has a medical school which uses VR simulations for training, some of this technology could be modified for use in social work and psychology departments for clinical training and/or treatment protocols. In an age of limited state and governmental funding for both higher education and substance abuse treatment and prevention, cooperation among institutions is critical to meeting the needs of our substance abusing clients. Along these same lines, time and resources spent on development of alternatives to traditional VR labs such as laptop or tablet based VR delivery systems would help contain cost further and make the technology more accessible to those who could benefit from it.

Fear of technology and of traditional paradigms of treatment becoming obsolete also drive the objections to the widespread acceptance of VR technology for the treatment of substance abuse. Certain clients may be reluctant to try any treatment that incorporates technology, especially those who have limited technological savvy (Garcia-Palacios et al. 2006; Baños et al. 2011). However, interactions with trained personnel can address these fears and build efficacy in using VR in even the most technologically challenged individuals. Although certainly there are individuals with specific health issues such as epilepsy, schizophrenia, or heart disease that may not be indicated for VR treatment (Gregg and Tarrier 2007), many more people would benefit from its wide scale use.

There are also concerns raised by some in the helping professions against the process of evidence-based practice due to the supposed lack of the human element (Coeckelbergh 2010) and the shift away from relationships towards interventions (Bean et al. 2006; Wilson et al. 2009; Zayas et al. 2011a; Gibbs and Gambrill 2002). These objections have been well documented in the literature but are largely based on a mischaracterization of the process of evidence-based practice as applying the same intervention to every client in the same way (Thyer and Pignotti 2011; Mullen and Bacon 2004). On the contrary, it is the ability to customize exposure sessions and skills training that make VR based interventions truly client centered. VR offers an alternative to powerlessness by empowering the client to be active in his or her own recovery, and assisting the client to understand the psychological and physiological science of addiction.

There is a fear of some clinicians and substance abuse treatment professionals that if VR treatment is effective and is widely implemented, they will lose status or be out of a job (Spiegel 2013). The second author, who is also a practicing mental health professional and supervisor of clinical interns, welcomes the day when this will happen. It *should* be our goal as mental health and substance abuse professionals to put ourselves out of a job. At that point we will know that we have done our jobs well (Zayas et al. 2011b). When the need for our services is decreased through improved efficacy of interventions, everyone wins. It is important to note, that the

VR drug and alcohol applications described in this chapter, requires a trained clinician. We have an ethical obligation to provide our clients with interventions and treatments that are known to be effective (Myers and Thyer 1997). To deny them the opportunity to utilize these interventions or to discount them out of hand appears to border on professional malpractice (Thyer 2008).

Clearly, VR technology has significant potential for the effective assessment and treatment of substance use disorders. From 2007–2016, under Dr. Bordnick's leadership, the Virtual Realty Clinical Research Laboratory (VRCRL) at the University of Houston, Graduate College of Social Work developed VR environments for drugs, alcohol, and obesity. Currently, Dr. Bordnick continues developing and testing VR applications for substance abuse other behavioral health disorders at the Tulane University School of Social Work. Dr. Washburn at the University of Houston, has recently evaluated the use of virtual humans to teach clinical assessment skills to graduate students (Washburn et al. 2016; Washburn et al. 2017). Dr. Washburn's future research will explore the use of VR for opiate misuse and dependence. Future studies in these areas, will expand the use of VR into traditional behavioral based approaches to decrease relapse rates. Through evaluation of baseline physiological arousal and mood, followed by extinction of craving via prolonged exposure and finally relapse prevention in the form of skills training, VR could be the substance abuse treatment of choice in the future that we can begin to utilize today.

In summary, virtual reality has been used to study substance abuse and food craving. Specifically, significant increases in drug craving have been observed in virtual parties, bars, restaurants, and drug using environments demonstrating that VR is a viable medium to explore relapse behaviors. Since VR is established as a method to study craving, VR environments are now used to teach coping skills and relapse prevention strategies to improve cessation rates. In a seminal study described previously, Bordnick et al. 2012 demonstrated that coping and relapse prevention skills learned in VR decreased smoking rates and led to increased confidence to resist smoking in the real world 6 months post-trial (Bordnick et al. 2012). This study supports the theory that skills learned in virtual environments translate to actual skill use in the real world, marking an important step for VR in clinical treatment. Building upon years of research, the next step for VR is a move towards the use of smartphone based VR (e.g., Google Cardboard, Samsung Gear) to bridge the gap between clinical and real-world settings. The use of portable VR on smartphones provides a needed tool for clinicians to extend gains realized in the clinic to patient's daily lives. The future of VR in behavioral health care (addiction and mental health) will be realized in smartphone-based applications and portable high quality HMD's, which will lead to widespread dissemination an impact. Dr. Bordnick provides an overview and demonstration of VR uses for behavioral change and the move towards smartphone based applications during his 2015 TEDx talk "How can virtual reality help us deal with reality?" (https://www.youtube.com/watch?v=OPfQQw72kus). Overall, VR is a novel tool that can be used to augment traditional intervention approaches and enhance therapeutic gains towards the goal of long-term sustained recovery.

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