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The Evolution of Social Behavior over Time in Second Life

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Abstract

The current study tracked eighty participants who spent an average of six hours per week in Second Life over six consecutive weeks. Objective measures of movement and chat were automatically collected in real-time when participants logged in to Second Life. Data regarding the number of groups and friends was self-reported through online questionnaires on a weekly basis. Results demonstrated that although the social networks of users continued to broaden over the course of the study, users became less inclined to explore regions, decreased their use of high-energy actions such as flying or running, and chatted less. We discuss implications for theories of virtual social interaction as well as the use of Second Life as a social science research platform.

Introduction

This paper describes a six week-long study that tracked behavior in the virtual environment, Second Life. Blascovich (2002) proposed a model of how virtual human representations may influence users and result in realistic behaviors, that is, behaviors that would be seen in the real world. Many studies based on this model have illustrated the ways in which the characteristics of virtual environments and interactions result in realistic user behavior. Although most research has focused on individual behavior within interpersonal or small group contexts, only a handful of studies have applied the social influence model to study individual or group behaviors within larger social contexts. The study presented here contributes to the current literature by providing additional evidence for the social influence model in a large-scale context. Furthermore, it is unique in its use of the Second Life platform as a methodological tool for an extended, controlled study within a naturalistic virtual setting. The following sections review Blascovich's model and research of realistic individual behavior within small and large scale social contexts.

A Framework for Studying Realism in Virtual Environments

Virtual environments are two- or three-dimensional representations of natural or imagined spaces (Biocca & Levy, 1995; Blascovich, 2002; Blascovich, Loomis, Beall, Swinth, Hoyt, & Bailenson, 2002; Kalawsky, 1993; Lanier, 2001) that often contain objects or representations of humans. Immersive virtual environments (IVEs) heighten the perceptive experience of individuals, typically the visual channel via a head-mounted display or projection system. Immersion increases feelings of environmental and social presence. Individuals feel as though they are interacting with their virtual surroundings instead of the physical space they occupy, and there is a greater connection with other digital human representations in the same virtual space. According to Blascovich and colleagues (2002), the realism of immersive virtual environments can be leveraged as a methodological tool to study social processes, in particular, the manner in which virtual agents and avatars influence real behavior.

One goal of using virtual environments in research is to understand human social behavior. Blascovich and colleagues have developed a model of social influence in virtual environments that delineates the manner in which realism and perceived agency of digital human representations moderate influence (Blascovich, 2002; Blascovich et al., 2002). They define *realism*, the degree to which a digital human representation looks and behaves like a real human, and the three dimensions that contribute to the overall realism effect, *communicative*, *anthropomorphic*, and *photographic realism* (Blascovich, 2002; Blascovich et al., 2002). Communicative realism, the extent to which a digital representation physically and socially behaves like a real human, is the most consequential dimension (Blascovich, 2002; Blascovich et al., 2002). Anthropomorphism is important in its contribution to communicative realism, as physical attributes (e.g., mouth, arms) are required for speaking, gesturing, and moving (Blascovich, 2002; Blascovich et al., 2002). The greater the realism a digital human representation achieves, the less perceived agency is needed for social influence, and vice versa. The model also predicts that individuals will respond differently to varying degrees of perceived agency, with computer controlled representations (agents) being the least socially influential, and human-controlled representations (avatars) being the most

(Blascovich et al., 2002). Thus, agents need to display more realism than avatars in order for the same amount of social influence to occur. As realism and social influence increase in virtual environments, so does the likelihood that individuals will respond in realistic ways.

The following sections detail previous research which illustrates how individuals respond realistically (i.e., exhibit social influence in response to virtual stimuli as they would to real, physical stimuli) in virtual environments, with the goal of reviewing the literature and demonstrating that social influence does occur in virtual worlds.

Previous Research on Realistic Behavior within Virtual Environments

Social Influence in Immersive Virtual Environments

Personal Space. Personal space is broadly defined as the physical region around an individual. Hall (1966) defines *personal* space as the space between a one and a half meter radius and a four meter radius from the individual. Although the typical amount of personal space varies with factors such as culture and population density, it still remains an important in gauging how individuals feel about their surroundings, need for privacy, and attitudes about other people (Sommer, 1969). Using a virtual reality environment, Bailenson and colleagues (Bailenson, Blascovich, Beall, & Loomis, 2001, 2003) studied personal space and found that female participants more closely approached and inspected agents than avatars, suggesting that they were respecting the human-controlled avatars' personal space.

Persuasion, Conformity, and Obedience. Research in virtual worlds has also replicated a number of interpersonal psychological processes. For example, Hoyt, Blascovich, and Swinth (2003), discovered that participants were more socially inhibited while performing a complex task when they believed they were performing in front of an audience of avatars than when performing in front of an audience of agents, or with no audience at all; a replication of this study was provided by Zanbaka, Ulinski, Goolkasian, and Hodges (2007). Eastwick and Gardner (2008) used the virtual world There.com to study interpersonal persuasion. Experimenter-controlled avatars employed two common persuasion techniques in an attempt to get participants to have their snapshots taken, and both were successful in the virtual environment. Moreover, to study conformity, using a virtual blackjack game Swinth and Blascovich (2001) studied participants' betting behavior. When participants were seated at a table with virtual human players, they conformed to the betting patterns of the other players more when they believed the player avatars were human-controlled instead of computer-controlled.

Realism and Influence. As predicted by the model of social influence, individuals react differently to varying degrees of realism expressed by a virtual human. The amount of eye gaze directed towards an individual has real effects in virtual spaces. For example, in one study, when virtual presenters used augmented eye gaze directed toward participants compared to naturalistic eye gaze, the female participants expressed more agreement with the presented information, and both genders reported a greater feeling of social presence (Bailenson, Beall, Loomis, Blascovich, & Turk, 2003). Virtual eye gaze is most effective when it is relevant to the content of the conversation itself. Garau, Slater, Bee, & Sasse (2001) confirmed that avatars displaying conversation-relevant eye gaze behavior had higher evaluations and were perceived to be more present and involved than avatars with random eye gaze.

In another example, Slater and colleagues (2006) manipulated the realism of agents when they used virtual reality to replicate Stanley Milgram's obedience experiment (1963). Participants were asked to administer a virtual shock to a virtual human whenever there was an incorrect response to a word test. Even though the participants were aware than the virtual human was not real, the behavioral and physiological responses were greater when participants received visual and aural feedback, instead of textual feedback.

Variability in Virtual Human Features

Although virtual humans can be created with nearly an endless type of features and abilities (Bailenson & Blascovich, 2004), individual differences in physical appearances play as important a role in determining attitudes and behaviors as they do in real life. For example, sex stereotypes extend into virtual environments. In a virtual reality study by Guadagno, Blascovich, Bailenson, and McCall (2007) male and female participants were presented with arguments about campus security measures by either male or female virtual humans. The greatest attitude change between pre-tests and post-tests occurred when the participants and the virtual humans were the same sex. In that study, female virtual humans were thought to be more likeable, replicating the finding that women are warm whereas men are viewed as competent (Fiske, Cuddy, Glicke, & Xu, 2002). Fox and Bailenson (2009) presented individuals in virtual reality with virtual females who exemplified either high or low female stereotypes in terms of appearance and behavior. Individuals who saw the stereotypical virtual females demonstrated higher levels of sexism and rape myth acceptance than individuals who saw virtual females with visual/behavioral inconsistency.

Like sex, race is another characteristic that elicits stereotypes and in-group favoritism in both real and virtual contexts. Dotsch and Wigboldus (2006, 2008) found that when Dutch participants needed to inspect an avatar's clothing at a virtual bus stop, participants more closely approached avatars with White features than avatars with Moroccan facial features. Implicit negative attitudes towards Moroccans were positively correlated with the distance kept between participants and the Moroccan-featured avatars. Not only do real world racial attitudes affect virtual behavior, but a virtual experience can also shape real world racial attitudes. Groom and colleagues (2009) showed that regardless of actual race, participants who saw themselves transformed into Black avatars had stereotypes activated, showing greater racial bias than participants who saw themselves as White avatars. Although this instance of perspective taking resulted in greater prejudice, other uses of perspective taking have reduced negative stereotypes. In a study by Yee and Bailenson (2006), participants who saw their avatars represented as elderly in virtual reality associated more positive words with older adults than participants who saw their avatars represented as younger avatars.

The height and attractiveness of a user's avatar can also affect his or her real world attitudes and behaviors. Recent studies (Yee & Bailenson, 2007; Yee, Bailenson, & Ducheneaut, in press) showed that participants who saw themselves represented with taller avatars were more aggressive in negotiation tasks than those with short avatars, both inside of the virtual environment as well as in subsequent negotiations face-to-face. This suggests that the participants felt the same confidence is attributed to tall people in real life (Stogdill, 1948; Young & French, 1996). In separate studies, participants with attractive avatar representations approached a virtual

confederate more closely and were more disclosing than participants with avatars of average appearance (Yee & Bailenson, 2007; Yee, Bailenson, & Ducheneaut, 2009).

Desktop Virtual Environments

The studies detailed so far in this section used primarily immersive virtual environments as contexts for research. Immersive virtual environments and desktop virtual environments differ in important ways. As immersion increases, so does the effect of realism, feeling of presence, and transfer to real behaviors (Loomis, 1992; Lombard & Ditton, 1997; Persky & Blascovich, 2008). However, despite their limitations, desktop virtual environments can be used to study social phenomena. Even through desktop interfaces, individuals react to the mere presence of human representations sharing the same virtual space, just as they would immersive virtual environments or real life. Friedman, Steed, and Slater (2007) found that Second Life users maintain certain levels of interpersonal distance when interacting with the avatars of other users. They also discovered that Second Life users behave similarly when approached by an agent; this is likely because the communicative similarity of avatars and agents in the Second Life domain that overcame the distinction in perceived agency. Consistent with Blascovich's model of social influence, individuals in virtual environments had more realistic behaviors when they believed they were virtually co-present with more realistic human representations.

Williams, Cheung, and Choi (2000) used a desktop interface to replicate a previous study on ostracism (Williams & Sommer, 1997). In their simple virtual tossing game, Williams and colleagues found that the greater level of ostracism participants faced, the greater the aversive effects. Another study by Zadro, Williams, and Richardson (2004) highlighted humans' need for social inclusion. Even when participants were told that computer behavior in a ball game was scripted, they still felt as much ostracism as other cases when they thought they were playing with computers or real people.

Applications of Virtual Environments

Currently, desktop virtual environments are far more common than immersive ones, due to issues of cost and technology. In this section we describe the reasons these virtual environments are an effective communication medium.

Productivity. The advantage of virtual environments, especially simple commercial products which are extremely popular and available through desktop interfaces, is that they are more accessible to non-researchers because there is no special equipment required and low associated costs. For this reasons, more business are considering virtual environments for e-meeting. These environments may provide a greater degree of presence than traditional conferencing technologies (telephone and video) and also eliminating the hassle and cost of corporate travel for face-to-face meeting. Reeves, Malone, and Driscoll (2008) propose that a special category of virtual environments, massively multi-player online role-playing games (MMORGs), hones important business skills such as leadership, motivation, and information management. A study by Hoyt and Blascovich (2003) found that group performance on a work task was comparable in real and virtual contexts, although group leaders received higher rating in face-to-face meetings. Furthermore, Yee (2006) demonstrated that MMORGs are a particularly good arena in which to study leadership skills and social relationships.

Phobias. Researchers also study the extent to which real life phobias are activated in virtual settings. The use of virtual reality has spanned the most common fears like public speaking. In a comparison of confident and phobic speakers, Slater and colleagues (Slater, Pertaub, Barker, & Clark, 2006) found that their behaviors in empty and populated rooms replicated real life reactions. When speakers addressed an empty virtual room, there were no significant differences between the confident and phobic groups. However, when individuals had to speak to virtual rooms populated by a small virtual audience, phobic participants had significant increases in self-reported anxiety and somatic responses. In this case, the realism of the virtual environment allowed researchers to replicate and evaluate phobic responses. However, the flexibility of virtual environments can also enable therapists to create, control, and modify realistic scenarios for the treatment of phobias (for a review see Riva, 2005). Wiederhold and colleagues showed that graded exposures to flying experiences in virtual reality were effective in helping participants to fly without the aid of medication or alcohol (Wiederhold et al., 2002).

Behavior in Macro Social Contexts

Despite the evidence that these studies provide for real behavior in virtual environments, their findings are limited to brief interpersonal interactions. Only a handful of studies have examined virtual communities and individual behavior within these communities by studying economics (Castronova, 2005; Castronova et al., 2009), the role of law (Lastowka & Hunter, 2004), and the potential for democratic processes (Noveck, 2003). The current study captures broad social and behavioral patterns in one particular virtual environment, Second Life.

Second Life is an online virtual environment, but unlike massively-multiplayer online role-playing games, it does not employ rule-sets to structure in-game achievements and goals. Since user behavior is neither pre-defined nor restricted, scholars have recently turned to Second Life as a research platform to study how people behave in the virtual environment (e.g. .Yee, Bailenson, Urbanek, Chang, & Merget, 2007; Friedman et al., 2007; Eastwick & Gardner, 2008). Blascovich and colleagues (2002) have proposed that immersive virtual environments may be unique in their ability to provide social science researchers both experimental control and a realistic context. In this way, a virtual world can provide all of the benefits of a laboratory study, with all of the generalizability of a field study.

There is a growing literature examining social networks which is relevant to these questions. In one study of the online game *World of Warcraft*, researchers unobtrusively collected longitudinal data from over 200,000 users via an automated script at intervals of approximately fifteen minutes (Ducheneaut, Yee, Nickell, & Moore, 2006). By examining patterns of social groupings in the game, researchers found that users were far more likely to be playing alone than with other players even though the game is billed as being "massively-multiplayer." The authors of that paper suggest that online games are popular not because of the direct social interaction they offer, but the persistent social ambience they provide—the appeal of being "alone together" (Ducheneaut et al., 2006).

Additional studies have also shown the ability to leverage the social networks in these environments to study other dynamics of social interaction. For example, prior research has demonstrated that social network metrics in *World of Warcraft* are able to predict the survival

likelihood of player organizations over a six month period (Ducheneaut, Yee, Nickell, & Moore, 2007). Thus, virtual environments are important research platforms in that they allow us to gather longitudinal behavioral data unobtrusively to study important aspects of social interaction.

Current Study Overview

This current study was motivated by the desire to understand individual behavior within the macro social context of Second Life. It is unique for two reasons. First, it is a study that collects data over a six week time period. Very few empirical studies in virtual environments actually track the same users over time to see the effect on behavior. As pointed out by Terman (1916), looking at behavior over time is essential to understanding behavior. Indeed, in a study by Bailenson and Yee (2008), patterns of presence, social presence, and usage changed drastically over time when the same users returned to the virtual environment week after week. Second, it leverages the virtual environment platform to allow for both a high degree of realism and the collection of both subjective report and objective behavioral data. Consequently, by combining behavioral measures and self-reported data gathered over six weeks of time spent in Second Life, we get a better gestalt picture of participants' usage patterns.

Method

Participants

Eighty undergraduate and Master's students were recruited to enroll in a class that was designed around participation in Second Life. None of the participants reported having any previous experience using Second Life before hearing of the course. Four participants were identified as outliers because their total time in Second Life was significantly more or less than the rest of the sample; consequently, their data was not considered for analysis. Two of these participants spent less than ten hours total logged in, and two spent more than sixty hours logged in. (for the entire study, $M = 36.19$, $SD = 8.97$, and with outliers removed, $M = 36.03$, $SD = 5.27$). Two of the outliers were female and two were male, leaving a total of twenty-five female and fifty-one male participants. The average age of the seventy-six participant was 21.07 years ($SD = 3.68$.) Thirty-two participants were Caucasian, twenty-seven were African-American, ten were Asian, five were Latino/a, and two identified themselves as Other.

Design

Our statistical goal was to examine the evolution of our dependent variables over time. Consequently, data were analyzed using a general linear model, repeated measures analysis, with the within-subjects factor having six levels representing each of the six weeks. In a given week, outlying values beyond three standard deviations were replaced with the next closest value. The reported *p*–values refer to the linear trend of the tests for within-subjects contrasts. The Appendix contains a report of the means and standard deviations by week. Due to technical problems, data was not collected for chat during the second week and only five levels were used. For each analysis, we report the number of participants used in each ANOVA (due to missing data the number slightly varies), the value of the *F*-statistic , the *p*-value, and partial eta-squared (η^2).

Procedure

Prior to the start of the study all participants were required to attend a one-hour tutorial that

was designed to help them quickly learn the mechanics of the Second Life interface and Linden Lab's Community Standards. The main topics of this session included how to modify an avatar, communicate with other residents, move through space, search, buy and sell items, and add friends and groups. Immediately following the lecture, participants were urged to create a temporary Second Life account to use for the next week; this test avatar was used only for the purposes of familiarizing participants with the Second Life interface and was not considered for data gathering purposes.

After a week of using the temporary avatar account participants created a second account as their official account for the study. Upon creating the new avatar, they visited the researchers in Second Life to receive three items. First, each participant was given one thousand Linden dollars (L$1000) to use as they wanted. Then, the *Sender* tracking object (Yee & Bailenson, 2008), developed using Second Life's scripting language (LSL), was transferred to the participant, and the researcher confirmed that it was attached to the avatar. The participants were aware that when the object was attached to the avatar, the tool would gather data on movement, action, and chat, and then transmit the information to a database.

At 5pm on the Tuesday following the distribution of items and creation of new avatars, the first week of data collection began; the participants logged in hours in Second Life from Tuesday until Sunday at 5pm. Between Sunday at 5:01pm and Tuesday at 5pm, no Second Life hours were required and participants completed the first week's questionnaire at their convenience. This pattern of a five day window for in-world activity followed by a two day questionnaire response period was repeated for weeks two through six.

Measures

The measures and results sections are each divided two categories, Social Involvement (SI), and Activity and Exploration (AE). Social Involvement measures include how participants established social networks (friends and groups), sought out social areas (residents in-radius), or interacted with Second Life users (chat characters). The Activity and Exploration measures look at the actions participants were involved in (high-energy, low-energy), and the degree to which participants explored different areas of Second Life (teleports, favorite regions, unique regions).

SI: Friends. Participants reported during the weekly questionnaire how many friends they had on their Second Life friends list ($M = 6.35$, $SD = 3.02$). In Second Life there is a formal way to become a friend with another which involves mutual agreement.

SI: Groups. Each week the participants also reported the total number of groups of which they were members ($M = 1.89$, $SD = 1.60$). Groups within Second Life are clubs, teams, and organizations that sometimes require permission to join.

SI: Residents In-Radius. This measure represents how often a user spent time in populated areas. The Sender tool automatically measured the average number of other Second Life residents within a radius of twenty meters of the participant's avatar. This data was collected in real-time by the Sender tool and sampled every five seconds, so the average represents the averaging of all the samples during a week ($M = 4.26$, $SD = 2.63$).

SI: Chat Characters. Chat data was collected by the Sender tool and the measure is defined as the number of characters per week the participant transmitted to other avatars in Second Life (M = 991.33, SD = 766.84). This measure roughly quantifies how much they talked to others.

AE: *Low-energy Actions.* This measure is the ratio of time the participant spent crouching, sitting, and typing, relative to his/her total time spent inside Second Life (M = .42, SD = .21).

AE: High-energy Actions. This measure is the ratio of time the participant spent flying, walking, and running, relative to his/her total time spent inside Second Life (M = .15, SD = .10).

*AE: Teleports***.** A teleport is an instance in which the Second Life resident jumps to a different location. When an avatar teleports, it is instantly transported from one set of coordinates in the virtual environment to another (M = 15.96, SD = 7.82).

AE: Favorite Regions. Second Life is divided into square parcels of land called regions. This measure is the percentage of time the participant spent in his/her top three regions, with the top regions defined as the three regions in which the participant spent the most time (M = .55, SD = .17).

AE: Unique Regions. This measure reflects the number of unique Second Life regions a participant visited during a given week (M = 15.03, SD = 9.08).

Results

Means and standard deviations of all dependent variables over time can be seen in Appendix A. We first discuss the social involvement measures and then turn to activity and exploration.

Social Involvement

Friends. With each passing week in Second Life, participants were able to expand their social networks. Participants made personal connections with other Second Life residents, adding over four friends during the first week, and nearly doubling this total by the end of the sixth week. This upward linear trend is significant (N = 71, F[5, 69] = 77.27, p < .01, partial η^2 =.53).

Groups. Not only were participants able to interact on a personal level and add friends, but also they found and joined groups that represented their interests. The total number of groups steadily increased from week one to week six (N = 72, F[5, 66] = 64.75, p < .01, partial η^2 = .48) with participants averaging less than one group at the start, and ending under three groups.

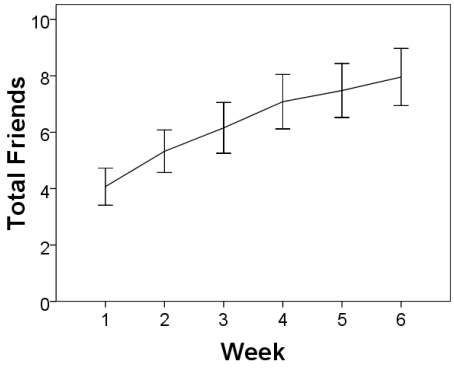

Figure 1: Total Friends

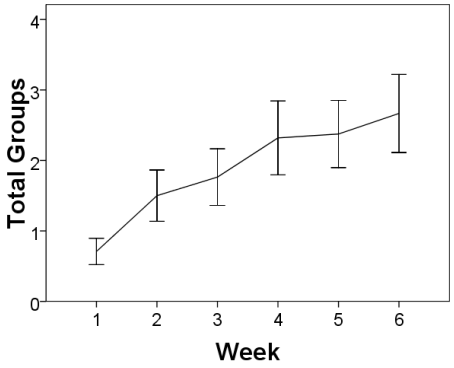

Figure 2: Total Groups

Residents In-Radius. Over time participants sought out more populous destinations ($N = 74$, $F[5, 68] = 5.66$, $p < .05$, partial $\eta^2 = .07$). During their first week, participants had an average of 3.5 other Second Life residents within a radius of twenty meters. By the end of the study, participants had 4.6 residents nearby. Thus, the participants grew more socially competent on several levels. They were engaged interpersonally, doubling friends between the first and last week; involved socially, increasing group membership; and found populated destinations successfully.

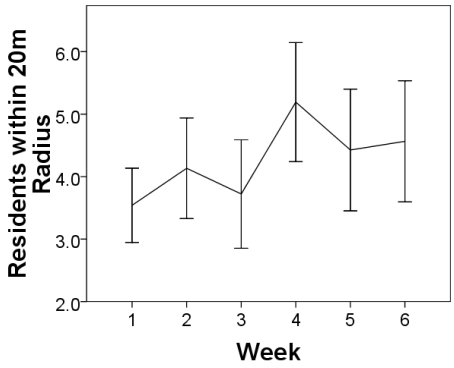

Figure 3: Residents within a 20m radius

Chat Characters. The quantity of chatting significantly decreased over the six weeks ($N = 76$, $F[4, 71] = 34.20$, $p < .05$, partial $\eta^2 = .31$). While the decrease in chat over time may seem counterintuitive at first, given the social emphasis on virtual environments, this finding matches the "alone together" phenomenon mentioned earlier that was found in another virtual environment (Ducheneaut et al., 2006). Taken together, the two sets of data suggest that while direct social interaction is appealing to new users, it is the indirect social ambience that is more appealing once the environment has become more familiar. Another possible explanation is that much of the early chat revolves around asking others about interesting locations or how to do certain things. As users familiarize themselves with the environment, the need to ask others for help decreases.

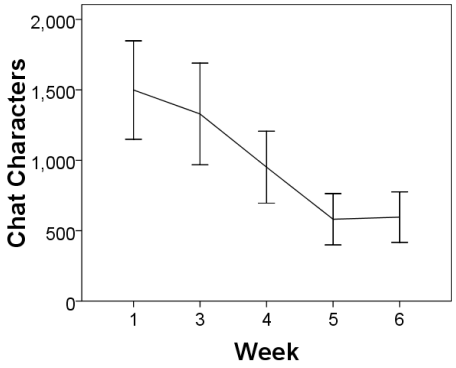

Figure 4: Chat Characters

Activity and Exploration

Actions. As participants established their social networks, they performed low-energy actions with greater frequency, high-energy actions with less frequency, and were less inclined to explore new regions. The participants' time performing low-energy actions doubled over the course of the six weeks, from twenty-four to fifty percent ($N = 76$, F[5, 70] = 36.98, $p < .01$, partial $\eta^2 = .33$). Conversely, the high-energy actions dropped from twenty-four to under ten percent of the time ($N = 76$, F(5, 70) = 65.35, $p < .01$, partial $\eta^2 = .47$). The high-energy actions did not require any more physical effort (i.e., more typing) than the low-energy actions, so the decrease in high-energy actions may simply indicate the participants' declining interest in exploring new areas.

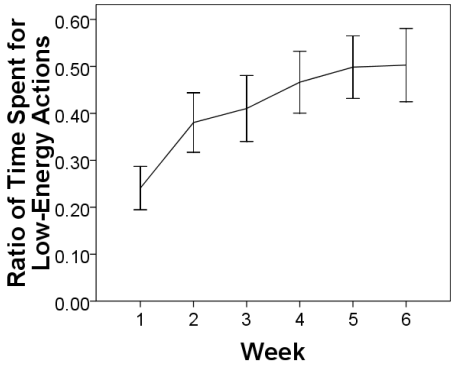

Figure 5: Low-Energy Actions

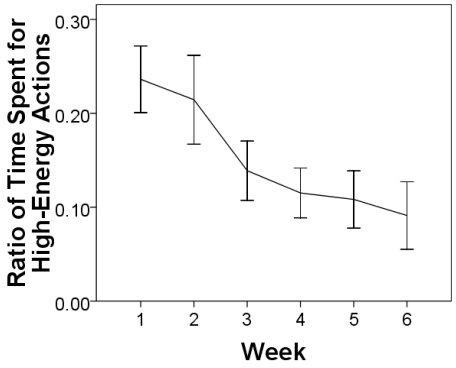

Figure 6: High-Energy Actions

Teleports. Teleporting dropped dramatically over the six weeks ($N = 75$, $F[5, 69] = 101.56$, $p < .01$, partial $\eta^2 = .58$) from an average of twenty-four teleports per week to nine, illustrating that the participants' initially had a high interest in exploring Second Life, but that this interest declined over time.

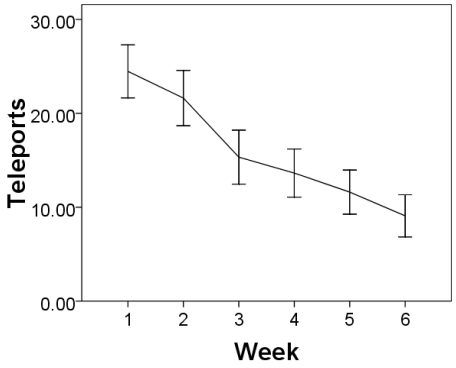

Figure 7: Teleports

Favorite Regions. The percentage of time spent in the participants' favorite three regions climbed significantly during the study ($N = 72$, $F[5, 66] = 110.25$, $p < .01$, partial $\eta^2 = .60$), from thirty-five percent in week one to seventy-two percent in week six.

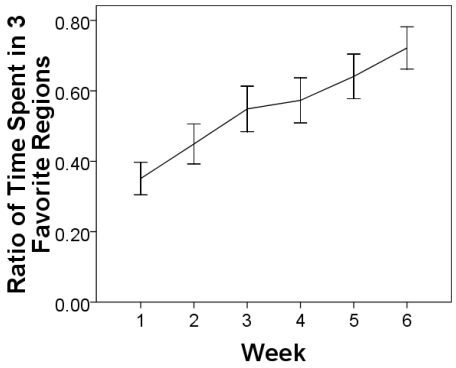

Figure 8: Favorite Regions

Unique Regions. Over the first six hours in Second Life, participants visited nearly twenty-four unique regions. After a steady decline ($N = 75$, $F[5, 69] = 117.48$, $p < .01$, partial $\eta^2 = .61$) over the next five weeks, participants visited a mere eight regions in their final week, further supporting the pattern of declining exploration.

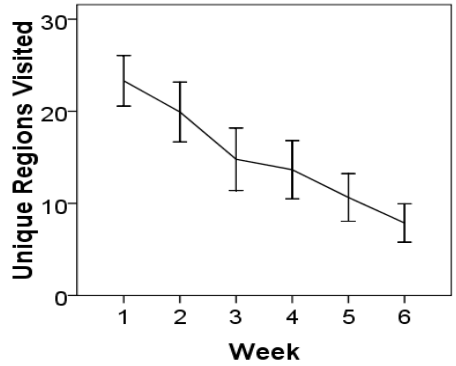

Figure 9: Unique Regions

Discussion

Summary

This is the first study to provide a large amount of quantitative and qualitative data in a controlled study in Second Life. Over the six week period, participants became more established in their social roles. As time went on they spent more time in populated areas, made more friends and joined more groups, but also became more habitual and sedentary, staying in the same location more often, teleporting less, and logging in via longer, more regular intervals. In addition, they found activities to occupy themselves that were negatively correlated with talking, and over time the frequency and duration of chat went down. These results replicate and extend some previous studies of virtual and online worlds. Research using the Microsoft virtual environment, V-chat (Smith, Farnham, & Drucker, 2002; Cheng, Farnham, & Stone), just as in this Second Life study, found that some behaviors such as avatar customization increased over time, but action-oriented gestures and positioning decreased over the course of the study. The increase in the number of friends and groups over time support William's (2007) finding that time online can lead to an increase in social capital gains.

Qualitative Responses

In addition to measuring objective behavior and questionnaire responses, we also had participants fill out open ended questionnaires. Each week in an open-ended response, participants also noted which events they attended. Two independent coders read the participants' event descriptions, and then counted the events they listed as being in one of the following categories: classes/learning, community outreach, cultural events, gambling, parties, religious ceremonies, sexual activities, and sporting events. Discrepancies between the coders were resolved through discussion. The most popular events were parties (e.g., night clubs, dances, bars) which comprised thirty-four percent of all attended events. The next most frequented events were classes and learning environments, accounting for nineteen percent of reported activities, followed by cultural events (e.g., music shows, museums, poetry) at fourteen percent. Gambling accounted for fourteen percent as well. Other notable categories were sporting events (six percent), sexual activities (six percent), religious ceremonies (five percent), and community outreach (two percent). There were no statistically significant changes in these trends over time. Previous research (Boellstorff, 2008) has conducted interviews with Second Life users to get an anthropological account of the types of activities that occur. The current study augments that research by providing a large sample of participants engaging in various activities over time. According to this data, there is actually quite a good balance between "enrichment" activities such as learning and cultural events and "entertainment" activities such as partying and gambling. In this sense, the activities that occurred in the virtual environment more or less mirrored the type of balance one sees in the physical world.

Implications

There are three main implications for these findings. The first deals with a "media effects" tradition. Research indicates that our virtual lives and physical lives are not independent, and our appearances and actions have both online (Taylor, 2002) and offline consequences (McArthur, 2008). Furthermore, our virtual selves shape our offline attitudes and behavior, both for better (Yee & Bailenson, 2008) and for worse (Bushman & Anderson, 2007). Consequently,

understanding the nature of social interaction in Second Life is important. Our preliminary findings indicate that people change their social lives over time to become more stable in their interactions, seeking out a fewer places with more people in them. They also revert to "real animations" that are more typical in the physical world—walking from point A to point B instead of running or using Second-Life-unique methods of locomotion such as teleporting and flying.

The second deals with experimental research. Many theorists argue that virtual environments can be a valuable forum for virtual research (Williams, Yee, & Caplan, 2008; Yee & Bailenson, 2006), a "Petri dish" in which to discover social science trends such as economics (Castronova, 2005), psychology (Blascovich et al., 2002), and law (Lastowka & Hunter, 2004; Noveck, 2003). Our data show that over time, social interactions change in ways that are consistent with the notion that stable patterns of interaction emerge, with people seeking out familiar places and falling into routines. In addition, as in the physical world, there are a wide range of activities and people vary in their use of those norms. Consequently, the current findings support the idea that virtual environments like Second Life can enable research programs in that people behave in a relatively natural spread of behavioral patterns.

Limitations and Future Directions

There are a number of limitations in the current study and design. First of all, some of our measures, have extremely large standard deviations. For example, on characters typed, the standard deviation is actually larger than the mean. While this pattern is problematic, issues of this nature often emerge when measuring behavior, as opposed to questionnaires. Previous researchers (Bailenson et al. 2005; Slater et al. 2004; Garau & Slater, 2001) have pointed out that more research needs to measure actual behavior, as opposed to self report data. While moving towards this measurement strategy is essential, it is not without cost, as behavioral data often presents more variance than typical Likert response scales. In future research we will avoid the specific dependent variables which produced such high variance.

Another notable limitation was that our study participants were not the "natural" Second Life users, in the sense that they were extrinsically motivated to use the virtual environment to get course credit. While this is no different from most usability studies, it would be useful to recruit actual regular users or people who planned on using Second Life (as opposed to people who had no intention of using the virtual environment before the study began) in order to gain a more holistic understanding of social behavior in Second Life. In addition, because of privacy issues regarding data collection, it was difficult to ascertain the exact nature of the activities of our subjects over time. In future work, it would be useful to get a more specific quantification of the nature of activities and chat. Finally, while this study accumulated more data than any empirical Second Life study to date, it would have been useful to monitor our subjects for a longer period of time (i.e., months instead of weeks) in order to get a more thorough understanding of how behaviors evolved.

Ethical Issues

The current study is one example of how multi-user virtual environments (MUVEs) can be valuable tools for social science research in "naturalistic" settings, but that MUVEs also carry with them ethical issues and privacy concerns (Schroeder & Bailenson, 2008). In the current study,

several steps were made to maintain as much privacy as possible for both Second Life residents and the participants in our study, for example referring participants to community standards, collecting data only from our participants (not from others in Second Life), and by making sure our participants did not have reference to their actual names in their Second Life names. Moreover, as in any study, we ensured, with the help of our institutional research board, that all collected data was kept anonymous.

In their chapter on ethics in online research, Enyon, Fry, and Schroeder (2002), comment that participants don't necessarily realize the extent to which online behavior and interactions can be captured and recorded. To make our data gathering obvious, when the tracking object was attached to the participant avatar, a highly-visible tie-dye rectangle became visible in the corner of the Second Life interface. In addition, prior to the start of the study, participants were explicitly told that the tracker object would gather their every word, gesture, and movement within the online world. Personal and potentially sensitive information was limited by the type of data we chose to include in our analysis; chat counts were chosen over the actual words typed, and in-world travel was used rather than the exact locations visited. Nonetheless, given the potential to use all of the tracked data in any virtual world, it is important to discuss and consider ethical issues surrounding this data.

In sum, this current study was largely exploratory. However, the patterns which emerged across a very large number of various dependent variables paint a surprisingly consistent picture of what realistic behaviors people replicate in Second Life, as well as how this behavior changes over time.

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Appendix A: Means of Variables By Week

		Friends	*Groups*	*Residents In-radius*	*Chat Characters*	*Low-energy Actions*	*High-energy Actions*	*Teleports*	*Favorite Regions*	*Unique Regions*
		n = 71	n = 72	n = 74	n = 76	n = 76	n = 76	n = 75	n = 75	n = 75
Week 1	m	4.07	0.71	3.54	1498.92	0.24	0.24	24.47	0.35	23.31
	sd	2.77	0.8	2.57	1529.69	0.2	0.16	12.29	0.2	11.95
Week 2	m	5.32	1.5	4.13		0.38	0.21	21.63	0.45	19.92
	sd	3.19	1.55	3.47		0.28	0.21	12.78	0.25	14.13
Week 3	m	6.15	1.76	3.72	1328.95	0.41	0.14	15.33	0.55	14.79
	sd	3.8	1.71	3.74	1580.49	0.31	0.14	12.52	0.28	14.72
Week 4	m	7.08	2.32	5.19	951.13	0.47	0.12	13.63	0.57	13.65
	sd	4.08	2.23	4.11	1119.03	0.29	0.12	11.14	0.28	13.76
Week 5	m	7.48	2.37	4.43	581.3	0.5	0.1	11.61	0.64	10.64
	sd	4.04	2.03	4.2	795.61	0.29	0.13	10.21	0.27	11.25
Week 6	m	7.96	2.67	4.57	596.33	0.5	0.1	9.08	0.72	7.87
	sd	4.28	2.36	4.18	784.98	0.34	0.16	9.78	0.26	9.05

Appendix B: Questionnaire Items

How many total friends do you currently have?
How many groups are you a member of?
Please list and describe the events you attended this week.