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Psychological Benefits of Participation in 3D Virtual Worlds for Individuals with Real-World  
Disabilities

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**Abstract**

One hundred and ninety-six individuals with real-world disabilities were administered a battery of psychological adjustment measures soon after joining the 3D virtual world of Second Life<sup>®</sup>. After three months, 61 participants who continued to be actively involved in Second Life were re-administered the adjustment measures and completed a survey about their virtual and real life experiences during the interval between assessments. Participants' scores significantly improved on measures of affective states (depression, anxiety, positive emotion, life satisfaction, and feelings of loneliness) and self-evaluation (self-esteem). An index of overall change was associated with the number of virtual friends and group affiliations in Second Life, as well as feelings about the self as a result of involvement in the virtual world. The current study provides initial empirical support that 3D virtual worlds can serve as a psychologically beneficial context for individuals with real-life disabilities.

## Psychological Benefits of Participation in 3D Virtual Worlds for Individuals with Real-World Disabilities

Each major phase in the development of the Internet has created new benefits for individuals with disabilities. Starting in the early 1990's, scores of websites were developed that provided individuals with disabilities instantaneous access to diagnostic, assessment, and treatment information. Subsequently, powerful browsers helped create the Interactive Internet and allowed individuals with disabilities to employ peer-to-peer applications such as blogs, instant messaging, text and video chat, on-line forums, and social-networking sites to connect with other persons with disabilities, share information and experiences, and increase their sense of social support and community.

Now the emergence of the new 3D or Immersive Internet (Driver & Driver, 2008) is once again generating new opportunities for individuals with disabilities. In this iteration of cyberspace, instead of digitizing 2D text and images, the entire 3-dimensional world, including the human body, is being digitally represented and placed on the Internet. These 3D graphical environments serve as interactive spaces where users, in the form of avatars (3D digital representations of the self), can work, learn, and engage in social interaction. While there are a number of advanced virtual environments in the new Immersive Internet, the most prominent is Second Life<sup>®</sup> – a free, downloadable software program where users can create avatars and engage in a variety of activities including shopping, working, and forming friendships and intimate relationships ([www.secondlife.com](http://www.secondlife.com)).

Individuals with disabilities have the potential to benefit from these new immersive environments in several ways. First, they can visit regions within virtual worlds that provide information and education about disabilities and connect with other avatars that are operated by

individuals with real-world disabilities. Second, like other digital applications, virtual worlds have advantages over support programs operating in the physical world because they eliminate many physical and logistical demands to access services (e.g., obtaining transportation, overcoming exhaustion, utilizing rest rooms, etc.) In addition, participants in 3D virtual worlds with disabilities can benefit from a unique aspect of immersive digital environments: The capacity to create an avatar that can participate in the social environment without many of the restrictions operating in their real lives. For example, an individual who is a paraplegic in the physical realm can choose to create an avatar whose limbs are not paralyzed and is able to walk, run, dance, and even fly in the digital realm. Similarly, individuals paralyzed with fear in the real-world via agoraphobia or a severe social phobia may find it easier to freely explore the virtual world and comfortably interact with others when their actions are mediated through an avatar who no one knows is struggling with significant emotional constraints in the physical world. Thus, avatar-mediated social interactions offer expanded possibilities from those that exist in the real life experience of many individuals with disabilities.

In considering the potential benefits of immersive digital environments on individuals with real-world disabilities, it is important to distinguish between 3D virtual worlds and a second type of 3D platform – Virtual Reality or VR. VR, whose development preceded advanced virtual worlds, involves specially designed computer simulations of a specific three-dimensional object or environment (e.g., a market, an office, etc.) that can be interacted with in a seemingly real or physical way. VR has been shown to be a valuable tool in the rehabilitation and treatment of individuals with physical disabilities by enhancing perceptual-motor, adaptive, and cognitive skills in a variety of domains including individuals who have experienced traumatic brain injury (Christiansen et al., 1998; Rose, Brooks, & Rizzo, 2005; Thornton et al., 2005); improving

perceptual-motor performance and social participation in children with cerebral palsy (Snider, Majnemer, & Darsaklis, 2010); increasing spatial memory in individuals with multiple sclerosis (Pugnetti et al., 1998); and improving upper limb utilization of patients following stroke (Merians, Poizner, Boian, Burdea, & Adamovich, 2006). Similarly, in the area of mental or emotional disabilities, Virtual Reality-based exposure therapy (VRET) has been an effective component in the treatment of clients struggling with a range of anxiety disorders including: specific phobias such as fear of flying (Tortella-Feliu et al., 2011); more general phobias such as social phobia or agoraphobia (Wiederhold & Wiederhold, 2005); and the treatment of veterans suffering from PTSD (Liu, 2008; Rizzo, Reger, Gahm, Difede, & Rothbaum, 2009). In addition, with respect to individuals with developmental or intellectual disabilities, the vivid, realistic scenes found in 3D graphical environments have been shown to increase focal attention in individuals diagnosed with ADD (Alm, Arnott, Murray, & Buchanan, 1998) and individuals with autistic spectrum disorders have benefited from training conducted in VR settings (Biever, 2007; Parsons & Mitchell, 2002).

While VR based treatments have documented benefits for individuals with a variety of disabilities, they have a number of considerations as a psychologically beneficial immersive environment relative to 3D virtual worlds. First, VR involves free-standing (i.e. non-networked) applications that are generally only available in research labs or specialized clinical facilities; and they typically require head mounted displays, TV monitors, and stereo earphones to create a sense of visual and auditory immersion. In contrast, virtual worlds such as Second Life are freely available, can be accessed via any location and device that offers a broadband connection, and the sense of immersion is achieved via a standard keyboard and screen without the need for specialized haptic devices. As a consequence, potential utilization and benefits of 3D virtual

worlds may be more widespread than VR applications. In addition, as previously discussed, the capacity to create and operate fully-enabled avatars provides individuals with disabilities greater opportunities for social interactions and experiences that are free of many disability-related, real-world constraints. Finally, virtual worlds are more diverse and expansive settings than specific VR applications and enable users to access to a wide variety of immersive experiences that more closely approximate the range and complexities of a real-world culture. The greater similarity between 3D worlds and real-life culture might support greater generalization of gains from the virtual to the physical environment relative to the cross-realm benefits obtained via VR applications, although this possibility has yet to be empirically investigated.

The potential advantages of 3D virtual worlds as a context to benefit individuals with disabilities has led to the development of a number of virtual world programs designed to provide information and support for individuals with disabilities (Gilbert, Walsh, & Dionisio, in press). These include Second Life-based programs such as Virtual Ability, a prominent educational and support region for the disability community (<http://virtualability.org>); AVESS (Amputee Virtual Environment Support Space; Thompson & Fisher, 2010); and ShockProof (ShockProof, 2005), an online community for stroke survivors. In addition, an educational and treatment program for PTSD using a virtual world treatment system developed by the USC Institute for Creative Technologies (<http://ict.use.edu/projects>) is currently under development in Open Sim, another prominent virtual world. However, in contrast to the body of research associated with VR applications, there is no published outcome research on these specific programs or more general investigations examining potential psychological benefits associated with participation in a virtual world environment by persons with disabilities. With respect to potential general impacts, Guest (2008) provides an anecdotal account of of nine adults with

cerebral palsy who reported psychological benefits from the collaborative creation and management of a single, fully enabled avatar in Second Life.

In response to the lack of formal research on the impact of 3D virtual environments on individuals with disabilities, the current study seeks to provide initial empirical data evaluating possible psychological and social benefits of virtual world experiences by people with a variety of real-world disabilities. Specifically, the proposed research seeks to determine whether individuals with significant physical, mental/emotional, or developmental/intellectual disabilities report a reduction in negative emotions such as anxiety, depression, and loneliness, and an increase in self-esteem, social support, and life satisfaction, as a result of participating in the three-dimensional virtual world of Second Life.

## **Method**

### **Pre-Test Participant Recruitment**

Participants, each of whom self-identified as having a significant real-world physical, mental, or developmental disability, were recruited from individuals who had selected Virtual Ability Island as a “gateway” or entry point into Second Life when they first opened an account in the virtual world. Virtual Ability Island is a prominent educational and support center for the Second Life disability community. To recruit participants, a virtual note card describing the study was prominently displayed at the conclusion of a one-hour self-guided orientation to Second Life held on Virtual Ability Island. The note card offered prospective participants the opportunity to earn 1000 Linden Dollars (virtual currency equivalent to approximately four US dollars) for completing a series of questionnaires about their disability and their current emotions and self-concept.<sup>1</sup> Individuals who were interested in participating in the study were instructed to click on a link embedded in the note card that connected them to an online survey website where

they were asked to provide informed consent and to determine if they met several screening criteria for participation. In order to be eligible for the study, participants needed to be an adult with a significant physical, mental, or developmental disability who had joined Second Life within the previous seven days and was able to read and understand English well enough to complete a set of English-language questionnaires.

Over the course of several months of pre-test recruitment, 316 individuals clicked on the link provided in the note card. A total of 118 of these individuals were excluded from participation for a number of reasons including not agreeing to the informed consent form ( $n = 5$ ); they were under 18 years of age in the physical world ( $n = 2$ ; despite the fact that this violated the terms of service in effect at that time); not having a real life disability despite joining Virtual Ability Island ( $n = 20$ ); they had been in Second Life for more than seven days ( $n = 51$ ); their English language abilities were insufficient to understand and complete a set of psychological questionnaires in English ( $n = 2$ ); they stopped filling out the measures before they had completed the entire set ( $n = 20$ ); their answers were obviously invalid (e.g. they marked the same response to every question;  $n = 6$ ), or there was no Second Life listing for the avatar name they used to complete the measures ( $n = 13$ ). This later source of exclusion could be the result of various factors including a Second Life resident sending the link to someone who was not a participant in the virtual world, being deleted by Linden Labs (the corporate parent of Second Life) for violating the terms of service, misspelling his or her avatar name, or deleting the avatar account and starting over because he or she wanted a new avatar name.

### **Pre-Test Participant Sample**

**Demographics.** The remaining 196 participants resulted in a pre-test sample with 64 men (33%), 122 women (62%), and 10 (5%) who did not indicate gender. The mean age was 35.12



years ( $SD = 11.37$ ; range = 18 – 67). Most participants identified as White/Caucasian ( $n = 152$ ; 78%), 6 (3%) were African American, 7 (4%) were Hispanic, 8 (4%) were Asian or Pacific Islander, 2 (1%) were Native American, and 21 (11%) identified as “Other” or preferred not to answer. Ninety-four participants (48%) were single or never married, 48 (25%) married, 32 (16%) divorced or separated, 2 (1%) widowed, and 20 (10%) preferred not to answer. With regard to education, 19 participants (10%) had less than a high school education, 52 (27%) had a high school degree or GED, 36 (18%) had some college education, 21 (11%) had a two-year college degree, 27 (14%) had a four-year college degree, and 18 (9%) had a graduate-level or professional degree; 23 participants (12%) preferred not to respond. In terms of income, 88 (45%) reported an income of less than \$20,000 (US dollars), 39 (20%) reported income between \$20,000 and \$49,000, and 25 (13%) reported income of more than \$50,000; 48 (25%) preferred not to answer.

**Disability type and severity.** In addition to providing demographic information, the 196 pre-test participants responded to questions about the nature and severity of their real life disability. Following the approach used in the PopCap (2008) survey of gamers with disabilities, participants noted the general *category* of their disability (physical, mental, developmental/intellectual, or multiple) and the specific *types* of disability that applied within a designated category. Participants were able to select more than one disability within a disability category as well as across disability categories. Sixty five participants (33%) reported a physical disability, 52 (27%) reported a mental disability, and 79 (40%) reported multiple disabilities. Of the 128 participants (65%) who reported some sort of physical disability, there was a broad range of physical disabilities reported. Listed in order of prevalence, these included: hearing impairment ( $n = 43$ ), low vision ( $n = 32$ ), obesity ( $n = 28$ ), diabetes ( $n = 13$ ), chronic back

condition ( $n = 12$ ), fibromyalgia ( $n = 12$ ), other chronic disease ( $n = 12$ ), chronic fatigue syndrome ( $n = 10$ ), arthritis ( $n = 11$ ), autoimmune disease ( $n = 9$ ), cardiovascular disease ( $n = 9$ ), spinal cord injury ( $n = 8$ ), cerebral palsy ( $n = 5$ ), traumatic brain injury ( $n = 5$ ), multiple sclerosis ( $n = 4$ ), muscular dystrophy ( $n = 4$ ), and orthopedic dysfunction ( $n = 4$ ). In addition, several other low-incidence disabilities (all  $ns < 3$ ) were reported, including: amputation, blindness or cataracts, HIV/AIDS, paralysis, and spina bifida. One hundred and forty five participants (74%) reported some sort of mental or developmental disability including dyslexia ( $n = 22$ ), attention deficit disorder ( $n = 20$ ), hyperactivity ( $n = 13$ ), and autism ( $n = 9$ ). A low incidence of mental retardation and epilepsy were also reported (both with  $ns < 5$ ).

Participants rated the *severity* of their disability as mild, moderate, or severe with respect to each category of disability that was relevant to their case. Twenty participants (10%) reported the severity of their disability as mild, 97 (50%) reported moderate severity, and 76 (39%) reported their disability as severe (3 participants declined to rate the severity of their disability). Because of the relatively small number of mild responses, the mild and moderate categories were collapsed into one mild/moderate category of severity.

### **Pre-Test Assessment**

Participants then completed a set of eight measures administered in a randomized sequence. The eight measures were selected to assess three areas of psychological well-being and adjustment: (1) affective states, which assessed the presence of positive and negative emotions; (2) self-evaluation perceptions; and (3) the level of perceived social connection or isolation.

**Affective state measures.** Four dependent measures were used to assess the presence of positive and negative emotional states or traits. The 20-item *Center for Epidemiological Studies Depression Scale* (CES-D; Radloff, 1977) measures depressive symptoms. *The Positive and*

*Negative Affect Scale* (PANAS; Watson, Clark, & Tellegen, 1988) lists 20 words that describe either positive or negative emotional states (e.g., “interested,” “irritable,” “nervous”) and asks participants to indicate the extent to which they have felt this way during the current day. The Positive and Negative emotional subscale scores of PANAS were treated as two separate dependent measures. *The State-Trait Anxiety Inventory* (STAI; Spielberger, 1983) is a 20-item measure that focuses on participant’s ongoing experience of anxiety.

**Self-evaluation measures.** *The Satisfaction with Life Scale* (SWLS; Diener, Emmons, Larsen, & Griffin, 1985) assesses participant’s overall sense of well-being. Positive self-perceptions were also assessed by the 10-item *Rosenberg Self-Esteem Scale* (Rosenberg, 1965)

**Social connectedness measures.** The remaining three measures were used to assess the degree to which participants experienced feelings of social connection and support or social isolation. *The Social Connectedness Scale* (SCS; Lee & Robbins, 2001) has 20 items that pertain to the psychological sense of belonging to a community or group. The *Multidimensional Scale of Perceived Social Support* (MSPSS; Dahlem, Zimet, & Walker, 1991) assesses a participant’s level of agreement with 12 statements related to perceived social support. Finally, the *UCLA Loneliness Scale* (Short form, Version 3; Russell, 1996) presents participants with 10 questions related to feelings of social isolation.

After completing these measures, participants were thanked and informed that 1000 Lindens would be transferred to their Second Life account within 72 hours. They were also asked if they could be contacted after three months to complete the second part of the study and receive an additional payment of 1000 Lindens.

### **Post-Test Participants and Assessment**

**Post-test participants.** All 196 pre-test participants indicated that they were open to being contacted three months about the possibility of completing the second (i.e., post-test) phase of the study. However, after three months, 39 participants had formally withdrawn from Second Life (i.e., their avatar name was no longer listed in the Second Life directory). The avatars of the remaining 157 pre-test participants were then sent up to three invitations in approximately one week intervals to take part in the post-test assessment and earn a second 1000 Lindens. Eighty-eight of these initial participants did not respond after three contact efforts. This attrition was either due to the fact that a) they were no longer active in Second Life but had not taken the time to formally close their account and withdraw the name of their avatar or b) they were still active in Second Life but decided not to participate in the post-test assessment, with no way of determining the proportion of the 88 non-responder who fell into each category. Eight of the remaining 69 participants who responded to the request to participate in the post-test assessment did not finish all of the post-test measures or had obvious errors in the way they completed the measures, resulting in a final post-test sample of 61 participants.

The post-test sample consisted of 15 men (26%), 41 women (67%), and 5 (8%) who did not identify gender. The mean age was 39.21 ( $SD = 12.08$ ). The majority were White/Caucasian ( $n = 47, 77\%$ ), 3 (5%) African American, 4 (7%) Asian or Pacific Islander, and 7 (11%) identified as “other” or preferred not to answer. Twenty-three participants (38%) were single or never married, 19 (31%) were married, 14 (23%) were divorced or separated, and 5 (8%) preferred not to answer. With regard to education, 3 participants (5%) had less than a high school education, 17 (28%) had a high school degree or GED, 7 (11%) had some college education, 5 (8%) had a two-year college degree, 15 (25%) had a four-year college degree, and 9 (15%) had a graduate-level or professional degree; 5 participants (8%) preferred not to respond to this item.

In terms of income, 27 (44%) reported an income of less than \$20,000, 13 (21%) reported income between \$20,000 and \$49,000, and 13 (21%) reported income of \$50,000 or more; 8 (13%) preferred not to answer this question. Twenty five participants (41%) reported a physical disability, 16 (26%) reported a mental disability, and 20 (33%) reported multiple disabilities. In terms of disability severity, 28 (46%) reported the severity of their disability as mild or moderate and 31 (51%) reported their disability as severe (2 participants did not report disability severity).

Analyses were conducted to test whether the post-test sample ( $N = 61$ ) differed markedly from those participants who only completed the pretest measures ( $N = 135$ ). The samples were did not differ significantly in gender, ethnicity, marital status, and disability type. Compared to the pretest-only sample, the post-test sample was slightly older (by approximately 6 years),  $t(194) = -3.49, p < .01, d = -0.50$ ; had more education,  $t(194) = -2.96, p < .01, d = -.043$ ; had a higher income,  $t(194) = -3.89, p < .01, d = -0.56$ ; and reported more severe disability (53% of post-test sample vs. 34% of pretest-only sample),  $\chi^2(1, N = 193) = 6.17, p = .01, \phi = .18$ .

**Post-test assessment.** The battery of measures administered during the three month post-test was almost identical to the one used during the initial assessment. The one exception was that post-test participants were also asked to complete a set of questions assessing their experiences within Second Life and in real life during the interval between their pre-test and post-test assessment. With respect to Second Life, they were asked how often they logged in to the virtual world and the typical duration of an in-world sessions; the number and quality of virtual friendships they had formed; the number of social groups they had joined and their level of involvement in these groups; whether or not they were employed in Second Life or had formed a virtual relationship and, if so, their degree of satisfaction with their virtual job and intimate relationship. Finally, they were asked to rate the degree to which they felt “more

connected to others” as a result of their 3-month participation and “how they felt about themselves” as a result of their period of involvement in Second Life. Similarly, a series of exploratory questions were asked about participants’ real lives during the previous three months. They were asked to indicate if they had experienced any significant changes, either positive or negative, with regard to relationships, employment, housing, physical ability, etc. and, if so, to describe the nature of these changes.

After completing the post-test measures, participants were thanked again for taking part in the study and informed that an additional 1000 Lindens would be transferred to their Second Life account, the names of their avatars would be deleted, and their data would be filed using only a numeric identifier.

## **Results**

### **Pre-Post Differences on Dependent Measures**

An initial series of analyses involved one-sample *t*-tests designed to assess how the pre-test scores (i.e., scores collected when participants first entered Second Life) for the 61 participants who completed both phases of the study compared to published norms for the nine dependent variables.<sup>2</sup> The results indicated that the majority of the sample participants who completed both phases of the study met criteria for psychological and/or clinical conditions on eight of the nine dependent variables at the time they entered Second Life, with the sole exception of the negative affect PANAS subscale. These findings strongly suggest that as a group participants’ were experiencing significant levels of psychological and/or social distress at pretest, although it is important to note that the published norms used for all of the measures of well-being were based on non-disabled samples.

Subsequently, in order to inspect which specific dependent variables significantly changed over time, a series of paired-samples *t*-tests were run on each of the nine dependent variables. Six of the nine variables showed significant effects. From Time 1 to Time 2, participants scores significantly decreased on CESD (depressive symptoms), trait anxiety, and loneliness; participant's scores significantly increased on positive affect, satisfaction with life, and self-esteem. No significant differences were found for negative affect, social connectedness, or social support. These results are summarized in Table 1.

### **Overall Psychological Benefit of Second Life**

To quantify the overall psychological benefit of the Second Life experience, difference scores from Time 1 to Time 2 were calculated for each participant on each of the six dependent measures for which there were significant changes. These difference scores were then converted to a percent change score for each measure. (The purpose of the percent change scores was to put all the measures on the same metric.) To calculate percent change scores, the difference score was divided by the total possible score on the given measure and multiplied by 100. (As an example, one participant received a Time 1 score of 35 and a Time 2 score of 26 on the UCLA Loneliness Scale. The participant's difference score was 9, indicating a drop in levels of loneliness from Time 1 to Time 2. This difference score was then converted to a percent change score by dividing 9 [the difference score] by 35 [the total possible score on the UCLA Loneliness Scale] and multiplying by 100, which resulted in a percent change score of 25.71 on loneliness.) Once the percent change scores were calculated for each measure, the percent change scores were averaged across the six dependent measure scores (for which there were significant changes from Time 1 to Time 2) to create an *overall percent change score* for each participant.<sup>3</sup> The overall percent change scores were intended to reflect a measure of overall psychological benefit

across time for Second Life involvement. Thus, positive scores would indicate positive psychological improvement whereas negative scores would indicate psychological decline.

The average overall percent change score was 5.29 ( $SD = 10.97$ ) and a one-sample  $t$ -test revealed a significant difference from zero,  $t(60) = 3.76, p < .01, d = 0.48$ , suggesting that participants experienced significant psychological improvement over time. A 3 (disability type: physical, developmental/intellectual, or multiple) X 2 (disability severity: mild/moderate or severe) ANOVA tested possible differences in percent change scores. Although there were no significant main or interaction effects (all  $F$ s  $< 2.70$ ), post-hoc analyses revealed a significant contrast effect such that those with developmental ( $M = 6.68, SD = 12.25$ ) or multiple disabilities ( $M = 6.21, SD = 9.28$ ) had significantly higher percent change scores than those with physical disabilities ( $M = 3.66, SD = 11.58$ ),  $t_{\text{contrast}}(60) = 8.35, p < .01, d = 2.16$ .

### **Second Life Activity and Overall Psychological Benefit**

To gauge the experience of participants in Second Life, participants answered a series of questions about their Second Life activity. Additionally, to test the relationship between Second Life activity and overall psychological benefit, each of the Second Life activity questions were correlated with percent change scores. First, participants were asked to report on their utilization of Second Life. Almost half reported logging on daily or almost every day ( $n = 29, 47\%$ ), 30% ( $n = 18$ ) reported several times a week, 13% ( $n = 8$ ) reported weekly or several times a month, and 10% ( $n = 6$ ) reported less than once a month. There was not a significant relationship between log-on frequency and percent change scores,  $r(59) = .15, p = .24$ . When logged on to Second Life, more than half the participants ( $n = 32, 53\%$ ) reported spending 1 – 3 hours in-world, 16% ( $n = 10$ ) reported 4 – 6 hours, 11% ( $n = 7$ ) reported 7 or more hours, and 20% ( $n = 12$ ) reported



less than one hour. There was not a significant relationship between log-on frequency and percent change scores,  $r(59) = .05, p = .68$ .

Participants also reported on their social experiences in the virtual environment. On average, participants reported 20.57 ( $SD = 52.00$ ) friends in Second Life<sup>4</sup>. However, closer inspection revealed that two participants reported over 200 friends; when these two outliers were removed the mean number of friends was 11.78 ( $SD = 13.30$ ). The overall number of friends in Second Life significantly correlated with percent change scores,  $r(57) = .44, p < .01$ . Of the 37 (61%) participants who reported having at least one close friend in Second Life, the mean number of close friends was 3.70 ( $SD = 4.17$ ). However, the number of close friends in Second Life did not significantly correlate with percent change scores,  $r(35) = .01, p = .97$ . The average number of groups each participant belonged to in Second Life was 9.82 ( $SD = 8.30$ ) and the number of groups in Second Life significantly correlated with percent change scores,  $r(59) = .28, p < .05$ . Of the 29 (43%) participants who reported being highly involved in at least one group in Second Life, the mean number of highly-involved groups was 3.07 ( $SD = 2.49$ ) but there was not a significant relationship between number of highly-involved groups and percent change scores,  $r(27) = -.07, p = .72$ . In terms of social involvement, it is interesting to note that five participants (8%) reported being employed in Second Life and 14 (23%) reported having an ongoing romantic relationship in Second Life. However, the low number of responses of individuals reporting these social activities precluded appropriate statistical analyses of their relationship to overall levels of change.

Additionally, participants were asked to rate aspects of their experience within Second Life during the interval between the pre and post-test assessments. With respect to whether they felt more connected to others as a result of their Second Life involvement, the majority reported

at least some increased connection (see Figure 1), however these ratings of connectedness were not significantly correlated with percent change scores,  $r(59) = .20, p = .12$ . When asked “How do you feel about yourself as a results of your involvement in Second Life?” the majority of participants reported feeling better about themselves (see Figure 2) and these self-ratings were significantly correlated with percent change scores,  $r(59) = .35, p < .01$ . In sum, overall percent change scores (i.e., psychological benefits) were positively associated with the overall number of friends and group memberships, and how the participant felt about him or herself as a result of involvement in Second Life.

Significant changes in participants’ real (i.e., physical world) lives were also examined to determine if there were real-life experiences unrelated to Second Life that might explain any psychological benefits during the interval between assessments. Relatively few participants reported any significant real-life changes including beginning ( $n = 6$ ) or ending a romantic relationship ( $n = 6$ ), starting a job ( $n = 4$ ), job promotion ( $n = 3$ ), ending/losing a job ( $n = 5$ ), or job hour reduction ( $n = 2$ ). The low number of responses to these questions precluded any appropriate statistical analyses of their relationship to overall change effects.

## Discussion

The current study represents the first effort to empirically evaluate potential social-emotional benefits of participation in a 3D virtual world on individuals with significant real-world disabilities. Because all participants were evaluated within days of entering Second Life, and again after approximately three months in the immersive environment, the study was able to assess the initial psychological impact of virtual world experience during a standardized exposure period.

## Major Findings

The pre-test assessment data indicated that the majority of the sample met criteria for psychological distress or clinical conditions on eight of the nine dependent variables at the time they entered Second Life. These findings suggest that the pretest participants were struggling with substantial amounts of psychological distress and compromised adjustment, with the one caveat being that they were being evaluated on measures that, while established and psychometrically sound, were normed on non-disabled samples.

At post-test, psychological benefits were observed on six of the nine dependent variables. Specifically, significant decreases in depressive symptoms, trait anxiety, and loneliness occurred along with significant increases in positive affect, life satisfaction, and self-esteem. At the same time, no significant improvements were found for self-reported negative affect, social connectedness, or social support. In evaluating why scores on these specific variables did not follow the majority trend of improved functioning, it appears that the measures that reflected the strongest gains all pertain to changes in affective or internal states (e.g. depression, anxiety, positive emotions, life satisfaction, feelings of loneliness) and self-evaluation (i.e. self-esteem), with the sole exception to this trend being the negative affect scale of the PANAS measure. In contrast to the strong findings regarding affective or internal states, the two variables that addressed general perceptions of social connection and support (i.e., the SCS and MSPSS) did not reflect significant improvement. This may be due to the fact that these measures assess relationships in both the physical and the virtual world and participant's experiences in Second Life may have had less effect on their physical world relationships. It is important to note, however, that changes in perceived social connection, while not robust enough to reach significance in the current study, were in the predicted direction. It is quite possible that an investigation involving a larger pool of participants, and therefore greater statistical power,

would have yielded a significant finding in this area as well.

The six individual variables that produced significant change during the exposure period (i.e., the interval between the Time 1 and Time 2 assessments) were combined to form an overall change score that was significantly different from zero, suggesting that participant's experienced significant overall improvement with time. Further analyses revealed that the level of overall change was unrelated to the severity of participant's disability: participants who rated their real-world disabilities as mild/moderate had equivalent levels of change to those that viewed their disability as severe. However, with respect to the type of disability, those with developmental or multiple disabilities had higher overall improvement scores than those with physical abilities. One possible explanation for this finding is that participants with physical disabilities alone had more positive scores at pre-test on several scales (e.g., depression, positive affect, and loneliness) which constricted their level of change relative to participants with developmental or multiple disabilities. Alternatively, certain physical impairments may have made it more difficult to use the Second Life software (e.g., limited vision, disabilities that impair the ability to type, etc.) and this derive benefit from the environment. In this later case, assistive tools such as Radegast, a lightweight (text-only) client to help the visually impaired or blind effectively use Second Life and Open Sim-based virtual worlds (<http://radegast.org/wp/>) could play an important role in helping to reduce or eliminate this disparity of benefit.

The overall change score was also correlated with Second Life utilization and social activity variables to determine if there was a relationship between these factors and the degree of psychological improvement. The results indicated no association between utilization variables such as the frequency of logging into Second Life or the typical duration of an in-world session. However, with respect to social variables, the level of psychological benefit during the exposure

period to Second Life was positively related to the *overall* number of friends and group memberships, but not the number of *close* friends or *high involvement* groups. In post-study discussions of the research results, experienced members of the Second Life disability were not surprised by the lack of relationship between depth of social involvement and overall benefit. A common observation was that many disabled participants in Second Life seem to approach the virtual world as a low cost way to feel involved and included while avoiding the depth and consistency of participation typically required for social engagement in the physical world. Finally, there was also a significant association between participants generally feeling better about themselves and overall improvement, but not between general feelings of being more connected with others. Thus, as with the individual dependent variables, the most powerful impacts of the virtual world experience appear to be more related to improvements in internal states, emotions, and self-perceptions than a sense of being more connected to the social world in general.

### **Methodological Considerations**

There was approximately a two-thirds attrition rate between the pretest sample ( $n = 196$ ) and the post-test sample ( $n = 61$ ). While sample attrition is expected in any multi-phase study, the current attrition rate was higher than the desired target of having approximately 50% of the pretest sample provide post-test data. One possible consequence of the higher than expected attrition rate was that the characteristics of the 61 participants who completed both phases of the study, and those of the 135 that only completed the pre-test assessment, were significantly different. A series of analyses designed to address this question revealed that pre-test only participants (those subject to attrition) and post-test subjects did not differ significantly in terms of gender, ethnicity, marital status, and disability type. However, compared to the pretest-only

sample, the post-test sample was slightly older; had more education and higher income, and reported more severe disability. Thus, while the samples were similar in many important respects, the obtained benefits of the 3D virtual experience were contributed to more by participants with these particular characteristics. One explanation for this finding is that it is possible that some combinations of greater maturity (age), stability (income and education), and motivation (severity of disability) supported the continuity of participation of the post-test sample while younger, less stable, and less disabled participants were more likely to withdraw from participation in the virtual environment and/or the study.

Another benefit of a lower attrition rate would be to maintain the largest possible sample size in order to maximize statistical power and reduce the probability of Type 2 or false negative errors (i.e., the failure to detect differences in the samples over time that actually exist.) Given the reduction in power caused by the higher than expected attrition rate, it is notable that significant differences were obtained for six of the nine dependent variable scores. However, as previously noted, it is quite possible that with a lower attrition rate and increased power significant benefits would have been obtained for two of the three remaining dependent variables (i.e. negative affect and social connection) given that these two variables were trending in the predicted direction.

Because of the potential interpretive and statistical issues posed by substantial sample attrition, it is important to understand more about the basis for decreased participation over time and to attempt to reduce this attrition rate in future studies. Currently, what limited analysis of attrition rates in Second Life and other virtual worlds exists (Nino, 2007), indicates that only 10% of new participants in massively multi-user online environments remain active after 90 days (i.e. the interval between the pre and post test assessments used in the current study). Thus, the

participant retention rate of over 30% found in the present study is actually substantially *higher* than typical 90-day retention rates of virtual world users. Nevertheless, to improve statistical power and interpretive clarity, it would be valuable to try and achieve even higher retention rates in future multi-phase studies conducted in the virtual world. For example, it may be possible to limit sample attrition by including periodic contacts with participants (either in the virtual world or via non-Second Life channels such as an email address) at designated intervals between assessment periods.

Another important methodological consideration is that the current study did not incorporate a control group. Following a common progression in outcome research, the purpose of this initial study was to determine if beneficial effects of participation in the virtual milieu were observed for individuals with real-world disabilities. If no significant improvements were found, the rationale for continued outcome studies in this area would be substantially reduced. However, having obtained encouraging initial findings, subsequent research can seek to determine the mechanism of effect and rule out possible interpretations that do not involve the impact of virtual world participation. Actually, in addition to demonstrating an initial effect, the current study examined and ruled out one competing explanation: That change was due to coinciding, positive developments in the physical world experience of the participants. This alternative interpretation was not supported by the data as very few participants reported co-occurring events in the physical world that could have underpinned the improvements during the course of the study. Going forward it will be important to address another possible confound: The possibility that it wasn't participation in a 3D virtual environment like Second Life per se that produced the beneficial outcomes but rather the fact that the participants tried something that was new and exciting. That is, one could reasonably ask whether similar benefits would have

been achieved if the participants in the current study had joined Facebook for three months or participated in an online forum during this time period. To address this alternative hypothesis it would be beneficial to conduct a study whereby participants with real-world disabilities were randomly assigned to either participate in Second Life or a 2D social networking group.

Alternatively, if this ideal experimental design was not possible, following a similar group of individuals with disabilities who recently self-selected to join a social networking site could help tease out this potential confound. Specifically, if the Second Life sample showed greater benefits than the 2D control group in either the experimental or matching-group design, it would strongly support the conclusion that the encouraging findings obtained in the current study were specifically due to the impact of the 3D, immersive, experience.

### **Conclusion**

In recent years the number of worldwide avatar accounts in Second Life and other 3D virtual worlds have grown by millions (KZero, 2011). While there is no hard data on the prevalence of individuals with real-world disabilities within the global population of avatars, anecdotal data provided by Au (2008), a long time participant and respected chronicler of virtual worlds, and the 2008 Pop Cap Survey of online gamers, suggests that between 15 and 20% of the population of Second Life is comprised of individuals with some form of significant real life disability. This figure is identical to published epidemiological studies on the incidence of mental and developmental disorders in the United States (Regier et al., 1984) and just slightly below global prevalence estimates (Disabled World, n.d.). Viewed relative to these data, the suggestion that perhaps 15-20% of Second Life user have either a mental, developmental, or physical disability seems unsurprising and plausible.

Given the significant and growing numbers of individuals with disabilities who are



creating avatars and participating in virtual worlds, it is important for social scientists and health practitioners to assess whether involvement in immersive digital environments can produce significant psychological and social benefits. In this context, the current study has provided the first systematic empirical data supporting the notion that 3D virtual worlds have promise as a psychologically beneficial context for individuals with real life disabilities. While further controlled studies are needed, these outcomes are particularly encouraging because they were obtained in a relatively short time period of three months with novice users just acclimating to a distinctive software program. Moreover, there was no specific intervention program that was implemented during the interval between assessments: The obtained benefits were derived solely from unstructured exposure to the general, virtual milieu. If personalized support or a specific intervention program is added to the impact of the general environment, it is reasonable to expect that the promising results of this initial investigation could be enhanced even further.

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### Footnotes

<sup>1</sup> This amount of financial incentive has served as a robust inducement for research participation in several prior studies conducted in the micro economy of Second Life (e.g., Gilbert, Gonzalez, & Murphy, 2011; Gilbert, Murphy, & Ávalos, 2011).

<sup>2</sup> We compared the pre-test only ( $N = 135$ ) and post-test samples ( $N = 61$ ) on the nine dependent measures. There were no significant differences on the Time 1 dependent measure scores between the non-post-test and post-test sample, with one exception. The post-test sample was significantly (albeit slightly) more lonely ( $M = 27.77$ ,  $SD = 6.49$ ) than the non-post-test sample ( $M = 25.53$ ,  $SD = 7.54$ ),  $t(194) = -2.00$ ,  $p < .05$ ,  $d = -0.29$ .

<sup>3</sup> The difference scores for the positive affect, self-esteem, and satisfaction with life were multiplied by -1 so that positive difference scores would reflect improvement over time.

<sup>4</sup> A friend in Second Life is any avatar that is added to a friend list, similar to a friend on Facebook. Thus, the concept of friend in the virtual world does not necessarily signal the same depth of knowledge or involvement as in the physical world.

Table 1

*Comparison of Time 1 and Time 2 Scores on Nine Dependent Variables of Psychological Functioning*

Psychological construct	Time 1 <i>M</i>	Time 2 <i>M</i>	<i>t</i>	<i>d</i>
Depressive symptoms	24.95 (14.45)	21.07 (12.70)	2.83**	0.29
Positive affect	26.10 (8.50)	28.10 (9.19)	-2.07*	-0.23
Negative affect	20.05 (8.35)	18.00 (8.21)	1.79	0.25
Anxiety	48.82 (12.22)	45.56 (12.44)	3.31**	0.26
Satisfaction with life	16.85 (7.65)	18.48 (7.19)	-2.38*	-0.22
Self-esteem	41.87 (13.28)	45.28 (13.34)	-3.09**	-0.26
Social connectedness	66.44 (15.97)	69.21 (17.21)	-1.75	-0.17
Social support	4.58 (1.31)	4.36 (1.43)	1.25	0.16
Loneliness	27.77 (6.49)	25.03 (7.83)	3.61**	0.38

*Note.* Numbers in parentheses are *SDs*; all *dfs* = 60. Depressive symptoms measured with the CESD (Center for Epidemiological Studies Depression Scale, Radloff, 1977). Positive and negative affect measured with the PANAS (Watson et al., 1988). Anxiety measured with the STAI (Spielberger, 1983). Satisfaction with life measured with the SWLS (Diener et al., 1985). Self-esteem measured with the Rosenberg Self-Esteem Scale (Rosenberg, 1965). Social connectedness measured with the SCS (Lee & Robbins, 2001). Social support measured with the MSPSS (Dahlem et al., 1991). Loneliness measured with the UCLA Loneliness Scale (Russell, 1996).

\* $p < .05$ . \*\* $p < .01$ .



Figure 1. Percent of participant responses regarding connectedness.

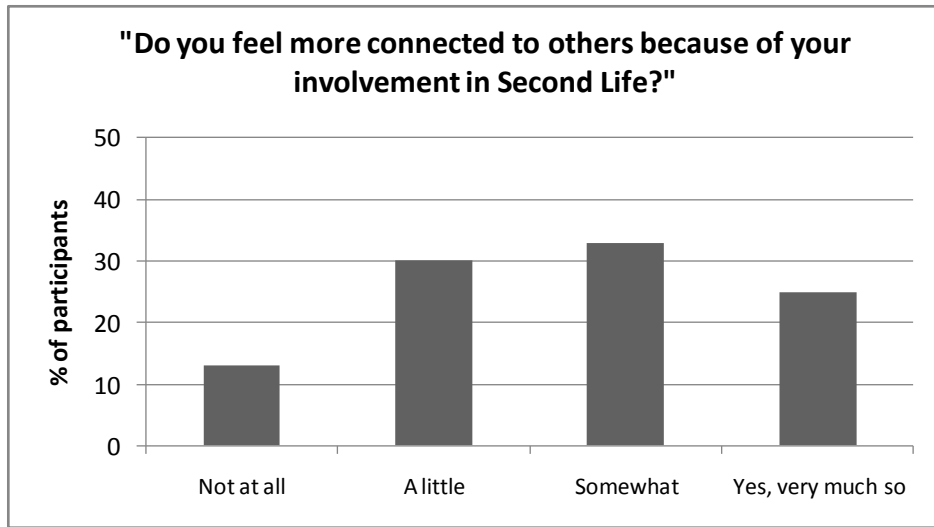


Figure 2. Percent of participant responses regarding self-evaluation as a result of involvement in Second Life.

