

Association for Information Systems

AIS Electronic Library (AISeL)

Pre-ICIS FRAIS 2022

French (FRAIS)

12-2022

Immersive Virtual Experiences affecting Drivers of Pro-Environmental Behavior: a Systematic Literature Review

Barbara Buljat Raymond

Follow this and additional works at: https://aisel.aisnet.org/icis_risques2022

This material is brought to you by the French (FRAIS) at AIS Electronic Library (AISeL). It has been accepted for inclusion in Pre-ICIS FRAIS 2022 by an authorized administrator of AIS Electronic Library (AISeL). For more information, please contact elibrary@aisnet.org.

Immersive Virtual Experiences affecting Drivers of Pro-Environmental Behavior: a Systematic Literature Review

Short paper

Barbara Buljat Raymond

Université Côte d'Azur, CNRS, GREDEG;
Faculty of Economics and Business Rijeka; Balkan Institute of Science and
Innovation of the Université Côte d'Azur.
barbara.buljat@etu.univ-cotedazur.fr

Abstract

By providing immersive virtual experiences, technologies such as augmented and virtual reality (AR and VR) offer possibilities to advance environmental communication and behavioral interventions. We surveyed studies published in peer-reviewed journals to identify key drivers of pro-environmental behavior (PEB) that have been affected using immersive virtual experiences. This systematic literature review contributes to our understanding of the effectiveness of immersive storytelling for motivating pro-environmental behavior.

Keywords: pro-environmental behavior, AR, VR, immersive virtual environments, literature review

Introduction

While major global institutions constantly warn about the impact of human behavior on the environment (IPCC, 2021), environmental communicators still face a great challenge: how to convince people to change behavior *now*, to contribute to something that will happen *in the future*? Information Systems (IS) community is expected to respond and propose foster research on Green IS – innovative technological solutions for addressing environmental sustainability challenges (Elliot & Webster, 2017; Melville, 2010).

In this context, one type of technology may be especially useful. Thanks to its ability to provide realistic and sensory-rich virtual experiences and create a sense of presence (Innocenti, 2017), technologies such as augmented (AR) or virtual reality (VR) may influence users' cognitive and psychological factors and become a promising tool for promoting environmental behaviors (PEB)¹ (Fauville et al., 2020). This paper aims at examining the existing literature to identify key drivers of PEB that have been affected by immersive virtual experiences. Overall, this systematic literature review contributes to understanding the potential of immersive storytelling² for pro-environmental communication efforts and behavioral interventions.

¹ We will use the term pro-environmental behavior (PEB) to describe any conscious behavior that intends to lower one's negative impact on the environment (Kollmuss & Agyeman, 2002).

² Immersive storytelling refers to a narration technique using immersive technologies (AR and VR) to provide sensory-rich experience in which users feel the sense of presence in a computer-generated environment. See example: Thomas et al., 2018

Methods

The literature search followed strict guidelines a logical procedure that ensures replicability and transparency (Linnenluecke, 2020; Templier & Paré, 2015). The search was conducted in the period between February 2021 and August 2021, in the databases Scopus and Web of Science, by using keywords: “augmented reality” OR “virtual reality” OR “mixed reality” OR “extended reality” OR “virtual” OR “immersive technology” AND “environmental sustainability” OR “climate change” OR “nature” OR “green” OR “pro-environmental behavior”. The initial search of the literature gathered 903 records from diverse sources. After removing duplicates (386), 517 items were further refined by examining the article abstracts and using the following inclusion/exclusion criteria: (1) we included only peer-reviewed journal articles; (2) written in English; (3) published after 2000; (4) containing empirical studies measuring at least one of the three elements of environmental engagement – cognitive, affective and behavioral (Lorenzoni et al., 2007). Our focus is on technology that provides highly immersive virtual environments (HIVE), but we also included studies conducted in low immersive virtual environments (LIVE) (Innocenti, 2017) to gain a deeper understanding of this phenomena. Finally, our literature search resulted in 25 papers (13 HIVE; 12 LIVE) from various disciplines, including computer science, environmental science, psychology, management.

Results and discussion

We conducted an in-depth analysis of the collected papers to identify the key drivers of PEB addressed using high- or low-immersive virtual environments. The analysis revealed interesting insights regarding the potential of virtual experiences for affecting PEB through six drivers: (1) beliefs that one’s action have an impact (such as self-efficacy and locus of control); (2) environmental concern and awareness; (3) connectedness to nature; (4) behavioral intentions; (5) psychological distance; (6) risk perception. Some studies measured the impact on real behavior (see Table 1 for details).

Reference	Beliefs	Concern and awareness	Connectedness to nature	Intention	Psychological distance	Risk perception	Real behavior	Technical and control measures
Ahn et al., 2014	x	x		x			x	x
Ahn et al., 2015	x			x			x	
Ahn et al., 2016		x						x
Bailey et al., 2015							x	x
Bateman et al., 2009				x				
Breves & Heber, 2019			x					x
Breves & Schramm, 2021		x		x	x	x		x
Chirico et al., 2020		x		x				x
Fiore et al., 2009.				x				x
Fox et al., 2019	x			x	x	x		x
Greussing, 2019		x						x
Hsu et al., 2018		x		x				x
Isley et al., 2017							x	x
Joerß et al., 2021				x				x
Markowitz et al., 2018		x		x				x
Matthews et al., 2017				x				
Moore & Yang, 2019		x		x			x	x
Nelson et al., 2020		x					x	x
Oh et al., 2020	x			x				x
Olschewski et al., 2012				x				
Prada et al., 2015		x						x
Schaeffer et al., 2018				x				
Soliman et al., 2017			x				x	x
Treuer et al., 2018		x		x				x
Zaalberg & Midden, 2013		x		x				x

Table 1. PEB and its underlying drivers addressed in the surveyed literature

Most importantly, data from the collected studies suggest that immersive virtual experiences can influence some psychological factors important for environmental engagement, such as beliefs (relates to the perception of the extent to which one’s action could have an impact to the environment, e.g. environmental self-efficacy and locus of control (see Ahn et al., 2014)); environmental concern and awareness (e.g. a study

by Chirico et al. (2020) tested how different presentations of statistical data on plastic consumption affected participants' pro-environmental attitudes); connectedness to nature (results of a study by Breves & Heber (2019) suggest that immersive videos, comparing to regular videos of nature, lead to significantly stronger sense of presence and commitment to the nature); behavioral intentions (a set of studies aimed at testing if presenting an information in visual forms, in contrast to conventional numerical format, can enhance the content evaluability in non-market valuation studies; those virtual simulation lead to subjective beliefs that are closer to actual risks (Fiore et al., 2009)); psychological distance (one study tested the impact of a serious game on environmental attitudes, psychological distance, and behavior; the feeling of being psychologically close to the an environmental issue (polluted river), that was manipulated in VR, enhanced the perception of an environmental risk, which consequentially lead to more environmental behavior and support for environmental policies (Fox et al., 2019); and risk perception (in one experimental study participants viewed a video explaining negative consequences of mono-cropping in agricultural practices; VR technology successfully created the sense of presence, it was not successful in manipulating all the variables studies in the experiment (Breves & Schramm, 2021)).

Several studies from the surveyed sample tested the impact of virtual experiences on real pro-environmental behavior (for example, while a study by Soliman et al., (2017) assessed PEB by participants expressing interest in the campus sustainability plan, a study by Ahn et al. (2015) measured if participants aimed at conserving the paper while cleaning water from the table with napkins). Results are mixed and suggest limited potential of immersive experiences that needs further exploration. One of the biggest strengths of immersive storytelling is their ability to generate the feeling of presence, which is suitable especially for those who are not able to vividly imagine future scenarios. However, we warn that despite their potential, immersive behavioral interventions poses some risks and challenges. In some cases, virtual experiences were counter-effective in promoting PEB as they distracted users from obtaining relevant information (Greussing, 2019). Also, in order for a virtual experience to have an impact, people must want to experience it in a natural settings (Fox et al., 2019), which is one of the greatest challenges that affect emerging technologies not yet fully adopted by masses.

This study has several limitations. First, we advise to take this analysis with caution due to small effect sizes of most of the surveyed studies. Most of the studies did not measure real behavior (but rather intentions of hypothetical behavior), did not include a control treatment, did not incentivize participants for participation. Therefore, to make conclusions with confidence, more research is needed. Furthermore, our survey sample consisting of 25 paper is very small. We are aware that the application of virtual environments for addressing PEB is a very novel topic, and perhaps including the conference paper would provide more insights into this emerging field. Also, we focused on empirical and experimental papers, but conceptual or qualitative papers should not be neglected as they would help us in understanding the potential of immersive storytelling. Finally, the heterogeneity of surveyed papers posed a great challenge for analysis. It took a great deal of time to analyze and synthesize data from studies that investigated diverse set of measures applying different methods, and communicated results using different terminology.

Conclusion

Despite limited empirical support, immersive communication and storytelling offers great potential to enhance traditional environmental communication. There is an obvious potential for improving environmental communication with AR and VR, but we need more research on this topic to make concrete conclusions. This systematic literature review could serve our community to better understand the possibilities and challenges of AR and VR for enhancing environmental campaigns and motivating PEB. This paper provide a theoretical base for conducting controlled experimental studies in virtual environments, which is the next step of this research project.

Acknowledgements

The author would like to thank anonymous reviewers, as well as colleagues at ICIS2022 Conference, for their constructive feedback.

References

- Ahn, S. J. (Grace), Fox, J., Dale, K. R., & Avant, J. A. (2015). Framing Virtual Experiences: Effects on Environmental Efficacy and Behavior Over Time. *Communication Research*, 42(6), 839–863.
- Ahn, S.J. (Grace), Bailenson, J. N.& Park, D. (2014) Short- and long-term effects of embodied experiences in immersive virtual environments on environmental locus of control and behavior. *Comput. Hum. Behav.* 39, C (October, 2014), 235–245. DOI:<https://doi.org/10.1016/j.chb.2014.07.025>
- Ahn, S.J., Bostick, J., Ogle, E., Nowak, K.L., McGillicuddy, K.T., Bailenson, J.N. (2016) Experiencing Nature: Embodying Animals in Immersive Virtual Environments Increases Inclusion of Nature in Self and Involvement with Nature, *Journal of Computer-Mediated Communication*, Volume 21, Issue 6, 1 November 2016, Pages 399–419, <https://doi.org/10.1111/jcc4.12173>
- Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50, 179–211.
- Bailey, J. O., Bailenson, J. N., Flora, J., Armel, K. C., Voelker, D., & Reeves, B. (2015). The Impact of Vivid Messages on Reducing Energy Consumption Related to Hot Water Use. *Environment and Behavior*, 47(5), 570–592. <https://doi.org/10.1177/0013916514551604>
- Bateman, Ian J. & Day, Brett H. & Jones, Andrew P. & Jude, Simon, 2009. "Reducing gain-loss asymmetry: A virtual reality choice experiment valuing land use change," *Journal of Environmental Economics and Management*, Elsevier, vol. 58(1), pages 106-118, July.
- Breves P. & Schramm H. (2021) Bridging psychological distance: The impact of immersive media on distant and proximal environmental issues, *Computers in Human Behavior*, <https://doi.org/10.1016/j.chb.2020.106606>."
- Breves, P. & Heber, V. (2019): Into the Wild: The Effects of 360° Immersive Nature Videos on Feelings of Commitment to the Environment, *Environmental Communication*, DOI: 10.1080/17524032.2019.1665566
- Chirico, A., Scurati, G.W., Maffi, C. et al. Designing virtual environments for attitudes and behavioral change in plastic consumption: a comparison between concrete and numerical information. *Virtual Reality* (2020). <https://doi.org/10.1007/s10055-020-00442-w>
- Elliot, S., & Webster, J. (2017), Editorial: Special issue on empirical research on information systems addressing the challenges of environmental sustainability: an imperative for urgent action. *Info Systems J*, 27: 367– 378.
- Fauville, G., Muller Queiroz, A.C., Bailenson, J.N. (2020) Chapter 5 - Virtual reality as a promising tool to promote climate change awareness, Editor(s): Jihyun Kim, Hayeon Song, *Technology and Health*, Academic Press, 2020, Pages 91-108, ISBN 9780128169582
- Fiore, S. M., Harrison, G. W. & Hughes, C. E. & Rutstrm, E. E., 2009. "Virtual experiments and environmental policy," *Journal of Environmental Economics and Management*, Elsevier, vol. 57(1), pages 65-86, January.
- Fox, J., McKnight, J., Sun, Y., Battelle, D.M., Crawfis, R., Using a Serious Game to Communicate Risk and Minimize Psychological Distance Regarding Environmental Pollution, *Telematics and Informatics* (2019), doi: <https://doi.org/10.1016/j.tele.2019.101320>"
- Greussing, E. (2019): Powered by Immersion? Examining Effects of 360- Degree Photography on Knowledge Acquisition and Perceived Message Credibility of Climate Change News, *Environmental Communication*, DOI: 10.1080/17524032.2019.1664607
- Hsu, W., Tseng, C., & Kang, S. (2018). Using Exaggerated Feedback in a Virtual Reality Environment to Enhance Behavior Intention of Water-Conservation. *J. Educ. Technol. Soc.*, 21, 187-203.
- Innocenti, A. (2017) Virtual reality experiments in economics. *Journal of Behavioral and Experimental Economics* (formerly *The Journal of Socio-Economics*), Elsevier, vol. 69(C), pages 71-77.
- IPCC, 2021: Summary for Policymakers. In: *Climate Change 2021: The Physical Science Basis*. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. Cambridge University Press. In Press.
- Isley, S. C., Ketcham, R., and Arent, D. J. (2017) "Using augmented reality to inform consumer choice and lower carbon footprints", *Environmental Research Letters*, vol. 12, no. 6, 2017. doi:10.1088/1748-9326/aa6def.

- Joerß, T., Hoffmann, S., Mai, R., Akbar, P. (2021) Digitalization as solution to environmental problems? When users rely on augmented reality-recommendation agents, *Journal of Business Research*, Volume 128, 2021, Pages 510-523, ISSN 0148-2963, <https://doi.org/10.1016/j.jbusres.2021.02.019>.
- Kollmuss, A., & Agyeman, J. (2002). Mind the Gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? *Environmental Education Research*, 8(3), 239–260. doi:10.1080/13504620220145401
- Linnenluecke, M. K., Marrone, M. and Singh, A. K. (2020) 'Conducting systematic literature reviews and bibliometric analyses', *Australian Journal of Management*, 45(2), pp. 175–194. doi: 10.1177/0312896219877678.
- Lorenzoni, I., S. Nicholson-Cole, S., & Whitmarsh, L. (2007). Barriers perceived to engaging with climate change among the UK public and their policy implications. *Global Environmental Change*, 17, 445-459.
- Markowitz, D.M.; Laha, R.; Perone, B.P.; Pea, R.D.; Bailenson, J.N. Immersive virtual reality field trips facilitate learning about climate change. *Frontiers in Psychology* 2018, 9, 2364.
- Matthews, Y., Scarpa, R., Marsh, D., 2017. "Using virtual environments to improve the realism of choice experiments: A case study about coastal erosion management," *Journal of Environmental Economics and Management*, Elsevier, vol. 81(C), pages 193-208.
- Melville, N. P. (2010), *Information Systems Innovation for Environmental Sustainability*, *MIS Quarterly* (34:1), pp. 1-21.
- Moore, M. M. & Yang, J.Z. (2019): Using Eco-Guilt to Motivate Environmental Behavior Change, *Environmental Communication*, DOI: 10.1080/17524032.2019.1692889"
- Nelson, K.M., Anggraini, E., Schlüter, A. (2020) Virtual reality as a tool for environmental conservation and fundraising. *PLoS ONE* 15(4): e0223631. <https://doi.org/10.1371/journal.pone.0223631>"
- Nisbet, E. K., Zelenski, J. M., & Murphy, S. A. (2008). The Nature Relatedness Scale. *Environment and Behavior*, 41(5), 715–740. doi:10.1177/0013916508318748
- Oh, J., Sudarshan, S., Jin, E., Nah, S., & Yu, N. (2020). How 360-Degree Video Influences Content Perceptions and Environmental Behavior: The Moderating Effect of Environmental Self-Efficacy. *Science Communication*, 42(4), 423–453. <https://doi.org/10.1177/1075547020932174>
- Olschewski, R., Bebi, P., Teich, M., Wissen Hayek, U. & Grêt-Regamey, A. (2012). Avalanche protection by forests – A choice experiment in the Swiss Alps. *Forest Policy and Economics*. 15. 108-113.
- Prada, R., Prendinger, H., Yongyuth, P., Nakasoneb, A., and Kawtrakul, A. (2015). AgriVillage: A Game to Foster Awareness of the Environmental Impact of Agriculture. *Comput. Entertain.* 12, 2, Article 3 (Summer 2014), 18 pages. DOI:<https://doi.org/10.1145/2701657.2633417>
- Schaeffer, S. E., Garza, S. E., Espinosa, J. C., Urbina, S. C., Nurmi, P. & Cruz-Reyes, L. (2018) A framework for informing consumers on the ecological impact of products at point of sale. *Behaviour & Information Technology*, 37:6, 607-621, DOI: 10.1080/0144929X.2018.1470254
- Soliman, M., Peetz, J., & Davydenko, M. (2017). The impact of immersive technology on nature relatedness and pro-environmental behavior. *Journal of Media Psychology: Theories, Methods, and Applications*, 29(1), 8–17. <https://doi.org/10.1027/1864-1105/a000213>
- Steg, L., & Vlek, C. (2009). Encouraging pro-environmental behaviour: An integrative review and research agenda. *Journal of Environmental Psychology*, 29(3), 309–317. doi:10.1016/j.jenvp.2008.10.004
- Templier, M. and Paré, G. (2015) "A Framework for Guiding and Evaluating Literature Reviews," *Communications of the Association for Information Systems: Vol. 37, Article 6*. Available at: <http://aisel.aisnet.org/cais/vol37/iss1/6>
- Thomas, A., Kumar, A., Krehel, R., Vasey, K., Khoo, E. T., Marsh, T., & Junting, B. L. (2018). Oceans we make. *SIGGRAPH Asia 2018 Virtual & Augmented Reality on - SA '18*. doi:10.1145/3275495.3275513
- Treuer, G., Broad, K. & Meyer, R. (2018). Using simulations to forecast homeowner response to sea level rise in South Florida: Will they stay or will they go?. *Global Environmental Change*. 48. 108-118. 10.1016/j.gloenvcha.2017.10.008.
- Trope, Y., & Liberman, N. (2010). Construal-level theory of psychological distance. *Psychological Review*, 117(2), 440e463.
- Van der Linden, S., Maibach, E., & Leiserowitz, A. (2015). Improving public engagement with climate change: Five “best practice” insights from psychological science. *Perspectives on Psychological Science*, (10), 758-763.
- Yoon, A., Jeong, D., & Chon, J. (2021). The impact of the risk perception of ocean microplastics on tourists' pro-environmental behavior intention. *Science of The Total Environment*, 774, 144782.
- Zaalberg, R. & Midden, C.J.H. 2013. "Living Behind Dikes: Mimicking Flooding Experiences," *Risk Analysis*, John Wiley & Sons, vol. 33(5), pages 866-876, May.