Social Maintenance and Psychological Support using Virtual Worlds

Peggy Wu[1], Jacquelyn Morie[2], J. Benton[1], Kip Haynes[2], Eric Chance[2], Tammy Ott[1], Sonja Schmer-Galunder[1]

[1] Smart Information Flow Technologies, Minneapolis, MN

{PWu, JBenton, TOtt, SGalunder}@Siftech.com

[2] All These Worlds, LLC, Los Angeles, CA

Morie@usc.edu, KipHaynes@gmail.com, Chance.Abattoir@gmail.com

Abstract. In the space exploration domain, limitations in the Deep Space Network and the lack of real-time communication capabilities will impact various aspects of future long duration exploration such as a multi-year mission to Mars. One dimension of interest is the connection between flight crews and their Earth-based social support system, their family, friends, and colleagues. Studies in ground-based analogs of Isolated and Confined Environments (ICE) such as Antarctica have identified sensory deprivation and social monotony as threats to crew psychological well-being. Given the importance of behavioral health to mission success and the extreme conditions of space travel, new methods of maintaining psycho-social health and social connections to support systems are critical. In this paper we explore the use of Virtual Environments (VEs) and Virtual Agents (VAs) as tools to facilitate asynchronous human-human communication, and counteract behavioral health challenges associated with prolonged isolation and deep space exploration.

Keywords: Virtual Worlds, Virtual Agents, Psychological support, Communications, Psychological Health

1 Introduction

At this very moment, there are tens of thousands of real people currently logged on, socializing, conducting commerce, and essentially living their lives in a virtual environment. Individuals unsatisfied with their real life can gain life satisfaction with their virtual life [1]. We speculate that satisfaction with social connections and interpersonal skills can be increased in real life, and environmental stressors can be alleviated through strategically designed experiences delivered through virtual environments. Currently, Virtual Environments (VEs) primarily provide entertainment value, but their predecessor, Virtual Reality, has been used to train technical skills that result in real life performance enhancements. VEs are no longer a novel concept, but their use as a construct to deliver real world benefits is just in its infancy.

In the domain of space exploration, NASA has identified the need to develop support and adaptation countermeasures to social isolation among the flight crew from their family, friends, and the ground crew. This problem currently occurs on Earth, where geographically distributed groups desire to share their lives or work together remotely. Both real time solutions such as video, voice, and text chat, and time delayed solutions such as email, social network websites, and micro voice messaging serve to keep communities connected. However, there are unique challenges for their application to long duration space missions. Given technical restrictions such as communication delays and data transfer/bandwidth limitations, no single interaction method can accommodate all different types of interactions (e.g. short casual messages vs. long discussions). The social monotony and isolation of a long duration mission can result in limited perspective taking, increasing ruminations and likelihood for misunderstandings. Maintaining and strengthening of social skills are crucial to counteract the risk for deterioration after extended periods of isolated activity. The astronaut in-flight needs the appropriate outlet and support system in place, such as to allow for the possibility to engage in social activities and to withdraw into a more private sphere on a routine basis. The solution must maintain ties with existing friends and family, but may also accommodate developing new ties with new friends and colleagues as suggested by prior research [2].

In the past decade VEs and intelligent Virtual Agents (VAs) have come together to make possible a new range of human interaction opportunities. Virtual Worlds (VWs) have taken the paradigm of Virtual Reality and transformed it into rich, persistent, networked 3D spaces populated by tens of thousands of people using embodied avatars. Intelligent VAs are able to work as tutors, guides, conversational partners, and even as virtual therapists [3]. VWs combined with VAs have been used by ourselves and others to address human interactions in a diverse set of domains, from language and culture training [4, 5] to medical consulting [6, 7]. Morie et al. used VWs as an advanced form of tele-health care to facilitate and support soldiers in reintegration into civilian life in a project called "coming home" [8]. The authors have been developing a socio-linguistics based engine for driving intelligent VA social behavior and for detecting emotional changes in humans through their speech or written word. This document describes the use of VEs for long distance, long duration exploration class space missions. VEs have demonstrated their utility in enhancing telemedicine [9,10 ,11 ,12, 13] supporting behavioral therapy [e.g. 14], and applications in language and culture training [15,16], as well as robotics and equipment maintenance training [17, 18]. We believe its promise can extend to enhancing psychosocial health in space flight to directly address the risk of adverse behavioral conditions. We describe our process and results below.

2 Benefits Gained from Virtual Worlds can Carry into the Real World

There is increasing evidence that behaviors learned in VWs can migrate into the real world. For example, in a meta-study of the field of VRET, Parsons and Rizzo [19] note the efficacy of Virtual Reality Exposure Therapy (VRET) in treating various anxiety disorders, such as acrophobia, agoraphobia, social anxiety and post-traumatic stress disorder. More directly, Yee and Balienson describe "The Proteus effect" [20, 21], the observed phenomenon where self-perception and skills obtained through a digital persona (i.e. through manipulations of their online avatar), including attitudes gained from virtual worlds, are maintained even when the human reenters the real world. All of this advocates that humans not only interact socially and meaningfully in VEs, they can also be primed for behavior modification and interpersonal sensitivities, and the effects of that priming can carry over into their offline interactions in live situations.

The ability to harness benefits acquired from virtual spaces translates to several applications in space. Psychological support can play an important role in risk mitigation since astronauts may experience anxieties while in flight, which then could be alleviated (or even prevented) by in vivo virtual world intervention. Given the limitations of the habitat, VEs may also be used to encourage relaxation and mindfulness: to create a spot to gather one's thoughts, to calm down, or to be alone in a manner that facilitates a restful state in the person. For instance, an astronaut may choose to sit in the VW near a quiet spot designed for meditation, or practice mindfulness therapy (as developed by John Kabat-Zinn [22]) utilizing awareness of the present moment and centering of one's thoughts. This type of work is being tested in Second Life at the University of Southern California's Institute for Creative Technologies [23]. Such quiet activities could help in providing support to people of different personality types, whereby some people gain energy by socializing (extroverted people) and others (introverted people) gain energy by isolating and recuperating alone. A tonic environment may be, for instance, a waterfall in a forest, or a mountaintop on a snow-filled valley. VEs may thus also provide a way to relax, recover and gather one's thoughts by a feeling of quiet and connection through one's environment. For many, this is an important way to "ground" oneself, even though one's physical environment is stressful, disengaging with that environment and changing it to a relaxed environment is crucial.

VWs may also provide good environments to acclimatize and acculturate crews that have been long removed from the world as a form of re-entry preparation. They can do this by providing them with updates on world events, news, new movies and cultural and historical development throughout the mission. As these long duration missions keep them out of the loop, we see a great benefit in helping astronauts get additional information through VEs that help them acclimate to the changes they have not witnessed or experienced while away from earth.

3 Method

Our goal is to create a holistic, evidence-based approach for formulating natural scenarios that address crew and Earth psychosocial health while ensuring its compatibility with currently known operational limitations such as bandwidth, communication delay as well as habitat restrictions. To design this system, we first leveraged a prior review of over 50 publications and technical reports to extract possible psycho-social dimensions of interest [24]. Using this literature review, we focused on psychosocial dimensions relevant to long duration exploration missions that can be addressed by virtual environments. We then conducted a review of current evidence-based best practices in supporting the psycho-social dimensions of interest identified above. In addition, we investigated methods of augmenting time delayed communication in VEs through VAs powered by Artificial Intelligence (AI) engines. In the last decade, researchers have begun focusing efforts on the merger of VEs and AI agents. A full survey of this work can be found in Morie, et al.'s survey on Embodied Conversational Agents (ECAs)[25]. The work of incorporating VAs into VEs is very much in its infancy, even more so than incorporating autonomous intelligent robots into the real world. Compared to other research into AI agents, the empirical data specific to VA effectiveness in either realism or helpfulness is limited. There are a few exceptions to this, however. For example, Jan D., et al. [26] note that virtual AI helpers are asked more questions than one might expect, while Weitnauer, et al. observed that when virtual world participants were unaware that they were conversing with an AI agent (named Max), they reported frustration with its repetitiveness [27], which paralleled reports about ELIZA, a simple natural language processor built in the mid-1960s which posed as a Rogerian psychotherapist[28]. Our own prior work showed that human subjects readily anthropomorphized even non-embodied agents [29], confirming Nass's findings that humans generalize patterns of conduct and expectations for human-human interaction to human-computer interaction [30]. Further, we found the social aspects of human-machine interaction affected not only subjective measures such as trust, but also objective performance metrics such as compliance [29]. More generally, we believe embodied VA will only amplify the human tendency to anthropomorphize technology, and increase the psychological investment and engagement of the human.

This work resulted in a list of broad and wide ranging strategies such as the use of plant life to combat monotony and sensory deprivation, training for marriage and family specific as well as general interpersonal skills, recalling moments of gratitude, and focusing on past and future responsibilities and expectations to reinforce sense of meaningfulness. These strategies can be implemented in a variety ways as VE realizations, ranging from novel virtual scenarios that families can experience together to the use of VAs to add social diversity and deliver training. Next, we selected a subset of strategies, reviewed commercially available VW technologies, and began to design activities surrounding those strategies within a virtual space. We describe the result of our designs below.

4 Implementation in Virtual Environment

We created a virtual space in which to implement the evidence based strategies that promote social connectedness and individual psychological well-being. The strategies we selected can be categorized as having the following objectives:

- Enhance human-human asynchronous communications
- Counter social monotony and isolation
- Combat sensory deprivation due to habitat and vehicle limitations

The resulting virtual environment consists of a main building, the Family Communication Center, or FAMCOM, and extensive outdoor spaces (see Figure 1).

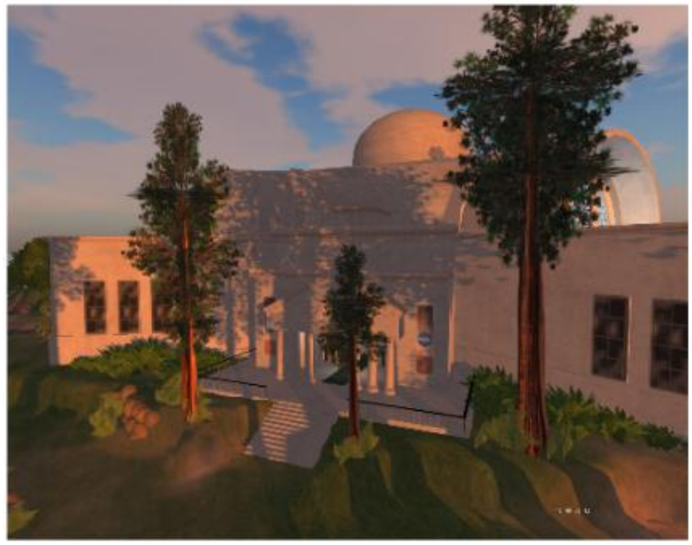


Figure 1 View of main building, FAMCOM from exterior.

The lighting and weather in the virtual environment can mimic those on Earth, providing the end user with reminders of the changing seasons and providing visual and audio stimuli otherwise not available. Currently on the International Space Station, the flight crew has a constant and majestic view of Earth. However, Earth will be a distant dot of light during some phases of a long duration mission. This can further increase the feeling of isolation and disconnectedness. Visuals as well as audio of nature sounds such as rain and wildlife will help to combat sensory deprivation. Looking at nature for even brief periods of time has been shown to decrease stress. There are many opportunities for virtual world implementation to leverage the positive effects of nature on psychological well-being [31]. Activities can be solitary, such as watching the sunrise/sunset and the movement of clouds, or they can be layered with social activities such as enjoying a camp fire (see Figure 2).

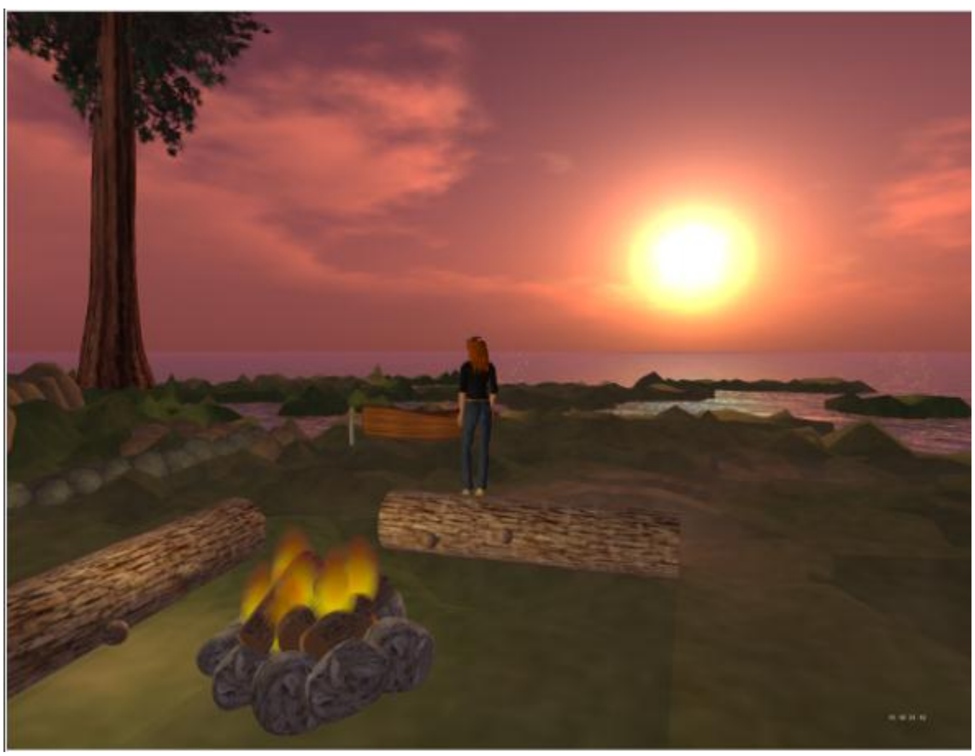
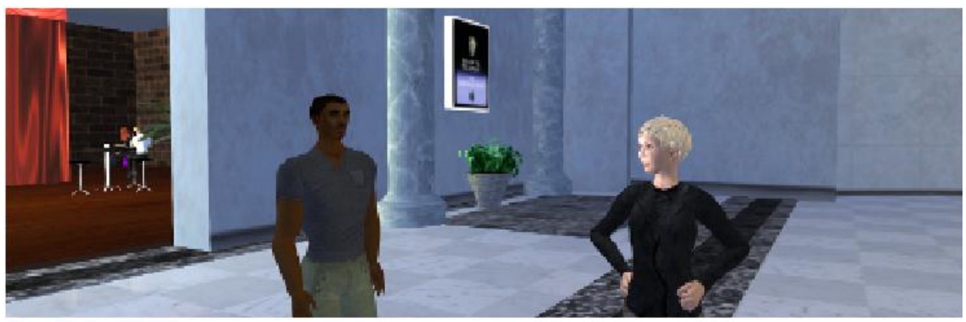


Figure 2 A virtual space outside of FAMCOM for enjoying nature.

Figure 3 Games such as chess are asynchronous in nature thus can be implemented in this application despite time latencies.

In addition to outdoor spaces, we created a variety of interior settings within FAMCOM. These include spaces for large groups, such as conference areas for conducting asynchronous educational outreach events, as well as gathering places for small groups where individuals can engage in activities such as an asynchronous game of chess with a friend on Earth (see Figure 3). Within the virtual space, end users can create and exchange virtual "care packages". This not only provides novelty to combat monotony, but gift giving boosts mood [32] and increases social connection to giver [33].



Due to the vast distance between the spacecraft and Earth, a communication delay will prevent real time network connections. As a result, flight crews and Earth-bound family and friends will not be able to interact in real time in the virtual environment. However, avatars that represent individuals can be automated and logged in to perform pre-recorded and even interactive behaviors. This activity of watching avatars in the virtual space is similar to watching a movie or a home video but with increased interactivity. Recently, the fields of neuroscience and film studies have come together in "neurocinematics". One area of interest is the role of "mirror neurons" and the effects of film watching on the viewer's emotions [34]. We believe this also applies in our application, where mirror neurons can be activated when viewing one's avatar interacting with objects and other individuals in the virtual space, causing real emotional responses. This idea is compatible with observations from both the "The Proteus effect" [20, 21], and "The Media Equation" [30], and is reported anecdotally by thousands of virtual environment users.

5 Future Work and Conclusion

The next phase of this work includes a ground based validation study to identify the effects of performing health promoting activities within the deigned virtual spaces. The specific application of supporting space exploration has a highly limited intended audience, but the ideas developed within this project can be applied to any groups for asynchronous communication, whether they are geographically distributed or not. The tremendous growth of asynchronous communication (e.g. IM, texting, email) shows that at least sometimes, the benefit of convenience outweighs the cost of coordinating with multiple parties for real time communication. While VEs are not meant to replace existing methods with which people connect, they can provide additional value. In the real world, interactions with people often go hand-in-hand with interactions with tangible things. VEs can unleash new dimensions of interaction that allows for shared manipulation of objects and shared experiences, potentially enhancing shared mental models and improving cohesion and coordination. Further, the persistence of objects within VEs makes them excellent vehicles for delivering experiential learning in the growing industry of online self-paced learning, which is estimated to become a $51.5 B worldwide market by 2016[35].

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References

1 Castronova, Edward, Wagner, Gert G. (2011). Virtual Life Satisfaction. Interanational Review for Social Sciences. Vol 64 Issue 3.

2 Cartreine, James A. Risks for Future Depression in Astronauts: A Narrative Review of the Literature. http://humanresearchroadmap.nasa.gov/Evidence/other/BMed%20Additional%20Evidence.pdf Accessed 1/2014

3 Litz, B.T., Wang, J., Williams, L., Bryant, R., & Engel Jr, C.C. (2004). A Therapist-Assisted Internet Self-Help Program for Traumatic Stress. *Professional Psychology: Research and Practice, 35*(6), 628-634.

4 Interactive Phrasebook - Embedding Human Social Dynamics in Language Training. Peggy Wu and Christopher Miller. In *Proceedings of Second IEEE International Conference on Social Computing* (SocialCom 2010) Aug 20-22, 2010, Minneapolis, MN.

5 Miller, C., Wu, P., Funk, H., Wilson, P., & Johnson, W. L. (2006, May 15-18). A Computational Approach to Etiquette and Politeness: Initial Test Cases. *Proceedings of 2006 BRIMS Conference*, Baltimore, MD.

6 Bickmore, T., 2003. Relational agents: effecting change through human–computer relationships. Unpublished Ph.D. Thesis, Massachusetts Institute of Technology, Cambridge, MA, USA.

7 Wu, P., Miller, C., & Ott, T. (2009, July 19-24) Utilizing Human Computer Etiquette to Encourage Human-Machine Therapeutic Alliance. *Proceedings of the 13th International Conference on Human-Computer Interaction,* San Diego, CA.

8 Morie, J. (2009). Re-Entry: Online worlds as a healing space for veterans. The Engineering Reality of Virtual Reality 21st Annual IS&T/SPIE Symposium, San Jose, CA. http://people.ict.usc.edu/~morie/ComingHome/Morie-2009-2SPIE-FINAL.pdf.

9 Schmer-Galunder, S., Sayer, N., Wu, P. & Keller, P. (2013). Continuous Anger Level Monitoring (CALM) - A mental health smartphone application. Paper submitted to SOTICS 2013.

10 Scherer, S. Stratou, G., Mahmoud, M., Boberg, J. Gratch, J., Rizzo, A. & Morency, L.-P. (2013). User-State Sensing for Virtual Health Agents and TeleHealth Applications. 10th IEEE International Conference on Automatic Face and Gesture Recognition. Shanghai, China, April 2013.

11 Rizzo, A., Strickland, D. & Bouchard, S. (2005). The Challenge of Using Virtual Reality in Telerehabilition. Telemedicine Journal and e-Health. Vol 10(2).

12 Morie, J. F. , Haynes, E., Chance, E. and Purohit, D. Virtual Worlds and Avatars as the New Frontier of Telehealth Care. Stud Health Technol Inform. 2012, 181:27-31.

13 Johnsen, K., R. Dickerson, A. Raij, B. Lok, J. Jackson, M.Shin, J. Hernandez, A. Stevens, D. S. Lind. "Experiences in Using Immersive Virtual Characters to Educate Medical Communication Skills." To Appear in Proceedings of IEEE Virtual Reality 2005 (VR 2005). Bonn, Germany, March 2005.

14 Morie, J.F., Antonisse J., Bouchard S., Chance, E.:Virtual worlds as a healing modality for returning soldiers and veterans. In: Wiederhold, B., Riva, G. (eds.) Studies in Health Technolology and Informatics: Annual Review of Cybertherapy and Telemedicine 2009 – Advanced Technologies in the Behavioral, Social and Neurosciences, vol. 144, pp. 273-276. (2009)

15 Zheng, D. & Newgarden K. (2011). Rethinking Language Learning: Virtual Worlds as a Catalyst for Change. International Journal of Learning and Media, Vol 3(2), pp 13-36.

16 Johnson, W.L., Friedland, L., Schrider, P., Valente, A., & Sheridan, S. (2011). The Virtual Cultural Awareness Trainer (VCAT): Joint Knowledge Online's (JKO's) Solution to the Individual Operational Culture and Language Training Gap. Proceedings of ITEC 2011. London: Clarion Events. Describes the instructional design and implementation of Alelo's VCAT courses.

17 Bluemel, E., Hintze, A., Schulz, T. Schumann, M. et al. (2003). Virtual environments for training of maintenance and service training tasks. Simulation Conference, 2003.

18 Guidali, M., Duschau-Wicke, A., Broggi, S., Klamroth-Marganska, V., Nef, T. & Riener, R. (2011). A robotic system to train activities of daily living in the virtual environment. Medical & Biological Engineering & Computing, Vol 49 (10) pp 1213-1223.

19 Parsons, T.D., & Rizzo, A.A. (2008). Affective Outcomes of Virtual Reality Exposure Therapy for Anxiety and Specific Phobias: A Meta-Analysis. *Journal of Behavior Therapy and Experimental Psychiatry, 39*, 250-261.

20 Yee, Nick; Bailenson, Jeremy; Ducheneau, Nicolas. The Proteus Effect: Implications of Transformed Digital Self-Representation on Online and Offline Behavior. Communication Research. 2009.

21 Yee, N. & Bailenson, J.N. (2007). The Proteus Effect: The Effect of Transformed Self-Representation on Behavior. *Human Communication Research*, 33, 271-290.

22 Kabat-Zinn, J. (1990). Full catastrophe living: Using the wisdom of your body and mind to face stress, pain, and illness, Bantam Dell; New York.

23 Morie, J. F., (2009). Virtual Worlds as a Healing Modality for Returning Soldiers and Veterans. 14th Conference on CyberTherapy and CyberPsychology Proceedings, in *CyberPsychology and Behavior* (12): 5, Mary Ann Liebert Publisher, Inc.

24 Wu, Peggy, Rye, Jeffrey, Miller, Christopher, Schmer-Galunder, Sonja, and Ott, Tammy (2013). Non-Intrusive Detection of Psycho-Social Dimensions using Sociolinguistics. Third Workshop on Social Network Analysis in Applications (SNAA) of IEEE/ACM International Conference on Advances in Social Networks Analysis and Mining (ASONAM 2013), Niagara Falls, Canada, August 25-28, 2013.

25 Morie, J. F., Chance, E. Haynes, E. and Purohit, D. (2012) Embodied Conversational Agent Avatars in Virtual Worlds: Making Today's Immersive Environments More Responsive to Participants. In *Believable Bots: Can Computers Play Like People*, Philip Hingston, Ed., Springer-Verlag: 99-118.

26 Jan, D., Roque, A., Leuski, A. Morie, J., and Traum, D. R. (2009) A Virtual Tour Guide for Virtual Worlds. In *Proceedings of the Intelligent Virtual Agents, 9th Annual Conference, IVA 2009*, Amsterdam, The Netherlands, September 14-16, 2009. Lecture Notes in Computer Science. Ruttkay, Z., Kipp, M., Nijholt, A. and Vilhjálmsson , H. H. (Eds). Springer: 372-378.

27 Weitnauer, E., Thomas, N. M., Rabe, F., & Kopp, S. (2008, January). Intelligent agents living in social virtual environments–bringing max into second life. In *Intelligent Virtual Agents* (pp. 552-553). Springer Berlin Heidelberg.

28 Weizenbaum, Joseph (January 1966), "ELIZA — A Computer Program For the Study of Natural Language Communication Between Man And Machine", *Communications of the ACM* **9** (1): 36–45, doi:10.1145/365153.365168

29 Can Polite Computers Produce Better Human Performance? Peggy Wu and Christopher Miller. In Proceedings of ACM Multimedia 2010 International Conference, Oct. 25-29, 2010 Firenze, Italy.

30 Reeves, B. and Nass, C. 1996. *The Media Equation*. Cambridge University Press, Cambridge, UK.

31 Valtchanov, D. Barton, K.R. & Ellard, C. (2010). Restorative effects of virtual nature settings. Cyberpsycholo. Behav Soc Network. 13(5), 503-12.

32 Anik, Lalin, Aknin, Lara B., Norton, Michael I., Dunn, Elizabeth W. (2009). Harvard Business School Working Paper. Feeling Good about Giving: The Benefits (and Costs) of Self-Interested Charitable Behavior. Accessed 7/2013: http://www.hbs.edu/faculty/Publication%20Files/10-012.pdf

33 Zhang, Yan and Epley, Nicholas (2012). Exaggerated, Mispredicted, and Misplaced: When “It’s the Thought that Counts” in Gift Exchanges. J. Experimental Psychology: General. Vol 141, No 4, 667-681. American Psychology Association. Accessed: http://faculty.chicagobooth.edu/nicholas.epley/ZhangEpleyJEPG2012.pdf

34 Konigsberg, Ira (2007). Film Theory and the New Science.” Projections: The Journal for Movies and Mind 1 (1): 1–24. Accessed: http://www.ingentaconnect.com/content/berghahn/proj/2007/00000001/00000001/art00002?token=005310af573d257025702c492b2f2d3125765747357c4e7547543c7e386f642f466f771614f4710e488

35 http://www.ambientinsight.com/Reports/eLearning.aspx