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A New Kind of Therapeutic Relationship: Exploring Factors that Influence the Effectiveness of Computer-Delivered Interventions for Alcohol Use Disorders

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DISSERTATION

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Abstract

Computer-delivered interventions (CDI) for alcohol use comprise a relatively new treatment for individuals struggling with problematic drinking. While CDIs for alcohol misuse have proliferated over the last decade, much remains unknown about factors that influence their effectiveness. This study evaluated the performance of *Overcoming Addictions* (OA), a CDI based on the principles of SMART Recovery (SR). Subjects were drawn from a sample of 189 participants enrolled in a randomized clinical trial (RCT) that compared three and six-month outcomes for two interventions for problematic alcohol use: control participants were enrolled in SR meetings (face to face and/or online); experimental participants also had access to OA. Primary analyses of between group differences were conducted to detect an additive effect of OA. Further, this study explored variables thought to mediate the effectiveness of OA, and CDIs for problematic alcohol use more generally. Within the experimental group, analyses were conducted to examine whether participants' amount of experience

navigating the Internet accounted for any variance associated with positive outcomes; also, the study examined the mediating effect of two other closely related variables: participants' sense of how easy the website was to use, and whether participants were satisfied with the amount of content on the website. Primary analysis indicated that both the control and experimental groups showed significant improvement across outcome variables, although no additional benefit of OA was detected. Finally, no evidence was found to support the hypotheses for the identified variables thought to mediate the effectiveness of OA. Implications of this null finding are discussed.

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Introduction

General Overview of Computer-Delivered Interventions

Computer-delivered interventions are implemented in a variety of contexts, to address a wide range of mental and behavioral health issues (Mohr, et al., 2013; Portnoy, et al., 2008; Spek, et al., 2007; Barak et al., 2009). They are offered in clinical settings and made widely available on the Internet, and may be presented as stand-alone treatments, as an adjunct to traditional care, or as a hybrid of the two. Both their form and content vary widely, from simple, text-based adaptations of brief screening instruments that take a minute or two to complete, to full-blown multi-session, multi-media, interactive interventions that extend over several hour-long sessions.

With regards to their ability to deliver treatments, CDIs afford consistent presentation of a given intervention with no possibility of therapist mishaps, no forgotten assessment, and no miscalculated cut-offs, let alone the absence of confrontations, counter-transference or other adverse therapist effects. (Rooke, Thorsteinsson, Karpin, Copeland & Allsop, 2010; Portnoy, et al., 2008; Vernon, 2010; Bewick, et al., 2008; Copeland and Martin, 2004). Accuracy and validity of assessment protocols, probabilistic feedback algorithms, reliable computations, impartial results and objective recommendations are all the rightful functions of computers, making them (theoretically) optimal for the delivery of behavioral health interventions. Thus, CDIs are assuming a major and burgeoning role in the wide-scale public dissemination of behavioral health via the Internet. At the same time, CDIs constitute a relatively new and rapidly developing domain within clinical psychology, and many questions exist about their design, effectiveness and optimal deployment.

For example, it is clear that people who receive interventions through computers do not engage the treatment in the same way as people do in traditional therapy. Even assuming that the techniques and strategies of an intervention can be faithfully rendered, all of the factors traditionally related to clinical setting and human interaction are, with CDIs, replaced by factors related to the relatively novel behaviors associated with activity on computers and the Internet. On a phenomenological level, a device, a program and a private input/output activity replace the experience of sitting, talking and empathy. As a society, we are just beginning to perceive, let alone understand, the impact of such phenomena as social media, hyperlinks, surfing, connectivity, pop-up alerts and multimedia on cognitive processing, development, identity and the latest forms of existential crises (Carr, 2010). The intervention may be the same, but the context of therapy shifts radically when placed in the dominion of the internet.

Computer-Delivered Interventions for Problematic Alcohol Use

Little is known about factors that influence the effectiveness of CDIs for problematic alcohol use. But the use of these interventions for problematic alcohol use is widespread—of the roughly 10,000 people per month that visited Internet-based CDIs for alcohol misuse in 2009, 56.4% availed themselves of the services thereon (Vernon, 2010)—and for good reason. People concerned about their drinking can find it easier to get evidence-based, clinically sound assessment and feedback on the Internet than from an actual therapist with training in the treatment of substance use disorders. The amount of resources it takes in a clinical setting to administer the appropriate instruments, score them and write a report—that addresses both the client's risk factors and behavioral recommendations—entails a significant amount of training,

time, attention and work. On the other hand, anyone who is so inclined may get on-line, search for a few moments, find one of an assortment of alcohol–related websites (e.g. Drinker's Check-Up; Down your Drink), and have, in less than an hour, an accurate and clinically valid assessment of his or her drinking, complete with targeted, normative feedback.

Researchers in the business of CDIs for problematic alcohol use frequently note the fact that most people with alcohol problems never seek face-to-face treatment (Cunningham, Kypri and McCambridge, 2011). The stigma often associated with alcohol problems, long assumed to be a reason people who need it don't seek treatment, may be handily averted by the anonymity of on-line access (see, for example, Rooke, et al; 2010; Vernon, 2010; Riper, et al., 2009). Cunningham (2009) notes that many people who use CDIs "report specifically seeking out a web-based solution to their addiction problems because they were concerned about privacy issues" (see also Cooper, 2004; Humphries and Klaw, 2001).

In addition to those who prefer the discretion, there are many people who can benefit from these interventions that might not otherwise seek treatment, were it not so readily available online (Cunningham, 2009; Cunningham, Kypri and McCambridge, 2011; Portnoy, et al., 2008; Vernon, 2010; Bewick, et al., 2008). Practically speaking, the Internet makes interventions available to drinkers who—whether due to physical infirmity, geographic isolation, lack of resources or general ambivalence—might have issues accessing traditional treatment services. And in fact people have engaged on-line interventions for alcohol misuse in the last 15 years on a scale that would overwhelm conventional resources (White, et al., 2010; Riper, et al., 2014).

Exordium

This study evaluated the relative effectiveness of a CDI developed for people wishing to make changes in their problematic alcohol consumption. Moreover, it examined whether specific variables influenced the performance of the CDI. In order to better understand the nature of these variables and the intervention to which they pertain, this introduction presents preliminary information about the domain in which they exist. First a brief review is provided of the evidence supporting the use of CDIs, and in particular those intended for problematic alcohol use. There follows a synopsis of the contextual and methodological issues unique to the testing and implementation of CDIs. Then, a qualitative, non-comprehensive summary of the generic qualities of CDIs is presented, which includes their general aims, intervention components, functions and design elements. This summary establishes the basis to frame the variables of interest in the present study. The introduction concludes with a concise statement of the purpose and hypotheses of the study.

Review of the Effectiveness of Computer Delivered Interventions

Computers have been used in one way or another for the treatment of psychological and behavioral problems for around 30 years now (early examples include Selmi, Klein & Griest, 1982; Burnett, Taylor & Agras, 1985). Initially, studies were primarily descriptive and examined things like feasibility and demographic characteristics of users, or they reviewed various aspects of programs' theoretical orientation, content and format (Cloud and Peacock, 2001; Walters, et al., 2005; Linke, et al., 2007). As studies have accumulated over the last decade in particular, researchers, continuing to cite the core assumptions of CDI benefits (e.g. cost-benefit,

reach and convenience of dissemination, advantages for otherwise reluctant treatment seekers, consistent presentation of the intervention), began to cite some concerns: the field's methodological variability, the observation that CDIs exhibit low to medium effectiveness across studies, and the need to systematically analyze which characteristics of CDIs impact effectiveness. This has been difficult to do however, precisely because "there has been little consistency in how Internet programs are conceptualized, reported and evaluated (Glasgow, 2009). Nonetheless, in the last few years, a few high-quality, systematic and quantitative reviews of the various CDIs have been attempted, and with that effort has come some nascent attempts to provide models to guide their development and research.

Portnoy, et al., 2008, conducted a meta-analysis of 75 RCTs of computer delivered interventions for behavioral risk reduction that were conducted between 1988 and 2007. Of the 75 studies reviewed (taken from 628 potentially relevant sources that didn't meet all inclusion criteria), 23% addressed substance use and 65% were tailored to the individual using the program. They found that CDIs "can help individuals to make improvements in a variety of health behaviors including nutrition, tobacco and substance use, sexual behavior, binging/purging episodes and general health maintenance" (Portnoy, et al., 2008). The effect size found for reducing substance use when compared to no-treatment controls (d = 0.24, 95% CI 0.43) was about average for the study, and though relatively small, it compared "favorably to other commonly implemented public health and mental interventions" (Portnoy, et al., 2008).

These favorable effects disappeared when CDIs were compared with active comparison conditions.

A recent meta-analysis of CDIs for college students (analyzing 39 studies taken from 87 potentially relevant sources) found "qualified support for the efficacy of CDIs to reduce alcohol use and problems in college students" (Carey, et al., 2010). Carey reported that common findings associate CDIs with immediate reductions in problematic drinking, and slower developing but long-term reductions in alcohol related problems. Improvements tend to vary across outcomes depending on a variety of factors. Still, average effect sizes when compared to assessment-only controls, though relatively small (0.09-0.28), are similar to those found in CDIs for other treatment populations (Carey, et al., 2010). As with Portnoy's findings, Carey found that CDIs versus active comparison conditions yielded smaller effects, though Carey additionally observed that the variety of interventions to which they were compared precluded the ability to draw any conclusions about CDIs relative to other specific treatments (Carey, et al., 2010).

Rooke, et al., (2010) found 34 RCTs of CDIs for alcohol misuse and smoking cessation that met their inclusion criteria, seeking to quantify their effectiveness and determine whether that effectiveness was associated with such treatment characteristics as normative feedback, chat features, "entertainment features", number of sessions, treatment location and other factors related to user characteristics and methodology. The average effect size for studies in this meta-analysis was $d = 0.20$, $p < .001$. Studies employing active treatments for comparison conditions produced effect sizes close to zero. When heterogeneity was controlled, CDIs for alcohol misuse

produced an effect size of d = 0.26. Low effect sizes were associated with chat (d = 0.12) and entertainment (d = 0.14) features; normative feedback produced an effect size of d = 0.21. There was no significant effect of number of sessions, treatment location or length of time to follow-up. (Rooke, et al., 2010).

White et al., (2010), presumably surveying the same field of RCTs of CDIs for alcohol problems as Rooke, found 17 of 31 identified studies to be eligible for meta-analysis. According to their evaluation CDIs produced an average effect size of d = .47 (ranging from 0.02 to 0.81). As with other researchers, White lamented an inability to generalize about the efficacy and utility of CDIs for alcohol use due to variable intervention uptake and completion rates, heterogeneity of outcome measures and different follow-up periods across studies. Nonetheless, White et al concluded that CDIs bring about "small but meaningful differential reductions" in a range of alcohol-related measures (White et al., 2010).

Most recently, Riper and her team have published two meta-analyses (Riper, et al., 2014; Riper, et al., 2011) that nicely illustrate the generally unsatisfying and confounding results presented in earlier studies. In 2011 Riper, et al., determined that the seven (of 492 identified) studies of *unguided* CDIs for problematic alcohol use meted a medium effect size (g = 0.39). They also found that CDIs deploying multiple sessions had a significantly greater effect size than those that did not (g = 0.61 and g = 0.20, respectively). This effect inexplicably disappeared three years later, when her team included *guided* CDIs in their analysis (Riper, et al., 2014). In the more recent analysis Riper found a small but significant overall effect size of g = 0.20 for CDIs over control conditions. Also in contrast to her previous study, Riper's 2014 recent study

found no difference between guided or unguided programs, nor any difference between brief, single-session interventions and more lengthy ones. In their discussion, Riper's team was unable to provide a convincing reason for the much diminished newer effect size.

More noteworthy perhaps than the diminishing effect size itself for CDIs between her 2011 and 2014 studies, is Riper's choice to emphasize methodological standards, both in the studies chosen and in her meta-analytic methods. Riper's team included only studies that contrasted the intervention with a no-treatment or assessment-only control group, and established alcohol consumption as the criterion outcome measure. For the 2014 paper, Riper and her team reviewed 1,087 studies of CDIs for alcohol misuse and from those selected 38 that were deemed sufficiently rigorous to be eligible for serious consideration, only 16 of which met their ultimate criteria. The disparity between the number of reports that were available and the number chosen reflects both the proliferation of interventions as well as the field's earnest attempt to attain validity (i.e. by excluding studies with active comparison conditions). In sum, Riper, et al., (2014) reflects how CDI researchers are beginning to settle into a more homogenous set of methodological standards for developing and gauging the effectiveness for alcohol CDIs, even if the result is a deflation of their impressiveness.

Summary of Findings and Related Methodological Issues

The desire for methodological cohesion is certainly understandable. If nothing else the forgoing review makes clear that the study, development and implementation of CDIs grew more quickly in the past decade than findings could be usefully

interpreted. The fact that the rapid proliferation of CDIs for behavioral health has been driven more by technological advances and consumer demand than by scientific progress (White et al., 2010) has contributed to uncertainty about precisely what research evidence is sound enough to govern future implementation (Murray, 2013; Portnoy, 2008).

This problem is exacerbated by challenges to validity that are posed by testing CDI's. Cunningham and others have argued that evaluating CDIs in a clinical setting seriously compromises the ecological validity of a treatment that will likely be encountered in a variety of markedly different contexts (2009; see also Cunningham, et al., 2011 and Cunningham and van Mierlo, 2009). In a typical research setting, control over the environment ensures internal validity, but eliminates just the sort of extraneous variables that a typical user of a CDI is likely to encounter. "There is no way to know," writes Cunningham, "whether the [CDI], if used in real world conditions [i.e. at home or the office], would show a similar level of impact" (Cunningham and von Mierlo, 2009). And there is some recent evidence showing that CDIs are more effective when implemented in a clinical environment, rather than remotely, in unspecified contexts. (Rodriguez, et al., 2015).

Unfortunately, RCTs conducted entirely over the internet (from recruitment to treatment delivery to follow-up), and theoretically tapping potential users in their "natural" environment, are fraught with rather intractable methodological perils. The most significant challenges to the validity of the experiment include uncertainty about who exactly has been recruited (Thompson, et al., 2006), what level of sincerity they bring to the program and, quite often, remarkably low follow-up rates (Danaher, et al.,

2005; Cunningham, 2009). When testing CDIs entirely through the Internet, researchers often have to contend with the fact that as few as 1% of participants may complete a clinical trial (Thompson, et al., 2006; Farvolden, et al., 2005). This problem is so persistent and pervasive an issue for CDI researchers that it has generated a dubious appellation, the "Law of Attrition" (Eysenbach, 2005). This conundrum has been called "the fundamental characteristic and methodological challenge in the evaluation of eHealth applications" (Eysenbach, 2005).

And attrition from research is but one aspect of this daunting law. Consider for a moment the level of motivation required to enter a clinical trial, to engage the intervention under supervision, and to attend follow-up sessions; it is doubtless greater than for those individuals casually entering "do I have a drinking problem" into a search engine and, after some clicking around, encountering a CDI at home, after work, perhaps with a glass of wine by their side. The fact that CDIs for alcohol problems can be encountered in this context gives Cunningham (2009) pause:

> People not only use the Internet in different ways, but an [CDI] user might react differently in front of a computer screen than they might in a face-to-face setting. Primarily, on the Internet, the person is not a captive audience. If they get bored, they have the ability to move onto another Internet page or application… Given these differences, we cannot assume that what might work in a face-to-face format, or even in a paper and pencil format… will necessarily work when translated to an [CDI] (Cunningham, 2009, pg. 178).

From the developers' perspective, "there is accumulating evidence that many participants in web-based interventions exhibit less program engagement than program developers envisioned" (Danaher & Seely, 2009). While CDI developers have "absolute control over what goes into the intervention… the user has a great deal of freedom in how they use the intervention" (Riper, et al., 2008). There is often a

significant proportion of users who drop out of programs after visiting the site once (Mohr, et al., 2013; Murray, et al., 2013); one study found that of the first 10,000 people who used their site, only 16.5% completed the whole program (Linke, Murray, Butler and Wallace, 2007). Thus CDI researchers must reckon with both pronounced attrition from the ranks of their participants *as well as* the fact that many (and unknown numbers of) participants are not fully engaging the administration of the intervention.

The ultimate difficulty given the "Law of Attrition" (Eysenbach, 2005), lies in calibrating the relationship of clinical trial adherence and program engagement to treatment dosage and outcome. Of late, a great deal of effort has gone into determining what factors (whether related to the users of the program or the programs themselves) influence adherence and engagement (Mohr, et al., 2013; Kelders, et al., 2012; Murray, 2012). There has also been research into whether or not there is in fact a dose-response effect of engagement, with some researchers finding support for a connection (Richardson, et al., 2013) and others finding no such connection (Murray, et al., 2013; Hester et al., 2013; Hester et al., 2011). Thus, the distant and uncontrolled context of implementation, as well as uncertainty about the user's interface with the conveyance of the intervention, are both key opaque mediators of the computer's effectiveness.

The situation has led to an "inconsistent, diffuse [and] incoherent" state of affairs in CDI research (Barak et al., 2009), leading one prominent researcher to opine, "having an exhaustive review of studies would not be particularly useful, as this is a fast developing field and summaries of extant research are often obsolete soon after they are published" (Cunningham, 2009), while another has stated flatly "it remains impossible to determine which of these interventions is most effective" (Vernon, 2010).

It would appear that CDIs constitute a field that burgeons with ideas, applications, methods, results, and questions, as well as a concomitant paucity of solid, systematic evidence. At the same time, the demand for CDIs is considerable, their feasibility proven, and their effect sizes, while unimpressive, are just large enough that they can't be ignored.

General Characteristics of the Intervention

In the last twenty years a wide variety of CDIs have been developed, researched and implemented; as discussed, these interventions have been found to have beneficial, negligible and obscure effects. The law of attrition, as well as the heterogeneity of models, methods and products, has long bedeviled researchers working to establish standards for interventions or to even make summary statements about what works. While it is still impossible to offer a universally recognized conception of CDIs, or to even organize a picture of their general characteristics without leaving something important out, the passage of time has nonetheless made it easier to construe patterns in the welter of forms and functions through which CDIs appear (Mohr, et al., 2014; Murray, 2012, Webb, et al, 2010; Barak, et al., 2009). Here I present a general characterization of features common to CDIs, in particular their generic aims, intervention components, functions and design elements.

Aims. As with any discussion of form, the distinctions to be made about a website's design are relative to the functions served, and in some ways the two aspects are indistinguishable. Every CDI is a fusion of a both a clinical purpose and a means of engagement (Mohr, et al., 2014). Some aspects of a CDI are oriented around the clinical characterization of the problem in question and the intervention offered to treat it, and

other aspects concern interface, engagement and usability. Developers may focus on creating a faithful, no-frills translation of an evidence-based treatment or, conversely, they may be more interested in creating a site with engaging technological features and the latest design wizardry. Each of these two aims has its own agenda, functions and objectives. While these aims are nominally distinct, understanding and controlling their interaction can crucially impact the effectiveness of a CDI (Kelders, et al., 2012). A developer who is not mindful of the fact that the two primary aims of CDIs may be married in more or less felicitous ways (Mohr, et al., 2014) may create a program that is difficult to use and clinically ineffective.

Intervention components. Depending on the target, the clinical aims of a CDI are typically rendered through any number of interventions, usually, but not always, related to well-known cognitive and behavioral strategies. Typical strategies common to CDIs include education, goal setting, feedback, motivation and skill-building. Cunningham (2009) notes, "any cognitive behavioral tool that can be put on paper appears to translate well into an Internet-based format." Thus, CDI users may encounter a wide variety of activities intended to facilitate behavior change. For example, programs often employ motivational components like cost-benefit analyses and "readiness rulers" to help users gauge and build their motivation to change; there are exercises to help users do functional analyses of their own drinking, and exercises that help them identify, track and manage "triggers" or stimuli related to their drinking; there are also various self-monitoring devices (e.g. drinking diaries) and related goal-setting modules.

Whereas all CDIs by their very nature provide information intended to educate the user, many CDIs also entail some form of assessment and feedback that may be either targeted (e.g. risks associated with abuse for college freshmen), or individually tailored (e.g. drinking profiles). Some assessment and feedback protocols are relatively brief (often referred to as "screeners") and may serve as a gateway to a more extensive intervention; others, including those with normative and/or tailored feedback, may be considered interventions in their own right. Feedback typically presents information about quantity and frequency of use, estimated peak blood-alcohol content [BAC] levels, risk factors, and other pertinent information from an individual's assessment that ties his or her behavior to some given consequences. Personalized *normative* feedback is one of the most researched and validated aspects of CDIs for college students (Cunningham, et al., 2010; Bewick, et al., 2008; Neighbors, et al., 2004; Lewis & Neighbors, 2006) though it has not been found as effective with older adults (Rooke, 2010). There is evidence that CDI users may provide more accurate self-report by way of computer than they do in person (Elliot, 2008; Gerbert, et al, 1999; Turner, et al, 1998) which, if true, would constitute a bona fide improvement over conventional, human-delivered therapy.

When spelunking the bowels of the internet for CDIs that address alcohol misuse, one will come across a variety of intervention components in addition to those already mentioned that have been designed to help users deal with the precipitants and consequence of their actions. There are mood tracking exercises, various forms of problem solving and skills building exercises, values clarification exercises, mindfulness exercises, aids to relapse prevention, and exercises to help users cultivate other

activities to replace the reinforcers they lose when they give up alcohol. Social support groups, such as listservs, blogs and chat rooms, both open to the public and moderated by professionals, are also frequently linked to or embedded in sites with other features.

Functions. At the interstice of the interventions themselves and the overall look and feel of the CDI are those elements through which the user interacts with the site. As stated above, the primary function employed in most CDIs is information delivery. Information may be proffered through a variety of formats: narrative or instructional text, voice-over, image, graph, animation, video, etc., or some combination thereof. CDIs, like any website, can present users with a rich and interactive array of multi-media features far surpassing the client's experience with bibliotherapy, not to mention an over-taxed and lightly snoring therapist. Other functions include embedded text and email features that allow users to send themselves targeted content to themselves at specific times and places, greatly increasing the reach and potential impact of the intervention (Ritterbrand et al., 2009; Rook et al., 2010). Other functions noted by Mohr (et al., 2014) include social network and messaging features (e.g. chat rooms, blogs and messaging to other users of the intervention) as well as assessments, data logs, passive data collection, and the delivery of feedback reports (Mohr , et al., 2014). Again, the point here in delineating these elements as functions of the site as well as interventions is to draw attention to what the user of the CDI is actually doing to engage the intervention's mechanisms of change. Cunningham (2009) notes that CDIs also frequently utilize a feature that requires users to register and create an account, often with options to customize various aspects of the site, which both establishes the basis for the tracking instruments and provides a sense of proprietary rights (for other

reviews describing programs with these various features, see Vernon, 2010; Walters et al., 2005; Cunningham, 2009, Barak, et al., 2009).

Design. Beyond the active ingredients of the intervention components themselves, perhaps no aspect of a CDI is richer with potential and yet equally obscure in impact than its overall design. The look and feel of a site, including its style of presentation and over-arching effects, are commonly thought to influence the user's engagement with it—and thus the effectiveness of the intervention as well—but this influence is, as yet, poorly understood in the world of CDIs for behavioral health interventions (Barak, et al., 2009; Murray, 2012; Mohr, et al., 2014). Thus like the common or non-specific factors related to traditional talk therapy, the overall design of CDIs have become an increasing focus of research in the field.

Although long an area of active interest for website and game developers (Squire, 2012; Lemke, 2005; Lave and Wegner, 1991), the role of design has only recently been taken up by CDI developers (Mohr, et al., 2014; Oinas-Kukkonen, 2013; Brendryen, et al., 2013; Kelders, et al., 2012). For example, Brendryen proposed that a specific site structure (e.g. "tunneling", described below) works well as a design component of interventions intended for individuals with disorders that entail problems with self-regulation, especially when combined with "just-in-time" prompts that are delivered according to particular, pre-set triggers (Brendryen, et al., 2013). Mohr has offered a more generic account, describing various design aspects that CDI developers should be mindful of when developing their site (Mohr, et al., 2014). For example, he notes that people tend to associate aesthetic quality with usability

(Tractinsky, et al., 2000). Three commonly cited design elements relevant to our purpose here pertain to a CDI's complexity, structure and tailoring.

Complexity refers to both the amount and depth of content made available to the user. Complexity may manifest in the sheer volume of text, the reading level required to comprehend a text, the number of elements used to convey a point, or the range of options and activities available within a site (Mohr, et al., 2014). As yet, there are no well-established guidelines for how to think about the complexity of CDIs for alcohol problems, but researchers have learned that complexity pertains to both user preferences and site functions (Clark and Mayer, 2011). For example, Media Richness Theory (Daft and Lengel, 1984) holds that there is one level of media richness that is optimal for attracting a user's attention (i.e. music plus animation and voice-over) and another that is better for getting an important point across (i.e. text with histogram). As Internet connection speeds have increased, CDI developers have been tempted to load sites with more media activity and options, but researchers doing feasibility studies have found that richer content is not necessarily more effective for achieving either utilization of, or benefit from, a CDI (Walther and Parks, 2002; Yardley et al., 2010). Further, the complexity of a CDI can either draw users into the content or turn them off, depending on the user's individual characteristics (e.g. reading level, preference for static over animated stimuli). It's not only the case that some users prefer more elaborate content while others prefer leaner content, it is also the case that users can find the wrong degree of complexity aversive (Yardley, et al., 2010). Here I am referring not just to wording, pacing or concepts, but any possible function of the site; for example, regarding data input, some users will prefer the freedom to write about their

experience into an open text box, while others will prefer drop-down menus (Mohr, et al., 2014).

Another important aspect of a CDI is its structure or "information architecture" (IA). IA refers to "the structure of information space to facilitate intuitive access to content and task completion" (Danaher, McKay and Seely, 2005). Structure may refer to the way the program orders and presents the information itself, or the framework it has for determining what information should be presented. Danaher (2005), discusses four IA designs relevant to CDIs for health behavior: *matrix, hierarchical, tunnel* and *hybrid.* The matrix design provides the least structure, leaving "users free to pursue their idiosyncratic interests" and chart their own course through the content. While this design facilitates a user's exploration of the content, it also puts them at risk of getting disoriented or lost in the material, especially if it is unfamiliar or challenging. Nonetheless, this remains a popular format in CDIs for alcohol problems.

The hierarchical design organizes information in a top-down way that helps users find the content they are looking for and then presents a clear path to pursue more detail about that subject. The typical format of a hierarchical site will include a home page with several headings which, when selected, will display drop-down menus. A tunnel design, the opposite of the matrix, guides the user along a prescribed path, eliminating all distractions and anticipating the sequence of the user's needs. This structure "assumes that there is some optimal ordering and or *dosage* of content that is associated with greater effectiveness" (Danaher, et al., 2005). This design is typical of assessment and feedback strategies. The tunnel design can control the amount of information presented, the rate at which it is presented and the time spent on it. It is

also useful if the program designers want the user to do something outside the program before returning to it. The tunnel is on the other hand inflexible and if the user does not understand or appreciate the rational behind the tunnel's structure, they may reject the entire program if they begin to feel constrained or disinterested. While it has long been recognized that a CDI's IA can mediate engagement with the intervention thereon, research into this question has been challenging because as the internet has grown and evolved over the last decade, so has people's ability to navigate it (van der Vaart, et al., 2013; Schneider, et al., 2012; Nijland, et al., 2008). Currently, CDIs are generally classed by two general structural types: *guided* and *unguided*, with the former having more obvious intervention-related architectural aspects (typically tunneled) than the latter (typically utilizing a matrix design).

A final and very important structural characteristic of CDIs and websites in general is their capability to conform their content and mode of presentation to the person who is using the site. Often referred to as "personalization," (Mohr, et al., 2014) the concept has its origins in the "tailoring" of behavioral health interventions to individual patient characteristics. Generally speaking, tailoring is a method of persuasion that entails assessment-based methods "in which data from or about a specific individual and related to a given health outcome are used to determine the most appropriate information or strategies to meet that person's unique needs" (Rimer & Kreuter, 2006). Tailored Health Communication (THC), delivered as part of a behavioral intervention, is of particular interest here because it is something that CDIs are well suited for and often designed to do; tailoring in fact embraces the proper deployment of media, complexity and information architecture. It may well be argued

that all of the above characteristics of CDIs are most effective when their structures and functions are tailored to the unique preferences, histories, capacities and needs of the user who encounters them. In the introduction to their meta-analysis, Portnoy, et al., (2008) argued that the particular benefits of CDIs derive particularly from "the combined elements of tailoring and open access".

> The benefits of… CDIs include uniformity of intervention delivery, 24-hour access, and the ability to tailor an intervention to an individual… Although the first two benefits address the delivery of CDIs, the last feature promises to enhance intervention efficacy… Tailoring can increase both the efficacy of an intervention as well as user satisfaction and completion of the program by allowing for a more engaging personalized experience (Portnoy, et al., 2008).

It's no coincidence that computer-delivered interventions and tailored feedback came along at the same time (Kreuter, et al, 1999; Kreuter & Rimer, 2006), since they are, in a literal sense, made for each other. On a public health level, the 1980's and 90's witnessed care providers and policy makers increasingly calling for cheap and effective population-level interventions. Health communication researchers had been tinkering with tailored feedback in printed materials for a decade when Kreuter published a seminal article on the subject (Kreuter, et al, 1999). At the same time, clinicians were contemplating the advent of computers in the therapeutic milieu (Eysenbach, 2001; Barak, 1999). When suddenly home computers and the Internet were ubiquitous, intervention dissemination and public access were bridged by a system with the technological capabilities to quickly process information and provide accurate and often entertaining feedback (Kreuter, et al,1999).

There is a dual focus in THC, for in addition to producing the appropriate health-related assessment feedback information for the participant, tailoring is also intended

to "enhance the relevance and salience of the information" (Rimer and Kreuter, 2006) to motivate the patient to process the information more fully (Couper et al., 2010). Tailored communication makes the assumptions that people are more likely to attend to information that they find personally relevant, and further, information that is more thoroughly processed is more likely to lead to behavior change. Thus, THC researchers are intent to determine the "cognitive and behavioral mediating mechanisms hypothesized to influence individuals' health-related decision making and actions" (Kreuter, et al, 1999), both those that convey the content of the intervention, and those that enhance attending to the intervention.

In their early work (1999), Kreuter and colleagues put forth a theoretical framework for THC that was consistent with so-called dual-process theories of persuasion and attitude change. Dual-process theories attempt to explain "how people negotiate their sense of meaning and understanding of the social world by making inferential leaps from sensory stimulation" (Moskowitz, et al., 1999). The theory has roots in constructivist, gestalt, phenomenological, and pragmatic psychology, and manifests in conceptions about the nature of "social cognition" (foundational figures are commonly held to be Kohler, 1930; Lewin, 1936; James, 1907; Bruner, 1957). The term "dual-process" derives from the assumption, common to all theories in the class, that information processing happens along a continuum of more or less explicit or conscious reasoning:

> On the one hand, people can utilize little cognitive effort, elaboration, or capacity in thinking about the social world. They can lean on prior knowledge, heuristics, stereotypes, expectancies, scripts and schemas [*peripheral route* processing] to impose order on new situations. In each of these cases, people act in a somewhat "mindless" fashion, arriving at their sense of knowing through a "top-down"

> process whereby a preconception is imposed on new information. On the other hand, people can expend a great deal of time, effort and mental energy in systematically building decisions, beliefs and a sense of knowing [*central route* processing]. This more "mindful" strategy is a "bottom-up" process that requires the exertion of cognitive effort to reflect on and examine the stimulus. Neither strategy guarantees a bias-free response; they are just two distinctive paths to arriving at knowledge—paths that individuals have the cognitive flexibility to choose between. (Moskowitz et al., 1999).

The intent of dual-process theories is to explain how peripheral and central routes of processing interact; how peripherally processed cues mediate central processing, and how central processing influences the presence or absence of those heuristic cues. By positing the "elaboration continuum" dual-process theories recognize that it is "neither adaptive nor possible for people to exert considerable mental effort in thinking about all the messages and attitude objects to which they are exposed" (Petty and Wegener, 1999). Researchers in the field may also site Pirolli and Card's theory that cognitive structures and processes for "information foraging" have evolved to "maximize information gains per unit cost" (Pirolli and Card, 1999).

Kreuter and colleagues tied their theory of THC to one dual-process theory in particular, the Elaboration Likelihood Model (ELM). A core finding of the ELM is that the more people *elaborate* upon information, the more likely it is that information will mediate the behavioral determinants in question, and so ultimately lead to behavior change (Petty and Cacioppo, 1981; Cacioppo et al., 1981; Petty et al., 1994; Petty, 1977). Thus, ELM attempts to account for the "communication variables" which influence "people's general *motivation* and *ability* to think about a message" (Brinol & Petty, 2006). These variables may be content related or context related, and may mediate elaboration through such factors as confidence in a source, mood, recognition of biases,

complexity, mental exertion, message format, and so on (Brinol & Petty, 2006). For example, there is evidence to support the notion that tailoring the content of a CDI to match the learning style of the user (e.g. "wholist" versus "analytic"; "active" versus "reflective") enhances engagement by alternately reducing the cognitive burden or providing a preferred mode of engagement (Cook, 2005).

While these communication variables have been subject to extensive research, Kreuter admits "the specific place and role of perceived message relevance in the causal chain between exposure to a health communication and subsequent behavior change is poorly understood" (Kreuter and Wray, 2003; Rimer & Kreuter, 2006). Petty likewise acknowledges that it is "not always clear whether [tailoring] affects attitudes by serving as a simple cue or an argument, or by affecting the amount or direction of thinking" (Brinol & Petty, 2006). Thus, although dual-process theories in general, and the ELM in particular, seem like good frameworks through which to develop and evaluate CDIs that employ THC, and can inform how CDIs can increase attending to their own content, they do not provide insight into any causal relations.

Nonetheless, according to the logic of tailoring, there are two primary ways in which a computer may enhance the effectiveness of an intervention: it can compute and provide theoretically driven individualized feedback relative to the treatment components deployed, or it can manipulate the presentation of those components to increase engagement with them (Portnoy, 2008; Kelders, et al., 2012; Mohr, et al., 2014). The intervention itself provides the basis for the tailoring of the therapeutic feedback on key behavioral variables, which is calculated according to empirically derived algorithms. The program or website as the conveyance of this information

provides several design avenues for tailoring it, as discussed above. Here we come full circle to Mohr's conception of the two primary aims of CDIs—clinical and operational—which in many ways are parallel to the concept of central and peripheral routes of information processing. According to dual process theories, the design and functions of the CDI can influence peripheral route processing, which will in turn support and facilitate central route processing of the treatment's content. Thus, tailoring may hold the key to unlock the law of attrition by enhancing engagement with the active ingredients of the intervention.

Variables of Interest

Research into the design of CDIs has in fact begun to focus on peripheral route processing, and how technology can be used to aid learning, rather than simply presenting learners with new technology and expecting them to adapt to it (Mayer, 2009). This emphasis on the human side of the human-computer interface grounds research in pragmatic outcome variables that are amenable to behavioral health interventions, rather than succumbing to the blind pursuit of innovation for its own sake. "A learner approach does not rule out the use of new technological innovations," says Clark and Mayer, "it does however require the adaptations of those innovations in ways that support human learning processes" (Clark and Mayer, 2011). It's clear that research should be conducted upon ways to take advantage of a site's structure, the ways it may combine and order its various components, and the interaction of all of it with established behavioral treatments. Research into such tailoring functions as a way to increase engagement with CDIs has been described as "critical to their success" and

also one for which "research has only just begun" (Ritterbrand et al., 2009; see also Mohr, et al., 2014).

As reflected in Riper's recent study, over the last 10 years and with increasing urgency, CDI developers and researchers have begun to seek consensus with regards to the theories, terminology, methods, target behaviors, treatment approaches and so-called "common factors" germane to their work. Attention has been paid to two interrelated areas in particular; one concerns the generation of possible theoretical models to guide the development, implementation and evaluation of CDIs (Ritterbrand et al., 2009; Webb et al., 2010; Murray, et al., 2013; Mohr, et al., 2013; Brendryen, et al., 2013; Mohr, et al., 2014). Concomitantly, there has been an increasing interest in understanding the impact of various intervention and participant characteristics that are widely thought to influence "peripheral" route processing of the treatment content and so the effectiveness of CDIs.

In particular, there has been a great deal of research in the last ten years on which user characteristics influence both engagement with the CDI and outcomes in clinical trials. Researchers have examined gender, age, level of education and level of income, all of which inconsistently predict level of engagement with the intervention, but nothing at all significant regarding outcomes on various clinical measures (Riper, et al., 2008; Glasgow et al., 2011; Schneider, et al., 2012). Although more difficult to characterize, a user's relative experience with computers and the internet has long been viewed as a likely moderator of both engagement with CDIs and the ability to benefit from them. Researchers have discovered that potential CDI users do exhibit a range of abilities relative to internet skills (Van Deursen and Dijk, 2011) which lead to

difficulties operating computers and web browsers, navigating websites, and obtaining relevant information in ways that interfere with the treatments thereon (Van der Vaart, et al., 2013; Feufel and Stahl, 2012). As of yet, skills pertaining to computers and web-navigation have not been found to moderate outcomes (Borosund, et al., 2013; Riper, et al., 2008), but this question has not yet been put to users of CDIs for problematic alcohol use.

Relative to characteristics of the intervention itself, Clark and Mayer (2011) have evaluated factors that align learning objectives with the most appropriate site architecture. Their research has shown how different process goals—information acquisition, response strengthening or knowledge construction—work best with the structures—receptive, directive and guided discovery, respectively—that reflect their functions. Similarly, Clark and Mayer propose a "principle of coherence" which dictates that content be as uncluttered and concise as possible. Calling it their "single most important recommendation," (Clark and Mayer, 2011) this principle challenges conventional wisdom about jazzing up sites with lots of fetching multi-media content. For example, evidence shows that too much content can depress performance, especially in novice learners (Mayer, et al, 2008; Sanchez and Wiley, 2006). Evidence has also been obtained to support omitting extraneous audio (Moreno and Mayer, 2000; Knez and Hygge, 2002) and graphics (Harp and Mayer, 1998). The principle applies as well to text, whether it is added for interest (Lehman, et al, 2007), depth (Yardley, et al., 2010; Mayer and Jackson, 2005) or to expand on key ideas (Mayer, et al, 2007).

While there's more research to be done about the principle of coherence, the implication for CDI developers is clear: too much content suppresses learning.

Especially given the cognitive challenges often faced by individuals dealing with alcohol-use disorders, it may be important to know whether individuals using CDIs for their treatment respond better when they feel only the pertinent information and procedures are being presented to them, and nothing more.

Finally, with regards to navigating through course content, it has been found that low prior-knowledge and low metacognitive learners learn better when the program dictates the pacing and structure of the content (essentially relying upon guided information architecture), rather than leaving it to the learner to decide (using an unguided site architecture) how to proceed through it . The latter approach, called "discovery learning," often facilitated with games, multiple external links and an open, asynchronous structure to the material, has consistently been found to lead to poorer performance than lessons presented under "program control" (Gay, 1986; Young, 1996; Clark and Mayer, 2011). The idea is that novice learners don't know enough about the domain to benefit from "learner control" over the structure and pacing of the content. Moreover, feasibility studies have consistently found that site users are quite conscious of the difficulty they experience navigating CDIs, and may disengage from them if the process becomes too frustrating (Schneider, et al., 2012; Klein, et al., 2010; Nijland, et al., 2008). Thus, as with too much content, too much freedom to navigate around a site has found to be deleterious to learning. Once again, there are to date no empirical studies on how the structure of a CDI for alcohol misuse might deter or enhance benefit from the treatment contained thereon.

Purpose of the Current Study

The general purpose of this study was to determine whether access to the *Overcoming Addictions* website afforded better outcomes (on three drinking-related variables) relative to standard engagement with SMART Recovery. The primary hypothesis holds that people engaging SR would derive additional therapeutic benefit by having tailored and interactive SR treatment components available to them on OA. Further, the present study proposed a line of research to examine variables related to factors that influence engagement with CDIs for problematic alcohol use. Specifically, this study examined whether an individual's relative familiarity with the Internet—as measured by how much time they typically spend "on" the Internet (i.e. navigating sites, attending to online material)—moderated the effectiveness of the CDI. Secondly, this study sought to detect whether the CDI's structure mediated the user's ability to access and therefore garner benefit from the site's treatment components. Finally, the study explored whether participants' impression of the complexity of the site, as gauged by their assessment of the appropriateness of the amount of intervention content on the site, likewise mediated the effectiveness of the intervention.

In order to examine these variables, subjects were drawn from a sample of 189 participants enrolled in a randomized clinical trial being conducted by Behavior Therapy Associates, Research Division, under the leadership of Dr. Reid Hester. Control participants (SR) were enrolled in SMART Recovery meetings (face-to-face and/or online); experimental participants (OA), in addition to being enrolled in SMART Recovery meetings, also had access to *Overcoming Addictions*, a CDI based on SMART Recovery principles. Primary analyses of between group differences were conducted to

detect an additive effect of the OA. Within the experimental group, subjects were asked at the conclusion of the final assessment to characterize their internet use, and to rate the site across several dimensions. ANOVAs examined whether the participant's prior experience navigating the web accounted for any of the variability relative to treatment outcomes. Further, the study examined the participants perceptions of the effect of the structure of the website and the amount of information contained on the website.

Study Hypotheses

Hypothesis One: *The* OA *group will have better outcomes (greater reductions in drinking and drinking-related consequences) relative to the* SR *group.*

Hypothesis Two: *Within the* OA *group, hours-per-week spent on the Internet will be positively associated with better outcomes (greater reductions in drinking and drinking-related consequences).*

Hypothesis Three: *Within the* OA *group, subjective ratings of the amount of content in the program as "just right" will be positively associated with better outcomes (greater reductions in drinking and drinking-related consequences).*

Hypothesis Four: *Within the* OA *group, subjective ratings of the ease of using the program will positively associated with better outcomes (greater reductions in drinking and drinking-related consequences).*

Methods

The Interventions

SMART (Self-Management And Recovery Training) Recovery is a nonprofit educational organization run by a Board of Directors that consists primarily of clinicians with backgrounds in cognitive-behavioral practice (SMART Recovery, 2013). The Board determines, based on the empirical evidence and the feasibility of translating elements into self-help formats, what components will make up the SMART Recovery program. While SMART Recovery content may vary as empirical research evolves, the underlying philosophy of the treatment has remained consistent since its inception. In particular, SMART Recovery promotes the dissemination of, and instruction in, empirically supported techniques and practices that "empower" individuals to make changes in their own lives. SMART Recovery has been implemented historically in face-to-face and online self-help/mutual aid groups, with meetings that are facilitated by individuals who must receive official SMART Recovery training. SMART Recovery's web site states that the purpose of the organization is "to support individuals who have chosen to abstain, or are considering abstinence from any type of addictive behaviors (substances or activities), by teaching how to change self-defeating thinking, emotions, and actions, and to work toward long-term satisfactions and quality of life" (SMART Recovery, 2013).

SMART Recovery's program uses a common set of strategies to address all addictive behaviors (Horvath, 2013). Their rationale for this is based on two aspects of addictions: common etiological factors in both the development and maintenance of addictive behaviors (e.g., stimulus control, maladaptive reinforcers), and the broad

applicability of cognitive-behavioral and motivational strategies that are supported by outcome research in the treatment of various addictions. Its program for change is based on four points: 1) building and maintaining motivation for change; 2) dealing with urges; 3) problem solving; and 4) developing a balanced lifestyle (SMART Recovery, 2013).

SMART Recovery has active presence on the Internet. The message boards have over 13,000 registered users and between 50,000 and 63,000 visits per month. In addition to their online presence, they have 223 in-person support groups in the U.S. (130 more meetings are held in correctional facilities), and 107 in-person meetings in six other countries (Hester, et al., 2013). The present clinical trial constitutes the first attempt to establish an evidence base for the effectiveness of SMART Recovery.

Overcoming Addictions is a web application (developed by Dr. Reid Hester and his research team, including the present author) that is based on the SMART Recovery model. OA is an unguided and interactive web-based program designed to either complement traditional SMART Recovery (i.e. meetings and workbook) or to function as a stand-alone treatment. In that regard, OA also affords users the opportunities to address a wide range of addictions (e.g. stimulant use, opioid use, cannabis use and gambling.) While *OA* content is organized around the four target domains of the SMART Recovery program, it also contains intervention content not found in the SMART Recovery handbook or website, but which we deemed to be consonant with the SMART Recovery philosophy and objectives.

OA intervention components. The top-most section on the OA home page (see Figure 1), is entitled *Stages of Change.* This section is comprised entirely of text and

presents Prochaska and DiClemente's model of behavioral change (Prochaska, et al., 1994). The discussion is designed to help first-time users of the program determine where they are in their own change process, and contains links to other modules in the program (as well as content existing outside of the program and on the Internet) germane to their stage.

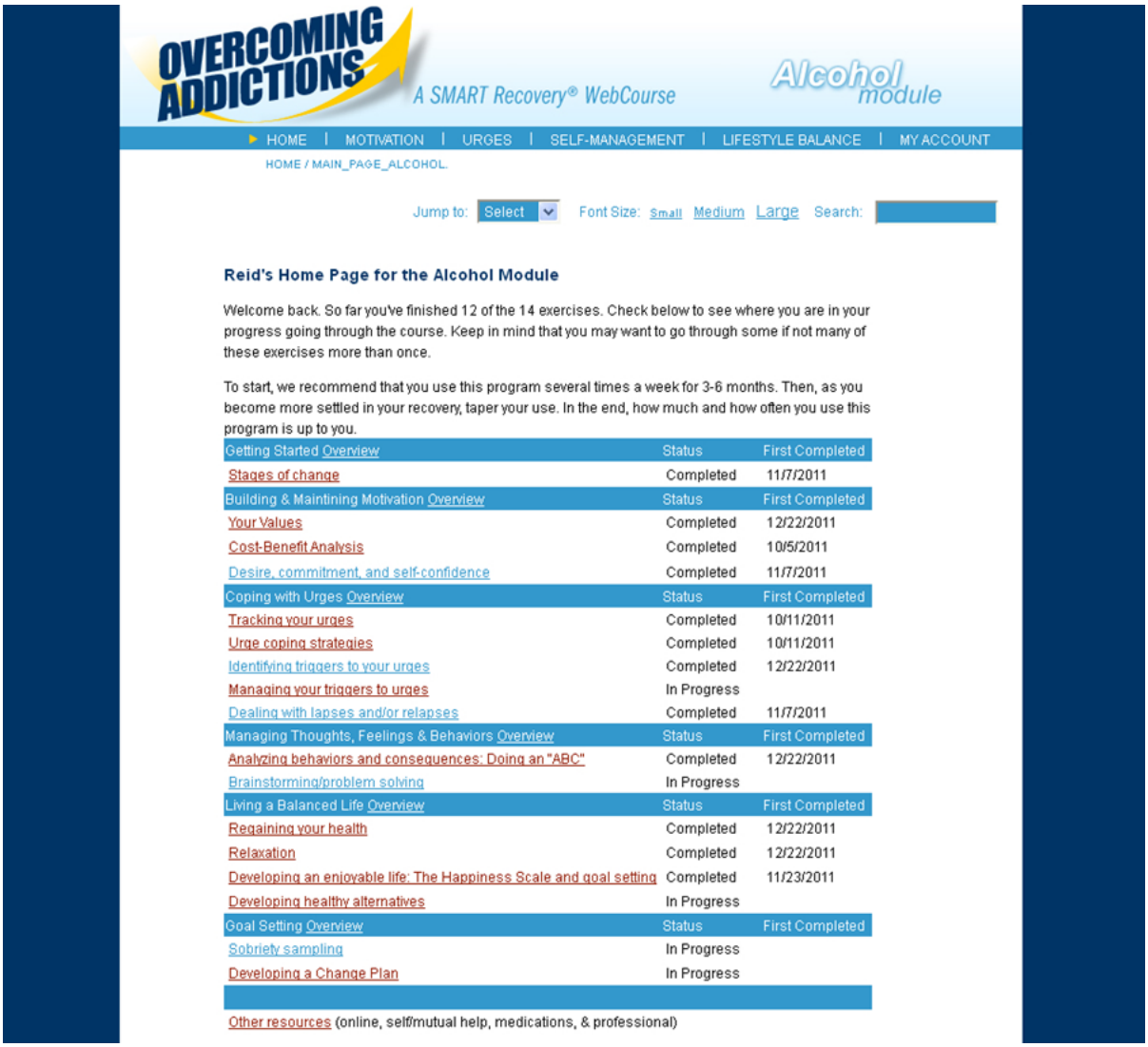

Figure 1. Overcoming Addictions Alcohol Module Home Page.

The next section down the page, *Building and Maintaining Motivation for Change*, contains three modules. The first is a values clarification exercise that helps users identify their values, including those that they feel can support them through the process of changing their drinking, and those that users hope to strengthen as a part of making those changes. A "Cost-Benefit Analysis" asks users to consider the advantages and the disadvantages of continuing with their addictive behavior as well as the advantages and disadvantages of abstaining. Another module that utilizes "motivational rulers" is designed to elicit "change talk" that users can enter into various text boxes.

Dealing with Urges and Cravings is the next section, and begins with a brief discussion of urges to drink and their relationship to sobriety and lapses/relapses. It teaches users to self-monitor their urges to drink, and provides them with interactive exercises that allow them to record the date, time, intensity, and duration of the urge, the trigger to the urge, how they handled the urge, and their reaction to how they handled it. The program provides users with the means to print a hard copy of a page of self-monitoring cards to collect these data as urges happen. When users enter their self-monitoring data into the OA program, they are provided with graphic feedback about the frequency, intensity, and duration of their urges over time. This feedback helps users see whether they're making progress in experiencing fewer urges over time. If a user is not experiencing a gradual decline in the frequency, intensity, or duration of urges over time, the program suggests they consider additional or alternative urge-coping strategies. The section contains a module with the urge-coping strategies recommended by SMART Recovery and other exercises we added during development.

In addition, there is a piece on medications relating to the management of urges and cravings.

Since dealing with urges to drink involves identifying and managing the stimuli that precede the urges, there are is a module in OA to help users identify and manage these "triggers". It is a complex module. For each domain of triggers (e.g. relative to places, people, emotions, etc.), the program presents well-known and effective strategies for managing them that are drawn from evidence-based treatments, as well as strategies that other users of the site have found helpful and wish to share. Finally, this part the program prompts users to create their own change plan to address their triggers in each domain.

The next section is called *Self-Managing Thoughts, Behaviors, and Feelings*. There are three components to this part of the program: a module containing the "ABCs" of Rational Emotive Behavior Therapy (REBT) (Ellis & Velten, 1992); a module on unconditional self-acceptance, and a problem solving module. The ABCs module has multiple sub-components: dysfunctional beliefs; coping statements; changing one's self-talk to change one's feelings, and the process of analyzing and correcting dysfunctional beliefs that produce negative affect (Steinberger, 2004).

The final core section of OA is entitled *Lifestyle Balance for Preventing Relapse*. This part of the program has modules that address regaining one's health, relaxation, goal setting, social and recreational activities, and other relapse prevention strategies. A module on "regaining one's health" focuses on eating, sleeping well and exercising. The module on relaxation training is targeted both toward those with high levels of trait anxiety as well as those with situation specific arousal (e.g. when experiencing urges to

drink). The goal setting module focuses on setting short-term goals that are specific, measurable, achievable, realistic, and timed (e.g. once a day). The module on social and recreational activities encourages individuals to consider and sample enjoyable and rewarding pro-social activities that are compatible with their goals and values, and that make a sober life more rewarding than drinking, using drugs, or engaging in other addictive behaviors. The final module on relapse prevention strategies presents relapse as a learning experience (e.g. the Abstinence Violation Effect, Marlatt & Gordon, 1985) and offers some additional control strategies not covered in the other modules.

OA functions. Upon entering the site, the visitor is provided a brief overview of the program, given assurances about confidentiality, and offered the opportunity to register to use the site. Users are required to provide a first name, gender, username, password, and email address. Once registration is completed, the program creates a new database and personalizes content for that user (e.g., Welcome back, Elvis). Once the user enters the site, the primary functions of the site entail presenting information and eliciting written responses to content that direct the user towards certain questions or structured observations (e.g. breaking a problem situation down into antecedent events and ultimate consequences). The written text is presented back to the user and reframed in the context of the module goals. Some exercises allow the user to save multiple iterations of their responses, and most afford the opportunity to print out the results. Some of the feedback offered is presented in graphic form, and allows users to track their progress over time. Other functions of the site include watching videos, engaging in guided mindfulness exercises, and crafting individualized motivational

texts. Finally, the site has automated text and email functions with embedded links to remind the user to return to the site.

OA design elements: structure and complexity. As stated above, upon completing registration the user is taken to a homepage that lists all of the program's exercises and materials in a matrix "table of contents" fashion. As is common with CDIs structured with a central matrix, the user can access any section or module of the program in any order that he or she chooses. However, once the user chooses an exercise, the program guides them through it in "tunnel" fashion, with a link on any page that leads ineluctably to the next step or feature of the exercise. Thus the architecture of the site's information is structured in a hybrid style (i.e. matrix to tunnel, and back to matrix). In this sense, importantly, the intervention is essentially unguided; although the homepage offers feedback about which parts of the site a user has accessed, users are free to avail themselves of as much program content as they choose, in any order they choose, whenever they choose. When we developed the site, we chose to adopt this design as part of a "user-centered" approach, thinking that users would decide for themselves which components of the intervention were of most interest and import to them.

Similarly, supplemental text is often made available throughout the site via pop-up boxes and links that expand the page; in this way, we reasoned, users would not be confronted with more information on a topic than they were interested in. As for the complexity of the writing itself, we made use of the Flesch-Kincaid readability test (Kincaid, et al., 1983; built into the Corel *WordPerfect* program) to constrain the verbiage to an 8th grade reading level. The Flesch-Kincaid formula uses word-to-

sentence and syllable-to-word ratios which, when applied to the program content, often leads to simple and direct sentences with few if any sub-clauses.

As for overall appearance, there are no images nor animations on the site. Each of the site's pages are comprised almost entirely with text, imparting a "book-like" appearance. A banner at the top of every page affords quick navigation to the home page, module headings and the user's account page, where the text and email features are situated.

Experimental Design

Recruitment. Participants for the study were recruited through the home page of the SMART Recovery web site, as well as by announcements of the study made by facilitators at SMART Recovery face-to-face and on-line group meetings nationally. There was also a thread on the SMART Recovery online forum announcing the study and inviting new members to participate in it.

Inclusion criteria. Criteria for inclusion of participants into the study were that they 1) had a minimum age of 18; 2) provided a positive response to quantity/frequency screening questions regarding heavy drinking in the previous 90 days; 3) had an *AUDIT* score of 8 or higher*;* 4) were new to Smart Recovery (i.e. had joined within 4 weeks prior to screening); 5) had a computer at home with Internet access, and; 6) expressed a primary treatment goal to abstain from drinking.

Exclusion criteria. Potential participants were excluded from the study if they 1) were court-mandated 1st time DWI offenders at the time of screening; 2) had a current diagnosis of drug dependence or considered themselves to be drug dependent; 3) exhibited uncontrolled psychosis or bipolar disorder (based on Brief Symptom

Inventory scores and/or the research assistant's clinical judgment during screening); 4) exhibited evidence of significant cognitive impairment from brain dysfunction (based on self-report and research assistant's clinical judgment during screening); 5) had an English reading level below the 8th grade; 6) were unwilling or unable to be available for follow-up appointments at 3 and 6 months from entrance into the study, and; 7) were unwilling or unable to provide one Significant Other (SO) for corroboration of participant's self-report of drinking.

A minimum AUDIT score of 8 suggests that the person is at least "at risk" for alcohol-related problems. It was important to recruit participants who were new to SMART Recovery in order to evaluate its initial impact on their drinking and related consequences. A computer with Internet access at home was necessary for participants to use the web application. Finally, although SMART Recovery and OA do address other addictive behaviors, and study participants were encouraged to use the site for any additional addictive behavior they chose, the study sought to evaluate outcomes for people whose *primary* focus was their drinking (as this makes up the majority of SMART Recovery members).

Regarding exclusion criteria, court mandated first time DWI offenders are required to attend three self-help groups; there was a concern that these treatment-mandated offenders would have no motivation to continue beyond those first three meetings. Further, such a group would possibly prove to be difficult to find at post baseline assessments. Since the primary focus was on drinking, those with either a current diagnosis of drug dependence *or those who consider themselves to be drug dependent* at the time of screening were excluded. Criteria 3 and 4 reflect the need for

study participants who could reason, recall, and comprehend information both in the experimental and control group. The reading level of the Overcoming Addictions web application was set at the 8th grade. Potential participants were asked about their educational level, and none reported less than a high school degree. Lastly we contacted participants' SOs to corroborate their self-report of their drinking and consequences.

Screening. Potential participants were screened over the phone using a questionnaire addressing the inclusion criteria 1 and 4-6 and exclusion criteria 1,2, and 4-7. The research assistant administered the AUDIT over the phone, and asked two quantity/frequency questions, "How often have you had 5 or more (4 or more for women) standard drinks (explained briefly) in the last 90 days?" and "During the last 90 days have you drank as often as once a month?" A response of one or more times to both questions was sufficient to be included in the study. These two screening questions are adapted from those used by Cherpitel (2002), who found them sensitive and specific in screening for alcohol abuse and dependence.

If the potential participant qualified for the study, the research assistant emailed or faxed him or her a demographic form, the patient locator form (from Project MATCH), a copy of the BSI (Derogatis, 2000) and an Informed Consent form. BSI scores were reviewed prior to enrolling potential participants in the study and if their scores were elevated (e.g. depression subscale score > 60th percentile) the research assistant discussed their emotional state with them and referred them to treatment as necessary (N=7). If a potential participant passed the screening, had a consenting SO and signed the Informed Consent form, he or she was randomized to either the experimental or the

control group at that time. The time line for the post-baseline assessments began when the participant was accepted into the study.

Randomization. Participants were classified into blocks based on the two control factors of gender and ethnicity (White, Hispanic, or Other). Within each block, participants were randomly assigned to one of two groups.

Assessments. The primary quantity/frequency assessment was the Timeline Follow-Back (TLFB) (Sobell & Sobell, 1995). The 90-day TLFB was administered at baseline and again at 3- and 6-month post-baseline, which provided a total of 9 months of continuous data, three months prior to baseline and 6 months from enrollment. The TLFB was also used to collect data on study participants' attendance at SMART Recovery meetings and other interventions they may have sought. (Psychometric properties of the TLFB are presented in Sobell et al., 1979.) The TLFB has been used extensively in RCTs by clinical researchers and yields a rich dataset of quantity/frequency of drinking and drug use. Two quantity/frequency measures of drinking were to assess drinking outcomes: number of drinks per drinking day (DDD) and percent days abstinent (PDA). Each of these dependent variables taps a different dimension of use. DDD is a simple gauge of quantity, easily identifiable to the participant, but obviously relative, since the participant's weight mitigates the intensity of the effect of the alcohol. PDA is a global measure of how often the participant drinks.

Inventory of Drug Use Consequences. The Inventory of Drug Use Consequences (InDUC, Miller, et al., 1995) was used to measure both lifetime and recent alcohol- and drug-related life consequences along the five domains of interpersonal problems, intrapersonal problems, physical consequences, issues with impulse control,

and aspects of social responsibility. The InDuC is derived from the Drinker's Inventory of Consequences (DrInC), with the only difference between the two instruments is the addition of the words "or drugs" to the questions. Assuming comparability between the InDUC and DrInC scores, InDuC scores were interpreted according to the psychometric properties as described in the manual for the DrInC that was developed for Project MATCH (Miller, Tonigan, & Longabaugh, 1995)

Baseline interview. After participants were randomized and enrolled in the study, they were contacted to set up a baseline interview. During the interview, participants "shared" a live desktop (via "Go-To-Meetings") with the research assistant. Participants were encouraged to use the TLFB calendar to prompt their recollections of their prior three months of drinking as they entered their data. After that procedure, through which the RA assisted as much or little as participants requested, they were guided to the InDuC and asked to complete it.

Assessment reactivity was a concern during the clinical trial, especially considering the particular nature of ecological validity entailed by CDIs. Frequently as participants responded to these assessments they discussed their histories and struggles with alcohol and related (or not entirely related) struggles. In order to minimize any undue treatment effects, RAs responded as empathically (but briefly) as possible, without soliciting further processing by the participant. Further, RAs directed, as often as was reasonable, that the participant seek help from the interventions being tested in the trial. Participants were assisted (when they requested it) in registering for the online meetings and/or finding a local "face-to-face" group to attend. All

participants received a welcome email to the study, with an active link to the *OA* site for those participants receiving the experimental intervention.

Treatment exposure and fidelity. Treatment fidelity in the web application was maintained by the nature of the technology used. All participants in the group who used the OA web application were exposed to the same program. However, because participants were able to use the *OA* program and any module in it as often as they chose, the amount of exposure to the intervention, the number of modules used, and the way in which modules were used varied from participant to participant. There was no *a priori* minimum number of sessions or modules a participant had to complete to be considered as having received the intervention.

Protection from clinical deterioration. Conditions that would have led to a referral, had they come to our attention, included evidence of (1) acute psychosis, (2) suicidal and/or homicidal ideation or attempts, (3) cognitive impairment, (4) deterioration of physical health, and (5) drinking and/or drug use at a markedly increased level, or at any level producing consequences that would indicate a current serious risk to the participant's or another's safety. This did not occur post-screening. When they entered the study, participants were told to call any time they have a question about the study, or if they felt acute distress related to their attempts to change their drinking. The study office had a live after-hours answering service and a psychologist on call for emergencies.

Follow-ups. Participants were asked to provide detailed tracking information (e.g., physical and email addresses, phone numbers, names and contact information of others who would always know how to contact the participant). Participants were

contacted about 2 weeks before their 3- and 6-month post-baseline assessments to remind them of their appointment and to reschedule if necessary. If a participant called in to reschedule an appointment, office staff made the new appointment if the PI or RA was not available. There was also an automated voice mail service for times when all phone lines were busy, or if participants called after hours or on weekends.

Maximizing compliance with protocols. The *OA* program has an integrated email feature that contacts users who have not logged into the program within a week. A personalized email encouraged participants to log in and resume their progress through the program. There was no protocol for encouraging participants to attend their SMART Recovery meetings.

Excludes and dropouts. Experimental group participants who signed the Informed Consent and were randomized but who did not register to use the *OA* within the first two weeks were considered "excludes" and were replaced.

Tracking entire sample. Project CONSORT's categories (Moher, Schulz, & Altman, 2001) guided how participants were tracked through the study (see Figure 2). RAs tracked the number of individuals who made contact to participate in the study; the number of those who were excluded and the reasons for exclusion; the number who passed the phone screening; the number of individuals assigned to each group; the number of participants who withdrew from the study, as well as those who were lost to follow-up.

Six-month exit interview. The data for the analysis of the participant and intervention factors thought to impact the use of the intervention were collected in an exit interview at the six-month follow-up (see Appendix 1). It asked participants to

estimate how much time per week they spent on the Internet—at work or school, at home, and elsewhere (café, library, etc.). These estimated hours were totaled to create a continuous variable characterizing the participant's relative fluency with the Internet.

Further, all experimental participants in the study were asked to rate the website across several dimensions. Of particular interest to this study were questions pertaining to two factors: one question about the user's satisfaction with the amount of content on the site, and a group of questions pertaining to how easy or hard the site was to navigate. Additionally, several open-ended questions were posed to participants to gather data for further qualitative post hoc analysis.

Pre-planned analysis. To test Hypotheses 1, separate repeated measures analyses of variance were conducted on the three primary dependent variables: measure of drinking frequency (Percent Days Abstinent; PDA), a measure of drinking quantity (Mean Drinks per Drinking Day; DDD), and a measure of drinking-related consequences (InDuC Recent; IDR), one three-level repeated factor (time of assessment: baseline, 3 month, 6 month), and the between-subject factor of treatment condition (i.e. access to OA). For each analysis, two contrasts of the within-subject factor of time were conducted.

To test hypothesis 2-4, separate repeated measures analyses of variance were conducted on the three primary dependent variables (i.e. IDR, PDA and DDD), with two within-subject continuous variables (e.g. hours per week spent on the Internet; ease of use) and one within-subject dichotomous variable (amount of information: right/wrong) entered as covariates, and one three-level repeated factor (time of

assessment: baseline, 3 month, 6 month). Again for each analysis, two contrasts of the within-subject factor of time were conducted.

Finally, a post hoc, correlational analysis was conducted to explore for relationships between variables of interest, including possible dose-response relationships between drinking-related outcomes and actual use of the interventions, as well as for other results from the exit interview.

Results

Approximately 358 people new to SMART Recovery inquired about the study and of those, 345 agreed to be screened. During the initial screening 19 failed to meet inclusion criteria and 38 were excluded. After passing the screen, 99 potential participants did not complete the initial consent process, six more failed to follow through with the initial assessment, and one asked to be dropped from the study within a day of being randomized. This resulted in 188 individuals who were randomly assigned to one of three groups: SR, OA and SR + OA. However, as recruitment progressed, we found that many potential study participants expressed an unwillingness to be randomized to the OA only group. Because many individuals came to the study through the SR website, they were already anticipating attending SR meetings, and they were reluctant to be denied the opportunity to follow through on that interest for the sake of joining the study. After months of confronting this challenge, the OA only group was dropped, and individuals randomized to that condition were folded into the SR + OA group. The final allocation tallied 102 participants in the OA + SR group and 87 in the SR group. Recruitment began September 12, 2011 (3 pilot participants were recruited in the first 2 weeks of the study) and ended August 1, 2012. Three-month follow ups were completed November 1, 2012. Six-month follow ups were completed March 14, 2013. Figure 2 illustrates the flow of participants through the study.

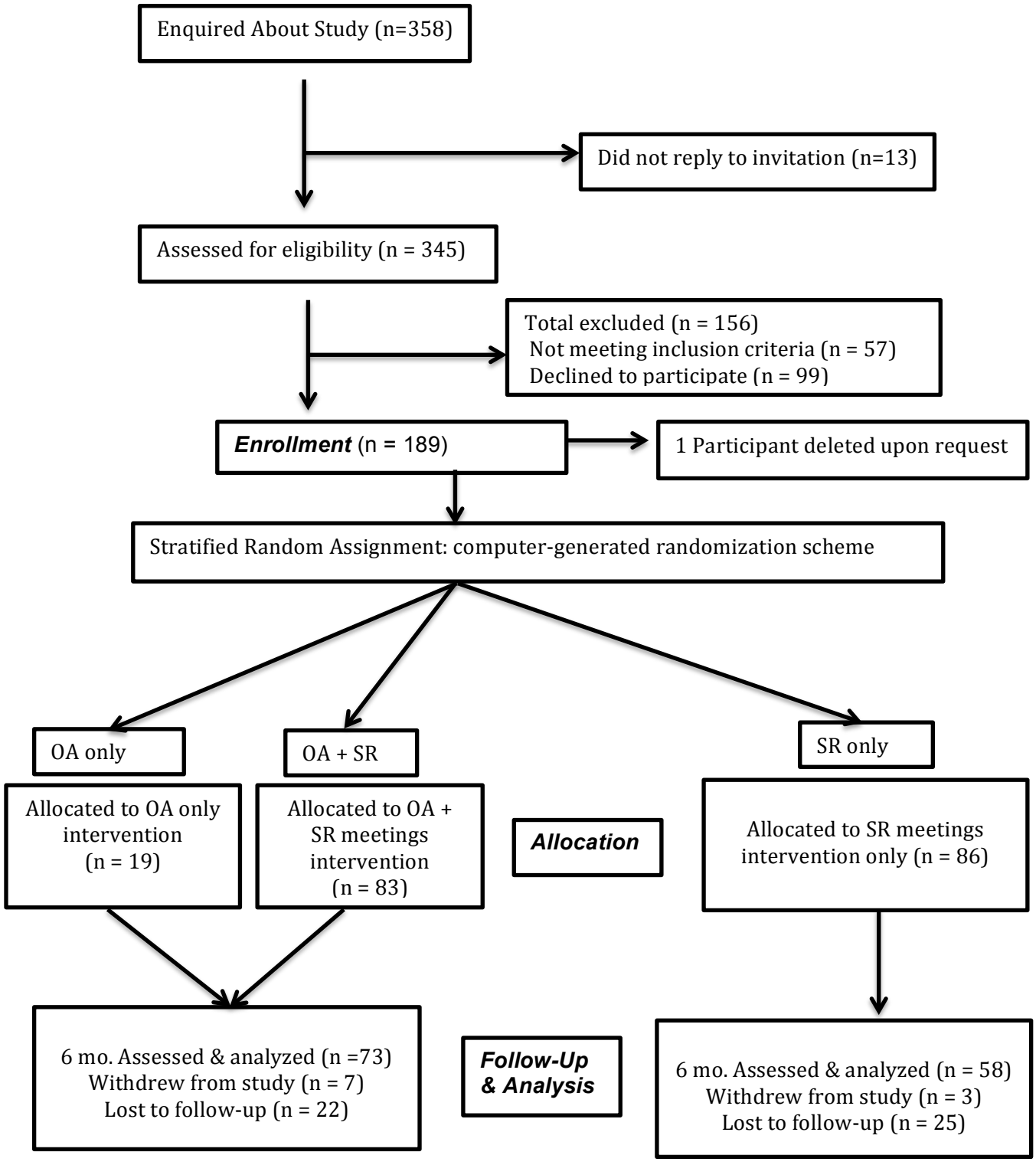

Figure 2. Flowchart of participant flow and follow-up.

The general characteristics of the study participants as a whole and by group assignment are presented in Table 1. It is noteworthy that, on average, the sample endorses clinical levels of psychological and alcohol-related problems. The mean score on the BSI of 17.4 (SD = 12.9) indicates that a majority of participants were struggling with significant depressive, anxious and/or somatic distress at screening. Moreover, mean scores on the AUDIT 24.7 (SD = 8.1), InDuC Lifetime 31.0 (SD = 7.2) and InDuc Recent 41.4 (SD = 17.9) suggest that many individuals in the sample could be recommended for a more extensive diagnostic evaluation for alcohol dependence. Further, the fact that the mean of the recent scores is substantially higher than the lifetime scores suggests that many in the group captured here were experiencing especially severe consequences of their use at the time they entered the study. Also of interest is the fact that the majority of the sample is female (61%), which is unusual relative to reported population statistics of alcohol consumption in the U.S. (SAMHSA, 2013), although not uncommon in clinical trials for CDIs (Riper, et al., 2011). There were no significant differences between groups on any variable. Finally, the sample is remarkably homogenous with regards to race (90% Caucasian).

Table 1. *Participant Characteristics*

Group	Whole Sample	OA Access	SR Only
Participants (%)	188	102 (54%)	86 (46%)
Female (%)	114 (60.6%)	62 (61%)	52 (61%)
Age, *M(SD)*	44.3 (10.9)	45.3 (10.7)	43 (10.6)
Caucasian (%)	170 (90.4%)	94 (92.2%)	76 (88.4%)
Education, *M(SD)*	16.1 (2.4)	17.7 (2.2)	15.9 (2.5)
BSI Total, *M(SD)*	17.4 (12.9)	15.7 (13.1)	19.4 (12.5)
AUDIT, *M(SD)*	24.7 (8.1)	24.6 (8.1)	24.8 (8.1)
InDuC Lifetime, *M(SD)*	31.0 (7.2)	30.8 (6.7)	31.3 (7.7)
InDuC Recent, *M(SD)*	41.4 (17.9)	40.6 (17.1)	42.2 (19.1)

Analysis of Baseline Characteristics of Participants Lost to Follow up

Baseline characteristics of participants assessed at the 6 month follow-up were compared to individuals who were lost to follow-up at 6 months. There were no significant differences detected on age, AUDIT, BSI scores, nor on the outcome variables of InDuC scores, DDD, or PDA. However, there was a significant difference between those who remained in the study and those who dropped out with regards to education level: participants who stayed in the study reported that they had completed more years of education (16.4) relative to those who did not (15.5), t (186) = 2.24, P = .026. This finding is consonant with other findings in research on CDIs for problem alcohol use (Postel, et al., 2011).

Intent-to-Treat Analysis of Hypothesis 1

In order to test for the possible additional benefit of OA, a between subject factor of treatment condition (OA and SR) was established, and separate repeated measures analyses of variance were conducted on the three primary dependent variables (i.e. IDR, PDA and DDD), along the within-subjects factor of time. For each analysis, two contrasts of the within-subject factor of time were conducted to explore two a priori hypotheses: one contrast examined whether change occurred between baseline assessment and time points following treatment, which was defined as an average of follow-up assessment at 3 and 6 months; another contrast examined whether the two follow-up time points differed significantly, so that if the course of change indicated either delayed improvement or deterioration, the effect could be further examined. Table 2 presents the means and standard deviations and within-group effect sizes for each outcome variable for each treatment condition.

Table 2. *Means (and standard deviations) and within-group effect sizes for each outcome variable for each treatment condition.*

Variable & Group		Baseline	3-month f/up	6-month f/up	Change: baseline to average of f/ups	Change: 3 to 6 months	Within group effect size *d* [a]
(PDA)							
	OA+SR (*n* = 73)	42.13 (29.01)	74.03 (30.65)	67.28 (33.64)	28.53	-6.75	.98
	SR only (*n* = 58)	43.26 (29.11)	69.92 (32.43)	72.72 (31.57)	28.06	2.80	.97
(DDD)							
	OA+SR (*n* = 73)	7.64 (4.45)	4.33 (3.70)	5.08 (5.20)	2.56	-0.75	.65
	SR only (*n* = 59)	8.19 (4.61)	4.82 (4.77)	3.99 (4.84)	4.20	0.83	.84
(IDR)							
	OA+SR (*n* = 73)	39.37 (17.43)	19.01 (17.78)	19.88 (21.52)	19.92	-0.87	1.08
	SR only (*n* = 58)	41.25 (19.72)	20.24 (19.50)	19.58 (21.27)	21.01	0.66	1.14

[a] Cohen's *d* for change from baseline to average of 3-month and 6-month follow-ups.

All participants in the study reported highly significant improvement regarding the amount of time they abstained from drinking over the course of the study, $F(2,128) = 78.26$, $P<.001$. Improvement from baseline to the average of the two follow-up assessments was highly significant, $F(1,129) = 154.85$, $P<.001$, and the change from 3 months to 6 months was not, $F(1,129) = 1.09$, $P=.299$. However, when assessing for added benefit of access to OA, while the test of the treatment by time interaction was in fact significant, $F(2,128) = 3.16$, $P=.046$, it was so in the opposite direction of the first hypothesis. That is, tests of interaction contrasts revealed that although individuals in

the both SR and OA made equivalent improvements from baseline to the average of the follow-ups, $F(1,129) = 0.10$, $P=.920$, the change from 3 months to 6 months was significantly different in the two conditions, $F(1,129) = 6.32$, $P = .013$. Results indicate that while SR participants continued improving from the 3 to the 6 month follow-ups, the group with access to OA regressed slightly.

With regards to how many drinks study participants said they were drinking on days they did drink, their outcomes showed a similar pattern as did their rates of abstinence, although the differential effect of treatment-type did not quite reach significance in this case. As with PDA, the improvement within subjects for DDD over time was highly significant, $F(2,129) = 36.88$, $P<.001$, and again the significant improvement occurred between baseline and the average of the follow-ups, $F(1,130) = 72.95$, $P<.001$, with the change from 3 months to 6 months being non-significant overall, $F(1,130) = 0.008$, $P=.928$. While the treatment by time interaction did not quite reach significance, $F(2,129) = 2.53$, $P= 0.083$, and the pattern was for the improvement to be similar in both groups, $F(1,130) = 1.15$, $P=.285$, once again the SR group continued to improve between 3 months and 6 months while the OA group regressed slightly, albeit non-significantly, $F(1,130) = 3.37$, $P= 0.069$.

Finally, we examined changes in study participants' subjective ratings of their alcohol-related problems over the course of the trial. Responses on the InDuC also reflected meaningful improvements for individuals across groups from baseline to an average of the two follow-ups $F(2,129) = 59.96$, $P<.001$, and again the significant improvement occurred between baseline and the average of the follow-ups, $F(1,130) = 120.86$, $P<.001$, with the change from 3 months to 6 months being non-significant

overall, $F(1,130) = 0.004$, $P=.947$. With regards to IDR scores there was no evidence of a treatment effect at all $F(2,129) = 0.20$, $P= 0.821$.

The results of the test of the first hypothesis revealed no added benefit of OA and, further, showed that the group with no access to OA actually had slightly better outcomes on the two drinking variables. On the other hand, it is fair to say that overall, both groups experienced comparable improvements across the course of the clinical trial.

Analysis of Hypothesis 2 – 4

Three sets of analyses were conducted on participants with access to OA in order to explore for the influence of common factors hypothesized to impact the effectiveness of CDIs. For each moderating variable, separate repeated measures analyses of variance were conducted on the three primary dependent variables (i.e. IDR, PDA and DDD) including the between-subject factors of gender and age, since both have been found to moderate CDI use and outcomes in prior research (Linke, et al., 2011; Van Deursen and Van Dijk, 2011; Klein, et al., 2010; Riper, et al., 2008).

The continuous moderating variable of average amount of time on the internet per week was zero-centered. Participants with access to OA reported spending an average of 23.0 (SD 16.8) hours per week on the Internet. Analysis indicated that the impact of participant's facility with the Internet did not significantly impact treatment outcomes, whether PDA $F(2,63) = 1.004$, $P=0.372$, DDD $F(2,63) = 0.983$, $P = 0.38$, or the IDR $F(2,63) = 0.029$, $P = 0.972$.

In order to test for the impact of the user's sense of how easy the site was to navigate and use, responses to three questions asking about that on the exit interview

(Items # 4, 5 and 6) were assessed for shared variance, and a new variable—"ease factor"—was created (that was also z-centered) to test for the impact of this factor. Analysis indicated that participant's ability to navigate the OA site did not significantly impact treatment outcomes, whether PDA $F(2,44) = 0.55$, $P=0.582$, DDD $F(2,44) = 1.21$, $P = 0.31$, or the IDR $F(2,63) = 1.029$, $P = 0.344$.

Interestingly, when time on the internet was entered into the analysis with the ease factor, together they did account for variance on one outcome variable, Percent Days Abstinent: $F(2,42) = 4.10$, $P = .024$. Improvement from baseline to the average of the two follow-up assessments was significant, $F(1,43) = 5.28$, $P=.027$, although the change from 3 months to 6 months was not, $F(1,43) = 2.09$, $P=.155$.

In order to test for the impact of the user's satisfaction with the amount of content on the site, the three possible responses on the exit interview (Item #2: too much, too little, just right) were collapsed into a single, dichotomous variable indicating either a satisfactory or unsatisfactory amount of information. Analysis indicated that participant's satisfaction with the amount of information on the OA site did not significantly impact treatment outcomes, whether PDA $F(2,44) = 0.699$, $P=0.503$, DDD $F(2,44) = 1.06$, $P = 0.34$, or the IDR $F(2,63) = 0.010$, $P = 0.990$. Another interesting finding, although without impact on outcomes, is that the amount of time participants typically spent on the internet correlated negatively with satisfaction with the amount of information available on the site ($r = -.331$, P= .020), indicating that people who are frequently on the internet tended to want more information from OA than was there.

Post Hoc Analysis

Of further interest regarding hypothesis one, beyond whether people with access to OA benefitted therefrom, was what they actually did with that access. Did participants make full use of the intervention, or did they succumb to the "law of attrition"? Again, given the parameters of the clinical trial, as well as the unguided nature of OA itself, users were quite free to use the site as much or as little as they chose to. The first question, then, asked how much people actually used the site and, secondly, whether the people who did use it more exhibit more positive changes in their drinking behaviors.

We had two non-intrusive means for assessing participant use of OA: number of log-ins to the site and number of modules completed. By the three-month follow-up, 59 (71%) of the 83 OA participants had logged onto the site 2 or more times. Although far fewer than the number of visits we envisioned, our prior research has indicated that two visits is sufficient to deliver an effective treatment "dose" (Hester, et al., 2010). Overall, participants logged into the OA program an average of 7.2 times (SD = 6.4). The number of logins to the site declined between the 3 and 6-month follow-ups, to 1.29 (SD =2.8) on average. These figures correspond to the results from our exit interview (Item #9 in appendix 2) in which the majority (44 of 69; 64%) of queried participants reported that they "used the site a lot and first, and then tapered off".

To assess whether there was evidence for an engagement-outcome relationship, the number of sessions users logged in the first 90 days of the clinical trial were correlated with the values of the primary outcome variables at 3 months and with the improvement in those variables from baseline to 3 months. As shown in Table 3, none

of these six correlations were significant, nor were they significant when correlated with outcomes at the 6-month follow-up. However, number of logins to OA during the first three months of the trial did predict positive changes in drinking behavior during the second follow-up period. Specifically, OA logins in the first 90 days after baseline correlated .359 (*P*=.005) with improvement in PDA from three to six months, and .352 (*P*=.006) with improvement in InDUC. This finding was first detected by our research team's statistician, Dr. Harold Delaney.

Table 3. *Correlations between modules completed, number of log-ins and outcomes.*

Variable	**Modules Complete**	**3m Log-ins**	**Total Log-ins**
3m PDA	.663 *r* = .044	.986 *r* = -.002	.645 *r* = -.057
6m PDA	.035* *r* = .263	.174 *r* = .179	.325 *r* = .130
PDA Baseline-3m	.663 *r* = -.052	.552 *r* = -.074	.283 *r* = -.133
PDA 3m-6m	.016* *r* = .297	.005** *r* = .359	.007** *r* = .346
3m DDD	.097 *r* = -.194	.740 *r* = -.041	.815 *r* = -.029
6m DDD	.018* *r* = -.292	.635 *r* = -.063	.646 *r* = -.061
DDD Baseline-3m	.718 *r* = -.043	.553 *r* = .073	.755 *r* = .039
DDD 3m-6m	.160 *r* = .176	.668 *r* = .057	.627 *r* = .065
3m IDR	.584 *r* = -.065	.585 *r* = .067	.537 *r* = .076
6m IDR	.003* *r* = -.362	.096 *r* = -.219	.225 *r* = -.160
IDR Baseline-3m	.159 *r* = -.165	.082 *r* = -.212	.077 *r* = -.216
IDR 3m-6m	.007** *r* = .332	.006** *r* = .352	.026* *r* = .290

We also examined the number of modules completed by participants in the first three months (M = 6.4; SD = 4.3) for a dose-response relationship (see Table 4 for frequencies). As with number of logins to the site, the number of OA modules completed during the first three months of the trial were not predictive of outcomes at 3-month follow-up, but again were predictive of improvement during the subsequent 3 months on PDA (r = .297, P= .016) and InDUC (r = .332, P= .007). In addition, the number of modules completed was associated with final levels on all three dependent variables: PDA, r = .263, P = .035; DDD, r = -.292, P = .018; and InDUC, r = -.362, P = .003.

Table 4. *Number of Modules Completed By Participants*

Number Completed	Participants Completing
0	5
1	7
2	4
3	10
4	10
5	11
6	4
7	8
8	8
9	3
10	5
11	3
12	4
13	2
14	3
15	2
16	3

With regard to how participants with access to OA responded to the structure, complexity and helpfulness of the site, several responses are of interest in the exit interview. There was reasonable variability in how participants rated OA's ease of use as well as its helpfulness (as demonstrated in responses to questions #1, 4, 5, 6 and 7; see appendix 2). At the same time, participants' ratings of the OA's helpfulness (question #7) correlated significantly with their ratings of how easy the site was to use (question #6: .049, r = .283), and even more so with their reported sense of whether the structure of the site provided a sense of how to progress through the site's content (question #5: .011, r = -.325).

There were roughly 20-23 participants at the six month follow-up who, although reporting little use of or benefit from the site (one aspect of the "law of attrition"), nevertheless stayed in the clinical trial to the end. This finding indicates that there is no direct correspondence between the two aspects of that law, which in turn suggests that perhaps two distinct laws ought to be devised to account for these effects; one for the attrition and another for lack of engagement.

When we examined the interventions to which participants attributed their behavioral changes (see Table 5), we found that they went far afield of the interventions offered within the clinical trial. For these data, participants were constrained to pick one factor that was "most helpful" to their process of change, but could report as many other factors as they chose regarding other perceived levels of helpfulness. While many did credit the interventions offered (OA and SR), even more gave primary credit to other factors, including some not specifically mentioned in the questionnaire (the top five are reported in Table 6). While this phenomena is certainly not unique to online

clinical trials, one cannot help but wonder if the relatively remote nature of the interventions tested here did not contribute to this finding.

Table 5. *Participants' attribution to factors that helped them make changes to their drinking.*

Treatment or influence	OA SR	Most Helpful	Very Helpful	Some Help	No Help	Total Positive
SMART Face to Face	OA	7	12	3	43	22
	SR	8	5	2	41	15
SMART Online	OA	2	16	8	41	26
	SR	13	17	3	42	33
Overcoming Addictions	OA	14	19	15	20	48
Alcoholics Anonymous	OA	3	5	1	6	9
	SR	1	7	0	1	8
Other Treatment Program	OA	3	2	2	0	7
	SR	2	3	0	1	5
Personal Therapist	OA	4	7	2	1	13
	SR	6	7	3	0	16
Self Determination	OA	20	4	1	0	25
	SR	11	8	0	1	19
Some other factor	OA	12	12	8	1	25

Table 6. *Other factors cited has "most" or "very" helpful.*

Treatment or influence	OA SR	Number citing
Social Support	OA	13
	SR	10
Changed thinking or awareness	OA	10
	SR	7
Joining the RCT	OA	7
	SR	3
Medication	OA	3
	SR	5
"Just did it"	OA	2
	SR	5

Discussion

The primary analysis sought to determine whether individuals afforded access to OA would reduce their drinking and alcohol related consequences more than those individuals who did not have that access. All participants in this randomized clinical trial improved on outcomes that are important to recovery from problem drinking. Participants significantly increased their percent days abstinent per week, significantly reduced the number of drinks they consumed on the days when they did drink, and experienced a concomitant reduction in alcohol related problems. These results are both statistically significant and clinically significant, which is good news for both the participants in the study as well as for OA and SR, especially given the severity of these individuals' problems at baseline.

In general, participants made much less use of the interventions on OA than we imagined they would when we designed the site. The intervention often did not engage participants, and many sought help elsewhere. Several individuals in the study made what could be at best described as a cursory glance at the site, and most used fewer than half of the modules available to them. This pattern of use looks every bit like the "law of attrition". Given this sparse attention, it is perhaps unsurprising that OA failed to provide an additive benefit over and above SR. Nonetheless, we did detect evidence of a sleeper effect, through which people who actually did make more use of the site reported increasing numbers of days without drinking and a possibly not unrelated reduction in drinking-related problems through the latter half of the trial.

Evidence for the impact of variables thought to moderate the effectiveness of OA was scant, at best. None of the identified factors exhibited any influence when

considered singly, although there was mild evidence to suggest that individuals with more internet experience, who therefore found the site easier to navigate, actually did benefit more from it, in that they reduced the numbers of days they drank relative to participants who struggled more to find their way around the site. Perhaps not unrelatedly, individuals who reported spending more time on the internet also expressed a desire for more information on the site. Combined with the relatively high level of education reported by participants in the study, an impression of OA suggests itself: people most likely to benefit from the site were individuals who are comfortable foraging for information on the web, and when these individuals find a source they trust, they want more from it. Other studies have found that more highly educated individuals are slightly more likely to benefit from CDIs, as well as to be less susceptible to the Law of Attrition (Postel, et al., 2011). Further, researchers have found that more educated individuals tend to problem solve more persistently and effectively when confronted with navigational challenges on websites (Van Deursen and Van Dijk, 2011). Still, given the weakness of the effect found here for moderating factors, drawing such conclusions constitutes more of a tentative conjecture than it does a solid finding. The fact is, we know as little about what people actually do with computer-delivered interventions as we do about the explosion of Internet-based human activity in general, and the ways it is shaping how we live, think, change and evolve.

The issue of Internet as context for consciousness is of course the stuff of modern mythos making, but such human activity has realities that directly ramify upon the field of CDIs. Wellman (2002; Wellman, et al., 2003) coined the phrase “networked individual” to describe the kind of “person” emerging from the interstice of social

connectedness and information accessibility that characterizes the Internet. He describes this theoretical person as more self-directed in their information foraging, on one hand, and yet more reliant at the same time on an amorphous and abstracted feedback and response consensus than on traditional notions of authority (Dutton, 2006; Wellman, 2002; Wellman, et al., 2003). Further, the environment in which the foraging occurs constitutes an "ecosystem of interruption technologies" (Doctorow, 2009) in which "our attachment to any one text becomes more tenuous, more provisional" (Carr, 2010). Immersion in this environment gives rise to a multi-tasking individual who frequently exhibits a "continual partial attention" that may be more aware of the remote and extended social network it is connected to through digital technology than it is to its actual, physical environment. From a cultural perspective, as the depth of the novel is usurped by the breadth of an infinite web, calm reflective thought is supplanted by a state of distraction in available associations (Carr, 2010). The pervasive and abstracted nature of this awareness creates an "absent presence" in people that cultural critics contend limits the quality of one's focus and ability to deliberate over complex ideas (Carr, 2010; Rainie, 2009). This development surely impacts the realm of psychotherapy and behavior change in ways that interventions developed long-before the Internet's existence have yet to adapt to. Perhaps most pressing to the development of CDIs is the fact that the very form of the Internet is designed to pull our attention in multiple directions, and away from the site we are currently on (Carr, 2010). Simply put, CDIs are embedded in a context that facilitates resistance to intervention components. This hardly makes for optimal treatment

conditions, particularly when the intent is to alter a behavioral repertoire as intractable (and stimulus seeking) as addiction.

Put another way, when an individual encounters an intervention on the Internet, they likely treat it like they do everything else thereon: as one plausible resource in a boundless ocean of possible resources that continually beckons us to its horizon. CDIs do not yet have the means to create the context for change that traditional therapy does. Given this, it may be worth reconsidering the remonstrations of researchers who argue that CDIs need to be tested entirely online in order to secure external validity. Whatever the effect of the assessment reactivity incurred by interaction with researchers, that influence does not interpose itself upon a "pure environment" in which only the participant and the intervention exist. It was clear, when asking participants about what they did to change their drinking behavior over the course of the trial, that they lived busy, active lives in which a few more or less clinically serious change strategies were not more salient than conversations with friends, a shelf of self-help books, a Sunday sermon, or a dream about a scolding mother. When considering this diverse and diffuse context for change, from which the fabric of the Internet itself seems to be spun, it's rather hard to believe that a couple of phone calls from a researcher are going to impart any significantly deleterious effect on the march of science. Given the fact that more research needs to be done in order to better understand how these interventions are approached, and how they are in fact engaged with, it seems premature to limit researcher's contact with the individuals who are using them.

Limitations

Apart from the usual lament about the lack of power to detect significant effects (here attributable to both attrition from the trial as well as the limited engagement with the intervention demonstrated by participants who remained in it), this study has crucial limitations. Chiefly, when analyzing variables thought to moderate outcomes (e.g. participant characteristics), the ideal method would be to assess them directly prior to beginning the process they are thought to influence. Our post hoc assessment, while acceptable given the lack of a feasible alternatives, was likely mediated by the participants' recollection of the site. One can't help but wonder whether a follow-up coming closer on the heels of the participant's disengagement from the site might not have yielded more vivid recollections of what it was like for individuals to use it. Further, given the exploratory nature of this study, it was unclear whether the constructs we intended to tap were in fact done so with as great a precision as might be hoped. There may be better questions to probe how participants' use of the site interacted with their engagement with the interventions it conveyed. Indeed, this question lies at the vanishing point where the development of, and research into, the next generation of these interventions converge.

Future Research

The results of this study did influence the subsequent development of OA. Given participant feedback via the exit interview, elements were added to facilitate navigation through the site. Even though navigation was not found to impact outcomes, anecdotal feedback from participants, as well as their low uptake of the intervention, motivated us to revise the site. We developed an automated guided program that sends users an

email each week in which a link is embedded. The email briefly describes the week's "lesson," and the link takes them directly to it after first allowing them to enter their urge data for the week. We also added linked summary statements in the headers of each module, and more "tunneling" within the site. Finally, we created a new intervention that combines OA with *The Drinker's Check-up*, an empirically supported assessment and feedback module that is designed to increase potential users' motivation for engaging the OA program.

Future research will likely pursue two primary routes to advance these interventions. One involves the deployment of ecological momentary assessment and analysis (facilitated by the incipient boom in "wearable" technology) to gather data *in situ* and to provide stimuli (e.g. assessment feedback data, pre-programmed motivational texts) to trigger alternative behaviors to drinking while the user of the intervention is still in those contexts. Such innovations hold the promise to increase both engagement with and the salience of intervention components. We will be developing just such a grant in the next phase of our research.

Another promising line of research, with benefits further out in time than those pertaining to wearable technology, will expand the ability of a website to be tailored to individual user characteristics. This tailoring will not only be responsive to user traits (e.g. preference for level of complexity; visual or textual style of learning) but will also as proactively adapt itself to user states and proclivities (e.g. stage of recovery or relapse; mood) in the course of its use. This "machine learning" technology will literally present a different site to every user, depending on their own profile, and will also alter its functions depending on where the user is in relation to their treatment goals. Mohr

notes tailoring "has generally relied on predetermined criteria to adapt the form of interventions; however, it is also possible to use machine learning methods that can learn from population or individual user data to automatically adapt the form of the interventions to meet the user's needs and characteristics" (Mohr, et al., 2014). With this innovation, the first rampart of client resistance will be breached; combined with the imminent changes in technology interface (i.e. wearables), future innovations have the potential to meet users responsively, in the context in which problem behaviors occur.

Finally, another way of thinking about CDIs becomes available to us if we broaden the frame of the treatment to consider everything that people are, beyond the behaviors they wish to change. The principle of coherence notwithstanding, feedback from study participants suggests that in order for a CDI to attract and retain users' attention, it must be able to compete for significance with all of the other stimuli on the Internet with which it exists, cheek to jowl. One method that has been explored, for example, is the incorporation of social media into the functions of CDIs, although this has yet to consistently exhibit positive treatment effects (Mohr, et al., 2013). Another possible means, as yet unexplored, involves embedding the intervention in a site that contains elements of general interest to the user. These elements could be predefined by the user, or could be provided adaptively by tracking the users activity on the web. Further, these elements could then be framed with related clinical findings (e.g. the impact of addiction and recovery on relationships; findings on individuals who have struggled with impulse control; research into spirituality and recovery) and refreshed

on a regular basis so that users would be continually able to adapt intervention components to the ongoing changes in other areas of their lives.

Summary

Computer-delivered interventions for alcohol misuse are not as unfamiliar as they once were, but a decade of intensive research and development has left many questions about their effectiveness unanswered. The adaptation of existing treatments to this relatively new mode of delivery is complicated by both the pace and dispersion of technological innovation, as well as human-user adaptation to those innovations.

This study found evidence of a positive treatment effect for the CDI *Overcoming Addictions*. The evidence did not detect an added benefit of *OA* over the existing intervention upon which it is based, in that it neither clearly surpassed nor enhanced the effectiveness of "traditional" SMART Recovery treatment. There was however strong evidence to show that *OA* serves as a feasible alternative to *SR*, and as a CDI it entails the advantages of access, reach and cost-effectiveness. Although this study made little headway into understanding factors hypothesized to influence the effectiveness of CDIs, our data suggests that further research and development of their "operational" or "peripheral" aspects is warranted. Given the low adherence to the treatment found in this study, which is typical for the field, it is crucial to better understand factors that promote engagement with the treatment's content. Just as with traditional therapy, these "common factors" of computer interventions hold the keys to their clinical success.

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Appendices

Appendix 1. Six-Month Exit Interview

1. Which of the following treatments have contributed to positive improvements in your drinking over the last 6 months? (Check all that apply and rank from most to least helpful:

Smart Recovery meetings, in person:
Smart Recovery meetings, on-line:
(When applicable) Overcoming Addictions website:
AA
Other Treatment Program
Therapist
Self
Other (please specify)

2. How much time do you spend on the Internet per week:

At work:
At home:
Elsewhere:
Total:

3. Which component of Smart Recovery was most helpful to you?

4. Was there any component of Smart Recovery that you did not like?

<u>Questions for participants with access to the OA program:</u>

1.) Overall, how helpful was the content (information, exercises, etc.) of the website?

1 2 3 4 5 6 7

2.) What do you think about the amount of information in the program?

a.) about right
b.) too much
c.) would have liked more

3.) What do you think of giving users the option to see more or less of the content on pages with a lot of information (like you see on review sites like tripadvisor or yelp)?

a.) would be a good idea
b.) not necessary
c.) people might miss something

4.) How easy or difficult was it to navigate around the site?

a.) easy
b.) not easy but manageable
c.) confusing

5.) Did you feel the structure of the site gave you a clear sense of how to progress through the Smart Recovery program's content?

a.) went from one thing to the next, no problem
b.) was sometimes unsure, but it wasn't a problem
c.) had no idea what I was supposed to be doing

6.) Overall, how easy was the website to use?

1 2 3 4 5 6 7

7.) How helpful was the website over all in supporting changes in your drinking?

1 2 3 4 5 6 7

8.) Did you rely more on the website or meetings to learn Smart Recovery?

OA meetings both

9.) How would you characterize your use of the website?

Used it regularly throughout the six months
A lot at first, then tapered off
On and off, depending
Checked it out, never used it
Never really got around to it

10.) What were the most helpful elements of the website for you?

11.) Was there any part of the website you didn't like?

12.) Do you have any recommendations on how to improve the site?

Appendix 2. Exit Interview Responses

Item #1 Content Helpful
(1=Not at All; 7=Very)

Rating	Number Endorsing
1	4
2	4
3	2
4	9
5	13
6	15
7	14

Item # 2 Did the site have the right amount of content?

Rating	Number Endorsing
Right Amount	26
Too Much	4
Too Little	19

Item #4 How easy was it to navigate the site?

Rating	Number Endorsing
Easy	31
Manageable	12
Confusing	6

Item #5 Did the structure of the site give you a sense of how to progress through the content?

Rating	Number Endorsing
Went easily from on thing to the next	34
Sometimes unsure, bit it wasn't a problem	19
Uncertain about what I was supposed to do	7

Item # 6 Site Easy
(1=Not at All; 7=Very)

Rating	Number Endorsing
1	0
2	2
3	3
4	6
5	12
6	14
7	12

Item # 7 Site Helpful
(1=Not at All; 7=Very)

Rating	Number Endorsing
1	17
2	6
3	4
4	5
5	12
6	14
7	10

Item #8 What resource did you utilize to learn SMART Recovery?

Source	Number Endorsing
From OA	35
From SR on-line or in-person	19
Both	13

Item #9 How would you characterize your use of the site?

Manner of Use	Number Endorsing
Regular	2
A lot at first, then stopped	44
On and Off	3
Checked it out, never followed up	13
Never used it	7