Effectiveness of Social Virtual Reality

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A lot of work in social virtual reality, including our own group's, has focused on effectiveness of specific social behaviours such as eye-gaze, turn taking, gestures and other verbal and non-verbal cues. We have built upon these to look at emergent phenomena such as co-presence, leadership and trust. These give us good information about the usability issues of specific social VR systems, but they don't give us much information about the requirements for such systems going forward. In this short paper we discuss how we are broadening the scope of our work on social systems, to move out of the laboratory to more ecologically valid situations and to study groups using social VR for longer periods of time.

CCS Concepts: • **Computing methodologies → Virtual reality**; • **Human-centered computing → Virtual reality**.

Additional Key Words and Phrases: virtual reality, 3D user interfaces

1 INTRODUCTION

Social virtual reality (SVR) applications have been around almost as long as virtual reality systems. For example, the seminal Reality Built for Two system from VPL Research dates from the late 1980s and the machines from Virtuality Systems were available to the general public in arcades from the 1990s. Since these early systems, it has been noted that the immersive nature of systems creates a collaborative situation that is quite different than video, text and audio-based communication. This appears to be because each user is represented as an avatar and that avatar is dynamically animated by tracking information. Thus body language is quite natural and we can observe spatial interactions between people that can use rules and styles that are inherited from real social situations (e.g. see [13]).

There are now a plethora of SVR systems to engage with, many of which are available on consumer VR equipment [5, 15]. There are many different design choices around the avatar representations, capabilities for interaction, tasks supported and social structures that are supported (e.g. see surveys [2, 4]).

While there is a lot of design variation, prior work of our own group has focused on interaction of small groups. The core activity is that a small group (2-5 persons) are engaged in a task that involves talk around a small number of objects in the environment. Our concern has been how effective tasks can be, especially when compared to a group engaging in a similar task in the real world (e.g. from [20] through to [6]). In this position paper we discuss the trajectories of some of this work.

2 VIRTUAL VERSUS REAL INTERACTIONS

Something seemingly unique happens when users are immersed in VR: they can be observed using behaviours or showing reactions, that would be appropriate in analogous real-world situations. Thus, even very early SVR systems solicited socially appropriate behaviours from participants, such as offering and receiving of handshakes, social group formation, and other non-verbal behaviours. Such behaviours demonstrate that the users are engaging with others, and many studies have looked at the necessary conditions for such engagement (e.g. see review [7]).

One tactic we have used in the past is simply to compare group collaboration in real and virtual worlds. The benchmark being that performance, or ratings of collaboration, should be similar in immersive SVR compared to real world environments (e.g. [14, 16])). While realistic behaviours are still a big concern of ours (see next section), we are developing a theme of work around how users adapt to use of the system over hours and weeks of use [1, 6]. A key point here has been the participant variability in adaptation to being represented as an avatar and interacting with representations of others, especially those they know well.

3 EVALUATION OF COMMUNICATION SOCIAL CUES

The success in completion of tasks in social VR is a testament to the effectiveness of certain types of non-verbal communication (e.g. [9]). We can delve into these behaviours to get more detail, but our own experience is that movement is well represented. Obviously more tracking points help (e.g. even foot tracking has an impact [11]).

Tanenbaum et al. inventory expressive nonverbal communication in commercial social VR platforms with four categories : movement and proxemic spacing, facial control, gesture and posture and finally virtual environment specific non-verbal communication [19]. They note that faces and eye-gaze are a particular remaining problem. We have tackled eye-gaze in a variety of projects in the past (e.g. [17, 18]). We have found eye-tracking to be highly communicative, but hard to simulate well. Fortunately eye-tracking is a feature we should expect in many more HMDs in the near future. Our own trajectory of work here is to focus on the fine-grained actions that combine multiple verbal and non-verbal acts, to see if they can support certain communicative acts, such as conversation hand-over.

4 EVALUATION OF TRUST

A particular component of social interaction we have focused on is trust. We feel that it is useful as a measure because it highlights a slightly higher level of response that the immediacy of gesture or communicative acts, but it is amenable to study in controlled experiments. Trust is term used in many different ways, but we will refer to behavioural responses, although we note that Salanitri et al. show that the best-known questionnaire to measure usability and trust could be applied to VR [12]. They also showed there is a relationship between user's satisfaction and trust in the use of VR, and a relationship between usability and trust for different VR technologies.

Behavioural responses that depend on trust are interesting because they are studied in business and economic contexts. We have adopted a couple of techniques from those fields in our SVR studies: trust through advice seeking (e.g. [8]), and trust through a game with stakes that depend on implicit trust of the other(s) [10]). Of course, when embodied by virtual avatars, users might act differently than in real life [3], but we can certain use such methods to study any bias between different communication configurations. This leads to our current objectives in this area: to understand how particular configurations of the VR, such as avatars representation and interface usability bias formation of these higher-level attitudes and relationships between users.

REFERENCES

[1] Ilona Heldal, Anthony Steed, Maria Spante, Ralph Schroeder, Sophia Bengtsson, and Marja Partanen. 2005. Successes and Failures in Co-Present Situations. *Presence: Teleoperators and Virtual Environments* 14, 5 (Oct. 2005), 563–579. https://doi.org/10.1162/105474605774918679 Publisher: MIT Press.

[2] Marcel Jonas, Steven Said, Daniel Yu, Chris Aiello, Nicholas Furlo, and Douglas Zytko. 2019. Towards a Taxonomy of Social VR Application Design. In *Extended Abstracts of the Annual Symposium on Computer-Human Interaction in Play Companion Extended Abstracts* (Barcelona, Spain) *(CHI PLAY '19 Extended Abstracts)*. Association for Computing Machinery, New York, NY, USA, 437–444. https://doi.org/10.1145/3341215.3356271

[3] Iris A. Junglas, Norman A. Johnson, Douglas J. Steel, D. Chon Abraham, and Paul Mac Loughlin. 2007. Identity Formation, Learning Styles and Trust in Virtual Worlds. *SIGMIS Database* 38, 4 (Oct. 2007), 90–96. https://doi.org/10.1145/1314234.1314251

[4] Anya Kolesnichenko, Joshua McVeigh-Schultz, and Katherine Isbister. 2019. Understanding Emerging Design Practices for Avatar Systems in the Commercial Social VR Ecology. In *Proceedings of the 2019 on Designing Interactive Systems Conference* (San Diego, CA, USA) *(DIS '19)*. Association for Computing Machinery, New York, NY, USA, 241–252.

[5] Joshua McVeigh-Schultz, Elena Márquez Segura, Nick Merrill, and Katherine Isbister. 2018. What's It Mean to "Be Social" in VR? Mapping the Social VR Design Ecology. In *Proceedings of the 2018 ACM Conference Companion Publication on Designing Interactive Systems (DIS '18 Companion)*. Association for Computing Machinery, New York, NY, USA, 289–294.

[6] F. Moustafa and A. Steed. 2018. A longitudinal study of small group interaction in social virtual reality. *Proceedings of the 24th ACM Symposium on Virtual Reality Software and Technology* (2018).

[7] Catherine S. Oh, Jeremy N. Bailenson, and Gregory F. Welch. 2018. A Systematic Review of Social Presence: Definition, Antecedents, and Implications. *Frontiers in Robotics and AI* 5 (2018), 114. https://doi.org/10.3389/frobt.2018.00114

[8] Ye Pan and Anthony Steed. 2016. A Comparison of Avatar-, Video-, and Robot-Mediated Interaction on Users' Trust in Expertise. *Frontiers in Robotics and AI* 3 (2016). https://doi.org/10.3389/frobt.2016.00012

[9] Ye Pan and Anthony Steed. 2017. The impact of self-avatars on trust and collaboration in shared virtual environments. *PLoS ONE* 12, 12 (2017), 1–20. https://doi.org/10.1371/journal.pone.0189078 ISBN: 1111111111.

[10] Ye Pan and Anthony Steed. 2017. The impact of self-avatars on trust and collaboration in shared virtual environments. *PloS one* 12, 12 (2017), e0189078.

[11] Ye Pan and Anthony Steed. 2019. How Foot Tracking Matters: The Impact of an Animated Self-Avatar on Interaction, Embodiment and Presence in Shared Virtual Environments. *Frontiers in Robotics and AI* 6 (2019). https://doi.org/10.3389/frobt.2019.00104 Publisher: Frontiers.

[12] Davide Salanitri, Chrisminder Hare, Simone Borsci, Glyn Lawson, Sarah Sharples, and Brian Waterfield. 2015. Relationship Between Trust and Usability in Virtual Environments: An Ongoing Study, Vol. 9169. https://doi.org/10.1007/978-3-319-20901-2_5

[13] Ralph Schroeder. 2010. *Being There Together: Social Interaction in Shared Virtual Environments.* Oxford University Press.

[14] Ralph Schroeder, Anthony Steed, Ann-Sofie Axelsson, Ilona Heldal, Åsa Abelin, Josef Wideström, Alexander Nilsson, and Mel Slater. 2001. Collaborating in networked immersive spaces: as good as being there together? *Computers & Graphics* 25, 5 (Oct. 2001), 781–788. https://doi.org/10.1016/S0097-8493(01)00120-0

[15] Ryan Schulz. 2020. Comprehensive List of Social VR Platforms and Virtual Worlds. https://ryanschultz.com/list-of-social-vr-virtual-worlds/ Accessed September 10, 2020.

[16] A. Steed, M. Slater, A. Sadagic, A. Bullock, and J. Tromp. 1999. Leadership and collaboration in shared virtual environments. In *Proceedings IEEE Virtual Reality (Cat. No. 99CB36316)*. 112–115. https://doi.org/10.1109/VR.1999.756941 ISSN: 1087-8270.

[17] William Steptoe, Anthony Steed, Aitor Rovira, and John Rae. 2010. Lie Tracking: Social Presence, Truth and Deception in Avatar-mediated Telecommunication. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '10)*. ACM, New York, NY, USA, 1039–1048. https://doi.org/10.1145/1753326.1753481 event-place: Atlanta, Georgia, USA.

[18] William Steptoe, Robin Wolff, Alessio Murgia, Estefania Guimaraes, John Rae, Paul Sharkey, David Roberts, and Anthony Steed. 2008. Eye-tracking for avatar eye-gaze and interactional analysis in immersive collaborative virtual environments. In *Proceedings of the 2008 ACM conference on Computer supported cooperative work (CSCW '08)*. Association for Computing Machinery, New York, NY, USA, 197–200. https://doi.org/10.1145/1460563.1460593

[19] Theresa Jean Tanenbaum, Nazely Hartoonian, and Jeffrey Bryan. 2020. "How Do I Make This Thing Smile?": An Inventory of Expressive Nonverbal Communication in Commercial Social Virtual Reality Platforms. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems* (Honolulu, HI, USA) *(CHI '20)*. Association for Computing Machinery, New York, NY, USA, 1–13. https://doi.org/10.1145/3313831.3376606

[20] Jolanda Tromp, Adrian Bullock, Anthony Steed, Amela Sadagic, Mel Slater, and Emmanuel Frécon. 1998. Small group behavior experiments in the coven project. *IEEE Computer Graphics and Applications* 18, 6 (1998), 53–63. https://doi.org/10.1109/38.734980