Innovation in Weight Loss Intervention Programs:
An Examination of a 3D Virtual World Approach

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Abstract

Obesity is a costly condition that can reduce quality of life and increase the risk for many serious chronic diseases and premature death. The rising rates, high prevalence, and adverse consequences of obesity call for the development and testing of new and innovative approaches that address weight loss barriers and bring help to those most affected by obesity. In this article, we examine the effectiveness of a 12-week behavioral-based weight loss program delivered via a 3D virtual world, Club One Island™ (COI) in Linden Lab’s Second Life. Intervention design was informed by social cognitive theory and emerging research on avatar identification and the Proteus Effect. Our results offer strong preliminary evidence that not only can a 3D VW-based program be as effective as a content similar in-person intervention relative to positive biometric changes, but it may serve as a more effective platform to influence meaningful behavioral changes and increased self-efficacy.

1. Introduction

From the US Surgeon General’s call to action to prevent overweight and obesity and Michelle Obama’s childhood anti-obesity campaign, health discourse is increasingly focused on obesity as one of the most significant health concerns in the United States (US). The Centers for Disease Control (CDC) statistics have found a marked increase in obesity over the last two decades with rates doubling for adults and tripling for children and adolescents (2-19 years old). In the US, approximately two-thirds of adults and nearly one-third of children and adolescents are either overweight or obese [15]. Obesity is a costly condition that can reduce quality of life and increase the risk for many serious chronic diseases (e.g., cardiovascular disease) and premature death. Strongly related to overweight and obesity, according to the National Diabetes Information Clearinghouse¹, nearly 26 million US adults have diabetes with an additional 79 million exhibiting pre-diabetes. These conditions are 16% more prevalent in rural areas than in urban ones [22].

Treatment and prevention strategies for obesity include appropriate food intake and nutrition relative to weight loss or maintenance, physical activity, and improved sleep. Regular exercise, for example, is known to lower the risks and symptoms of obesity and is consistently associated with reduced weight maintenance [12]. However, only 15% of US adults get enough regular exercise to receive health-related benefits and only 30% of those trying to lose weight meet national (e.g., National Institutes of Health, Institute of Medicine) recommendations for exercise [24]. Often cited barriers to exercise include a lack of motivation, social support, and an inability to self-monitor progress [29]. While joining a health/fitness club (one recommendation by the CDC) may be an option for some adults, it may be cost prohibitive or inconvenient, and/or intimidating for others particularly those who are overweight or obese [24]. In addition to these barriers, the application of often complex nutrition and lifestyle information, educational skills, as well as socioeconomic and psychosocial factors make the adoption of recommended behaviors and strategies challenging [32].

Traditionally, interventions have been face-to-face (FtF) programming either in the community, commercial or clinical setting. Over the last 15 years, Internet-based programming (e.g., online self-help, educational and diagnostic offerings) has emerged, although most are designed to inform and not necessarily elicit permanent behavior change [26][27][8]. Yet, the rising rates, high prevalence, and adverse consequences of obesity call for the development and testing of new and innovative approaches that address barriers and bring needed help to those most affected by overweight and obesity [14][26]. One such innovation is the application of

¹ http://diabetes.niddk.nih.gov/populations/index.htm
three dimensional (3D) virtual reality (VR) technologies – here, more specifically 3D virtual worlds (VWs) accessed via a computer/monitor and navigated using inexpensive computer mice – as a tool to produce behavior change to manage weight. A VW may be defined as a computer simulated space where users (via digital representations known as avatars) can meet and interact with others and with the content of the virtual environment. In essence, VWs combine ideas from VR with the connectivity and peer support offered by (2D) social networks [26]. While a nascent research area, by offering unique affordances as a platform for behavioral intervention programs, VWs may lead to more positive outcomes than FtF and/or web-based 2D interventions.

In this article, we examine the effectiveness of a 12-week behavioral-based weight loss program delivered on Club One Island™ (COI) in Linden Lab’s Second Life. COI is part of Club One Inc., a national company focused on fitness and wellness solutions including commercial health clubs and managed corporate and community fitness centers. Launched in 2003, Second Life is a widely used 3D space for many different purposes across business, educational, and government sectors [1]. We compare the effectiveness of COI-based intervention to a structurally and content similar FtF one. In the following, we discuss the relevant literature and consider the unique affordances of emerging 3D VWs. We then describe the design of COI and the weight loss program and our methods. Finally, we conclude with a discussion of our results and implications for future research.

2. Background

2.1 Prior intervention research

It is essential to identify effective, engaging and cost efficient means to combat overweight and obesity. As little as a 5-10% reduction in initial body weight can diminish the risk for the chronic diseases associated with it (e.g., coronary heart disease, type 2 diabetes) [20]. While there are a variety of means to achieve weight loss, one intervention is a weight loss program, many of which are informed by the work of behavioral and social scientists who have established models and theories in an effort to understand behavior. As noted earlier, FtF delivery is common and, more recently, Internet-based – “2D web” – programming has emerged [33][41]. This emergence is not surprising given that, as of 2010, Internet use has reached 79% of all US adults (Pew Internet & American Life Project). 2D web offerings may help participants address many of the challenges of FtF programming, including location neutral access, convenience, and lower cost (c.f.,[17][28][34]). Moreover, for those who find FtF programming intimidating, technology-based programs can offer some, if not complete, anonymity.

A meta-analysis by Neve et al. [27] examined eighteen 2D web interventions. The authors’ results suggest that they can be as effective as FtF interventions – however, the intervention must include a behavioral change component and not simply be educational or diagnostic. The importance of behavioral change and improving self-efficacy (i.e., one’s confidence in his/her ability to perform a specific behavior) in FtF weight loss interventions is well established (c.f., [5][21][39]). The basic premise is that changing daily habits and behaviors relating to diet, nutrition, social support, and exercise are necessary for weight loss and management [6]. Main components include restructuring an individual’s environment to control stimuli that lead to overeating, employing self-monitoring techniques to record food intake and physical activity, using cognitive restructuring to change internal dialogue undermining weight loss, and teaching stress reduction techniques. Emphasis is also put on the importance of positive social support and increasing physical activity. Berkel et al. [5] suggest that nutrition education and guidelines for physical activity are also keys to behavioral change.

Despite established effectiveness, inconsistency remains in how to meaningfully make use of behavioral change and self-efficacy improvement, particularly in 2D web programs. Open questions remain as to what elements (e.g., social interaction) are needed to support the behavioral change component. For example, prior research [35][36] suggests effectiveness is increased when interaction with a health care professional is included. However, while 2D web interventions often provide interaction tools (e.g., message boards, e-mails, and chat rooms) few studies have examined the importance of interaction and support, particularly among participants. Hwang et al. [19] found that participants of the online weight loss community “SparkPeople” used the website’s discussion forums to receive motivation, encouragement, general weight loss information, and share personal stories. Participants felt interactions were convenient, anonymous, non-judgmental, and reciprocal. While this study examined an online weight loss community and not a weight loss intervention per
se, it has implications for the extent to which social support and interaction can play a meaningful role.

2.2 Perspectives on behavioral change

Insights from research on FtF and 2D web-based weight loss interventions continue to emerge. Behavioral and social scientists have established theories and conceptual models in an effort to understand and evaluate health behaviors and enable the design of effective interventions. Social cognitive theory (SCT) proposes that personal, behavioral, and environmental factors operate as reciprocal interacting determinants of behavior [2]. These factors do not affect human behavior directly; rather, they affect it to the degree that they influence individual goals, self-efficacy, emotional states, and other self-regulatory processes. Interventions informed by SCT focus on the importance of the individual’s ability to control his/her own behavior and examine how changes in the individual, the environment, or both can produce changes in behavior. A key precept in SCT is self-efficacy which describes an individual’s confidence in their abilities to perform a specific behavior. One’s sense of self-efficacy about a behavior and perceived ability to cope with and control situations have been shown to be core determinants of health behavior change (e.g., healthy eating, physical activity adoption) [37]. An individual with high self-efficacy will perceive fewer barriers and be more likely to act (pursue goals) on their expectations of desired outcomes (outcome expectancy). Thus, key elements of a SCT-based intervention include goal-setting, self-monitoring, direct reinforcement, and engaging in problem-solving [3].

Importantly, as noted earlier, opportunities for interaction and social support are also important. Specifically, individuals are influenced by the behaviors of those in their social network. For example, the adoption of a particular health behavior by others in a community may influence the adoption of specific behaviors by an individual. Christakis and Fowler [10] found that the spread of obesity within social networks occurred in a predictable pattern, thus suggesting that this network phenomenon may be useful when striving to spread positive health behaviors. Social support that promotes positive health behaviors can be delivered through several channels, including emotional (encouragement and acceptance) and informational (advice or knowledge) [38]. Within this context, social support helps create a learning environment which provides a context for behavior and contributes to feelings of self-efficacy.

Weight loss interventions may also benefit from advances in understanding of how people learn. Straumanis [32] describes elements of effective learning environments: make the environment intrinsically rewarding (i.e., interesting, entertaining, as well as “productive of confidence, self-worth, and self-education”); provide plenty of social interaction; and, ensure engagement through active learning. While research on the use of social media for learning is limited, early indicators appear positive and evidence suggests that simulated experiences (e.g., games, virtual reality/virtual worlds) can help develop self-efficacy [31]. In fact, weight loss interventions should take advantage of the reality that participatory media (e.g., mobile/online games, social media) are components of the lives of many people.

By integrating an increased understanding of behavioral learning with innovative technologies, behavioral change may be further influenced. Clearly 2D technologies have helped overcome many challenges (e.g., access) associated with FtF interventions. However, 2D experiences have always been considered to be missing some important aspect of human interaction. In contrast, 3D virtual worlds offer unique affordances for behavioral intervention. In the next section, we discuss their potential as platforms for weight loss intervention programs, noting the affordances not previously available.

3. 3D Virtual worlds: New affordances

VWs grew from virtual reality technologies, but possess key differences. VWs are persistent (i.e., they continue to exist event when users are not logged in) and, as multi-user spaces, they are social in nature [25]. They are enabled by computer simulation technologies that model or parallel the real world, providing a locus for interaction. In a VW, participants act within the space generated by the computer. Thus, users have agency in the VW, most often through the use of an avatar (a digital representation of self) [4]. One’s avatar can be customized to portray self-image (actual or desired). In principle, users experience (varying degrees of) presence in the simulated virtual world. Presence is often described as the feeling of “being there” in the virtual place rather than in the physical space where one’s body is really located (c.f., [13]). And, the notion of “being there” is enhanced by the possibility of acting or “doing there” [43].

Importantly, with the ability to customize one’s avatar-self and use it to interact with others, VWs offer a new way to assert one’s embodied subjectivity. Early research suggests that it is avatar identification that matters so significantly for identity and behavior modification. Relevant to behavior change is research that suggests users transfer understanding of their avatar’s behavior to their own real-world behavior. The
effect of one’s VW experience on one’s being in the physical world has been coined the “Proteus Effect” [42]. It is a concept routed in both Human Computer Interaction and Social Psychology and it relates directly to SCT, discussed earlier. That is, an individual’s perceptions, actions and beliefs are affected by observations of the behaviors of others, particularly those who are perceived as being similar—in this case, an individual’s avatar embodiment [16]. For example, participants were exposed to either a Virtual Representation of Self (VRS) running on a treadmill, a Virtual Representation of an Other (VRO) running, or a VRS loitering. 24 hours after the experiment, follow-up surveys revealed that participants in the VRS-running condition reported significantly higher levels of physical activity than those in the other two conditions.

Given this, there is considerable potential for a VW as an intervention platform to facilitate behavioral change as users witness their avatars participating in behaviors (e.g., eating, physical activity) that contribute to weight loss and management. Thus, we pose the following questions:

**Q1.** Can a 3D VW-based weight loss program be effective as an obesity intervention?

**Q2.** How do outcomes (biometric, behavior change) compare with those of a FtF program?

In the next section we describe the context of our study before turning to our methodology.

### 4. Study context: Club One Island™

A leading company in the fitness club industry, Club One Inc. sought an innovative way to expand its market and update its current business model. Over the last two decades, while the number of commercial fitness companies increased substantially, the percentage of US adults using such clubs remained fairly constant (approximately 20%) as did attrition rates (35-40%). Thus, more competitors were vying for approximately the same number of potential customers available 20 years ago. Upon consideration of its business model, Club One concluded its model underserved those who were 30 and older, with a history of lifetime overweight or obesity, and who may have physical limitations. Lastly, a fitness club was not the solution for those with geographic, transportation, or physical limitations.

In response, Club One set forth to design an innovative and scalable digital environment that could address weight loss, incorporate non-traditional educational mechanisms, and address cited barriers. The result is *Club One Island™* (COI), an interactive weight loss community in the online 3D VW of *Second Life*. COI offers a way to provide service to a number of possible markets, including consumer level (the focus of this article), as well as corporate/business worksite health and fitness programs.

COI can be divided into two main, albeit interrelated, design elements: *program design and island* design. Both were informed by social cognitive theory (SCT), concepts from gaming, prior research on weight loss interventions, and emerging research on avatar identification and the Proteus Effect. Through the use of questionnaires, interviews, and focus groups data was collected from the targeted consumer base and professionals to identify a list of weight loss related challenges and barriers. Consistent with published research, these include (among others): educational needs as related to nutrition, activity, and behavior change; discomfort with a club environment; body image issues; emotional eating; lack of self-efficacy as related to both physical activity and eating; and, a lack of support and access (instructors, peer, and/or group).

#### 4.1 Program design

Broadly, COI provides individuals with a professional team, education, and specialized tools to help them overcome their individual barriers to weight loss. Access to educational components and specialized tools is 24/7, along with VW and e-mail access to instructors. The weight loss program was designed to move participants from a diet and exercise cycle of weight loss and gain to a view that they are on a healthy life path that does not have a stop and end date, but is maintainable for the rest of their lives. A key premise driving the program was that the words and concepts of “diet” and “exercise” were counterproductive. The word and the concepts of diet and dieting were replaced with identifying and working on a nutritional plan. Similarly, exercise and exercising were replaced with identifying and working to increase movement and play.

The 12-week fitness weight loss program consists of 4 hours/week of instructor-led class time in cohorts of 15-20 participants. The classes (*Nutrition, Movement, Healthy Habits, and Support Group*) are taught by certified fitness, nutrition, and support professionals. Each week is designed to address a common theme (e.g., emotion as related to eating, movement, and behavior) across all 4 classes. While seemingly a big time commitment for participants, the designers felt 4 hours/week was necessary to derive benefits from avatar identification and the Proteus Effect.

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3 For more information, please see: http://www.cluboneisland.com/ and SLURL://ClubOne%20Living%20West/221/138/25

4 An island is virtual land which entities can build on and customize.
Participants are also free to use island resources at any time outside of class sessions.

Participants can choose how their avatar looks – as they are today or as they hope to become. The Nutrition, Movement and Healthy Habits classes were all designed in such a way that the participant is always moving. For example, participants in any given Movement session are engaged in 1 to 4 different activities, ranging from roller skating to surf boarding to riding bicycles, to swimming and more. Similarly, when engaged in the Nutrition and Healthy Habits classes, participants spend 90% of their class time in (virtual) standing and moving positions. When proceeding from one activity to the next they run, bike, roller skate, etc. to get there. These program design elements are intended to encourage avatar identification, leading to the transfer of virtual behaviors to the physical world.

4.2 Island design

Tightly integrated with the goals of the weight loss program, COI was designed to be visually and functionally engaging. It offers highly interactive 3D spaces (e.g., restaurant, “Mini-Mart” convenience store, encouragement room, etc.), creative educational tools (e.g., nutritional jeopardy game, fire pit to illustrate how the body uses food as fuel), over 30 movement activities (e.g., bikes and bike paths, surfing, exercise balls, lap swim, etc.), as well as numerous healthy habits tools (e.g., tracking charts). All design elements are intended to engage participants in social networking, play, and ultimately learning. For example, the restaurant area was designed for use as a practice area for nutrition planning. It has an interactive menu that displays a full selection of items that a participant might encounter during a restaurant outing. The menu works on a stop-light (red, yellow, green) model and participants are asked to choose what they believe are the healthiest choices. The menu responds to their selection with the color appropriate to their selection and an explanation as to why this menu item was ranked at that particular color as well as ways to make the item healthier. Topics discussed are hidden calories, eating out, and portion control. The restaurant area also includes an ice cream counter, dining tables, a dessert bar, and bar area.

Overall, COI was designed to provide an environment that closely mirrors the physical world, and by setting up learning situations that incorporate practicing new behaviors (e.g., throwing away 3D food, addressing the “food-pushers” and non-supportive people in their lives, doing any physical activity in public etc.), help participants overcome their fears as it relates to weight loss.

Figure 1 illustrates available activities and Figure 2 provides a snapshot of the island and participants using the restaurant area.

Figure 1. Examples of program activities

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5. Methodology

5.1 Subjects

To explore our questions, we conducted a study of COI’s 12-week weight loss program and Club One’s content equivalent FtF program. The COI program involved 38 participants recruited via print and online media (e.g., San Francisco Examiner, Craigslist). Participants had to be over the age of 18, needed to lose 20 or more pounds, and needed access to a computer (capable of running the Second Life client viewer) and high-speed Internet. They were told they were helping to assess a new program and, as such, it was free. Of the 38 enrollees, 1 was a current Club One member, 9 were members of competing clubs, and 28 did not currently belong to any club. Concurrently, since the comparison FtF group had to attend a real facility, the cohort of 25 participants was recruited from Club One’s member base (via emails and newsletters). Like those in the COI program, they needed to lose 20 or more pounds. Across all 63 enrollees, they had on average previously tried 2 other weight loss programs. Prior to the start of the COI program, participants received training and support (e.g., setting up the client, navigating the island, etc.).

Procedurally, participants in both groups agreed to have body composition data (e.g., weight) collected at beginning and end of the program. For COI members, this meant visiting a real facility on two occasions. In addition, participants agreed to complete pre- and post-surveys.

5.2 Measures

Both objective and self-report measures were captured at baseline (pre-program) and within one week of program completion. Objective data included height, weight, body mass index (BMI). We calculated the % change in baseline weight; a reduction of 5% or more of baseline weight results in clinically significant health benefits [18].

The baseline and post-surveys captured data regarding health-related behaviors (i.e., general health, sleep, and degree of moderate and vigorous physical activity) and nutrition/eating habits (i.e., frequency of breakfast, number of servings of fruit and vegetables/day). These items were adapted from the CDC’s Behavioral Risk Factor Surveillance System Survey [9]. In addition, self-efficacy with regard to both physical activity and weight management were captured. Items were drawn from the Physical Activity Confidence Scale [23] and the Weight Efficacy Life-Style (WEL) Questionnaire [11]. In addition to demographic data, the pre-survey asked questions about attitudes towards exercising at a club with items adapted from Miller et al.[24]. COI participants were also asked questions about their prior experience with Second Life and, on the post-survey, some questions about their perceptions of the 3D virtual environment. Lastly, COI participants were given an opportunity to offer open-ended responses about the experience.

6. Analysis and results

Regarding our surveys, all construct reliabilities exceeded .70. While not shared here due to space limitations, specific items, constructs with reliabilities, and factor analytic results are available, upon request. The analyses tested for group (COI, FtF) differences in baseline characteristics using a multivariate analysis of variance (MANOVA). A repeated measures multivariate analysis (MANOVA) was utilized to detect group differences, within subject differences
(time), and interactions (group x time) in measured outcomes from baseline to post intervention. Paired t-tests were used to identify where significant differences occurred pre- to post-intervention. Differences were considered significant at the p<0.05 level and SPSS version 18 was used for analysis.

Full data sets were available for 33 COI and 21 FtF participants. Demographically, the COI participants were 25 females; age 46.3±9.6; 72% held college or advanced degrees; and 76% had annual incomes exceeding $75,000. All 33 were novice users of Second Life (0-3 months). FtF participants were 20 females; age 37.5±10.6 years; 90% with college or advanced degrees; and, 71% reported incomes over $75,000. Across these data, there were no significant differences. However, regarding attitudes towards exercising at a real club, COI participants reported a statistically significant (p=0.032) higher negative attitude (3.35±1.13) than FtF participants (2.69±.97). While not statistically different (p=0.104), they also reported a lower positive attitude (5.94±.93) than FtF participants (6.32±.59).

The mean BMI of the overall sample was 32.0±6.05 (COI = 33.13±6.13; FtF = 30.21±5.62). No significant baseline differences were noted between groups for weight, BMI, general health, fruit and vegetable consumption, and breakfast. However, significant differences in baseline measures were observed for moderate physical activity (p = 0.021), vigorous physical activity (p = 0.001), sleep (p = 0.022), physical activity self-efficacy (p = 0.05), and the weight efficacy lifestyle (WEL) (p = 0.038).

Table 1 summarizes baseline and post intervention values for objective measures (i.e., weight, BMI). No significant group x time interactions were detected; however, both groups lost a significant amount of weight (COI = 3.9 kg, p <0.001; FtF = 2.8 kg, p = 0.002). Compared to baseline, the COI group lost an average of 4.28% (range -11.0% to + 2.7%), with 28% of the participants losing a clinically significant (5% or >) amount of baseline weight. The FtF group lost an average of 3.0% (range -11.0% to + 2.7%), with 28% losing a clinically significant amount of weight.

Table 2 summarizes baseline and post intervention values for self-report measures of behavioral change and self-efficacy. As shown, a significant group x time interaction was found when analyzing pre to post-intervention general health, moderate physical activity (PA), vigorous physical activity (PA), physical activity (PA) self-efficacy, fruit and vegetable consumption, and WEL. Post hoc paired t-tests indicated significant improvements across all of the above mentioned variables for the COI group, while the FtF group had non-significant improvements in PA self-efficacy, fruit and vegetable consumption and WEL. The FtF group did, however, have non-significant decreases in self reported moderate and vigorous PA. Lastly, a significant time effect was noted for general health and breakfast consumption. Paired sample t-tests indicated a significant improvement in perceptions of general health (p < 0.001) and an increase in the number of days the COI group ate breakfast (p = 0.003); in contrast, there were no significant changes in these variables for the FtF group.

7. Discussion

Our objective was to investigate the potential of a 3D VW-based intervention to engage participants in weight loss/management and foster more healthy behaviors (i.e., nutrition, physical activity). We drew from prior research on obesity interventions (FtF and 2D settings), as well as the work of behavioral and social scientists interested in social cognitive theory and avatar identification. In our exploration, we used a structurally and content similar FtF weight loss program to provide a comparative lens.

Empirical results provide encouraging evidence of the efficacy of the innovative COI intervention. At baseline, both groups (COI, FtF) exhibited generally similar biometric data and eating behaviors. Yet, the FtF participants began their 12-week program with significantly higher confidence in their ability to engage in physical activity and resist eating under various situations, while already engaging in higher levels of activity on a weekly basis.

<table>
<thead>
<tr>
<th>Table 1. Changes in body composition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outcome Variable</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Weight (kg)</td>
</tr>
<tr>
<td>(mean ± SD)</td>
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<tr>
<td>Body Mass Index</td>
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<tr>
<td>(mean ± SD)</td>
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</table>

a group x time interaction; b time main effect

*** significant at p<0.01; ** significant at **p<0.05; * significant at p<0.1
Table 2. Changes in health behaviors and self-efficacy

<table>
<thead>
<tr>
<th>Outcome Variable</th>
<th>Pre</th>
<th>Post</th>
<th>Pre</th>
<th>Post</th>
<th>p-Value</th>
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<tbody>
<tr>
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<td>COI</td>
<td>FtF</td>
<td>COI</td>
<td>FtF</td>
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<td>Health</td>
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<td>3.2</td>
<td>3.4</td>
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<td></td>
<td>±1.1</td>
<td>±1.0</td>
<td>±.7</td>
<td>±.9</td>
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<td>Sleep</td>
<td>2.82</td>
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<td>3.23</td>
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<td>Moderate PA (#days/week)</td>
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<td>4.2</td>
<td>3.9</td>
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<td></td>
<td>±2.2</td>
<td>±1.7</td>
<td>±2.1</td>
<td>±1.9</td>
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<tr>
<td>Vigorous PA (#days/week)</td>
<td>1.4</td>
<td>2.5</td>
<td>3.2</td>
<td>3.0</td>
<td>0.008***</td>
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<tr>
<td></td>
<td>±1.8</td>
<td>±2.0</td>
<td>±1.9</td>
<td>±1.8</td>
<td>0.038**</td>
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<tr>
<td>PA Self-efficacy (1=Not to 5=Extremely confident)</td>
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<td>3.42</td>
<td>3.39</td>
<td>3.41</td>
<td>0.038**</td>
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<td></td>
<td>±.80</td>
<td>±0.80</td>
<td>±0.92</td>
<td>±0.80</td>
<td>0.023**</td>
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<tr>
<td>Fruit and Vegetables (1=0 to 5=&gt;5/day)</td>
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<td>2.81</td>
<td>2.90</td>
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<td></td>
<td>±0.93</td>
<td>±0.89</td>
<td>±0.81</td>
<td>±0.77</td>
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<tr>
<td>Breakfast (1=0 to 5=&gt;5/day)</td>
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<td>6.52</td>
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<td></td>
<td>±1.48</td>
<td>±0.60</td>
<td>±0.98</td>
<td>±0.66</td>
<td>0.018**</td>
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<tr>
<td>Weight efficacy (scale 19 - 133)</td>
<td>80.70</td>
<td>108.7</td>
<td>92.0</td>
<td>97.3</td>
<td>&lt;0.001***</td>
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<tr>
<td></td>
<td>±20.1</td>
<td>±16.7</td>
<td>±17.2</td>
<td>±16.7</td>
<td>&lt;0.001***</td>
</tr>
</tbody>
</table>

*group x time interaction; **time main effect

*** significant at p<0.01; ** significant at **p<0.05; * significant at p<0.1

By the end of the 12-week intervention, both groups benefitted from their respective interventions in terms of weight loss and BMI reduction (Table 1). Importantly, the average weight loss results of COI participants (3.9 kg) compares favorably with studies of other short-term (12-16 week) behavioral programs. In those studies, weight loss ranged from 2.9-5.5 kg and 0.7 to 4.5 kg for FtF and Internet, respectively [40]. Interestingly, following the intervention, COI participants exhibited significant improvements in nearly all indicators (except sleep) of behavioral change (i.e., increased moderate and vigorous physical activity, fruit and vegetable consumption, and number of days eating breakfast), while the FtF participants showed no marked improvements in any indicator. Additionally, COI participants’ confidence in their ability to engage in physical activity (PA self-efficacy) and resist eating (weight efficacy) both increased significantly (Table 2), while again the FtF group exhibited no significant changes.

Collectively, these results offer preliminary evidence that a 3D VW-based program can be as effective in terms of positive biometric changes, but it may also be a more effective platform to influence meaningful behavioral changes. In fact, nearly 70% of participants agreed or strongly agreed that the COI program worked better than other things they had tried in the past. And, it is worth noting the COI were novice users of Second Life, suggesting that deep technical skills are a precursor to use.

In considering our results, it is important to emphasize the tight integration of and relationship between the program and island designs. The design of one influenced the design of the other, allowing for motivational reinforcement, practice-oriented instruction, and social support. Together, they created an intervention that fostered positive weight loss and changes to health behaviors. Importantly, the dynamic 3D spaces allowed COI participants opportunities to test both positive and negative behaviors like navigating complex food situations such as at party. Our results suggest that behavioral change and increased self-efficacy may indeed have been influenced by participants witnessing their avatars join in healthy behaviors, movement and eating habits in particular. In the current study, COI participants overwhelmingly created avatars that reflected real depictions of themselves. It appears that the closer to their real self they were able to design (and modify over time) their avatar, the greater the impact on their feelings and behaviors. As they lost weight in the real world, they made appropriate changes to their avatar’s appearance to reflect this. And, participants were able, many for the first time in their lives, to have a positive experience related to physical activity. Sample comments by COI participants suggesting avatar identification and the Proteus Effect include:

“During the workday, I remember my avatar sipping from a (3D) water bottle and I’d grab my own (real) bottle. Having the bottle and drinking animation has led directly to a change in my behavior”.

“Usually when I’m on the treadmill at the gym, I walk for 5 minutes and run 1 minute, which is really challenging. This last time, I pictured by avatar running and I felt like my avatar and it made me feel stronger. I ran for two minutes easily.”
Additional comments attest to the development of self-efficacy and role of social support:

“I’m integrating skills I didn’t know how to use. I usually read nutritional labels but didn’t really know what to do with the information. Now I have more confidence and know how to maintain my weight loss.”

“This was the best part of any class, when the other members talked about their experiences. It was just good to know other people out there are struggling with the same issues.”

8. Limitations and research directions

The sample in this study provided both strengths and weaknesses. Given our research focus and interests of our industry partner, the demographics of our sample were appropriate. However, future research should involve a broader recruitment strategy and controlled assignment to an intervention based on, for example, body mass index. Our study also followed past practice by comparing the new type of intervention to a traditional FtF delivery environment. The next step is to compare the 3D-based intervention to a 2D web-based intervention.

We also focused our attention largely on outcomes to compare the effectiveness of a 3D VW program to a FtF one. While we found positive benefits immediately following program completion, a longitudinal assessment is needed to ascertain if behavioral changes are sustained. In addition, research is needed regarding the relationship between individual characteristics (e.g., obesity classification, learning style, immersive tendencies, etc.) and outcomes. We have anecdotal evidence that avatar identification, the Proteus Effect, and social support components intertwine and are related to outcomes. Yet, as with earlier studies [27], how elements such as these actually work together, or whether (any) relationship to outcomes is correlational or causal, is not yet fully understood.

Lastly, from a human computer interaction (HCI) design perspective, a deeper understanding of how design elements (e.g., environmental or avatar realism) interact with individual characteristics (e.g., preferred representational system) is essential to advancing adoption. Moreover, while virtual presence is considered central to the utility of a 3D space, attempts to design spaces to maximize presence are premature without solid evidence that it relates to outcomes.

In sum, further empirical testing via both controlled experiments and field studies would lend to developing a rich understanding of the value of VW interventions to address obesity and overcome the challenges of existing interventions. Multiple, rich avenues exist for both developmental research that may lead to new 3D affordances and products, and for research that provides a venue for trials of innovative interventions.

9. Conclusion

As the incidence of obesity and associated diseases increases, the burden on the health care community grows [26]. While more research is needed into use in medical and health contexts (see [7] for review), as shown here, 3D VWs may offer a safe environment within which participants can participate in experiential learning, develop and practice skills, and simulate “what if” scenarios without serious repercussions. The affordances of simulated dynamic 3D experiences, anonymity, embodied personal representation in the form of an avatar, and rich social interaction constitute potential for a VW to have a strong effect as a weight loss intervention platform. While their use in its infancy, there are encouraging signs regarding application to a variety of medical, health, educational, and other contexts. We hope that the ideas and findings offered here contribute to this growing literature body.

10. References


