

The Role of Virtual Task Environments in Probing Human Cognition: Opportunities and Obstacles

Sean Brantley & Veljko Dubljevic (NC State University)

Virtual Task Environments (VTEs), developed using virtual reality technologies, are increasingly being adopted across a broad spectrum of cognition-based endeavors, highlighting their perceived applicability. The appeal of these virtual arenas lies in the belief that they add ecological validity to investigative assessments of human cognition by being complex, engaging, and replicable tasks. This paper presents three ways VTEs have enhanced cognitive science and empirical neuroethics research and outlines three issues inherent to their use. The aim is to emphasize the importance of continued VTE incorporation, advocating for their utilization despite recognized limitations.

Firstly, low-interactivity VTEs designed with rigorous big-data and psychological surveying practices allow for controlled and repeatable collection of preference data on a global scale [1]. Secondly, interactive virtual tasks, coupled with advances in telemetry techniques, enable the capture of traditional state variables and geometric decision patterns, enriching action analyses [2]. For instance, in a driving simulation, a participant's reaction time is a state variable, while the specific navigation strategy adopted during obstacle avoidance forms a decision pattern. Thirdly, VTEs depicting hazardous scenarios, like standing on the edge of a tall ledge, elicit physiological arousal [3], demonstrating that VTEs can provide psychologically realistic experiences while ensuring physical safety.

However, despite these advantages, challenges persist [4]. First, participants sometimes perceive audio and visual deviations in VTEs as uncanny, meaning small development teams using limited resources can struggle to accurately depict reality, like the mental states (emotions or intentions) of non-playable-scene characters, detracting from experimental realism. Second, the effects of exposing participants to highly stressful stimuli, like car crashes, remain unknown, emphasizing the need for mindful experiment design. Finally, as participants navigate VTE decision-making tasks, they inevitably follow unique decision tree paths, adding complexity to results analyses.

In conclusion, while VTEs have limitations, they nonetheless enhance the scope and resolution of cognitive analyses when carefully employed, especially in the context of creating and testing artificial moral agents [5]. VTEs provide a safe, immersive, dynamic, and globally accessible platform to examine human cognition. Future VTE research should strive to create brief, immersive tasks, to facilitate the interdisciplinary analysis of complex human mental processes like decision-making and learning.

Disclosures: ChatGPT was used as an iterative editing tool to increase the clarity of this abstract. Screenshots of such use are available upon request.

References

1. Awad, Edmond, Sohan Dsouza, Richard Kim, Jonathan Schulz, Joseph Henrich, Azim Shariff, Jean-François Bonnefon, and Iyad Rahwan. 2018. "The Moral Machine Experiment." *Nature* 563 (7729): 59–64.
2. Gagné, André R., Magy Seif El-Nasr, and Christopher D. Shaw. 2012. "Analysis of Telemetry Data from a Real-Time Strategy Game: A Case Study." *Computers in Entertainment*, October 2012.
3. Peterson, Steven M., Emily Furuichi, and Daniel P. Ferris. 2018. "Effects of Virtual Reality High Heights Exposure during Beam-Walking on Physiological Stress and Cognitive Loading." Edited by Ian Stavness. *PLoS ONE* 13 (7): e0200306.
4. Pan, Xueni, and Antonia F. de C. Hamilton. 2018. "Why and How to Use Virtual Reality to Study Human Social Interaction: The Challenges of Exploring a New Research Landscape." *British Journal of Psychology* 109 (3): 395–417.
5. Dubljević, Veljko. 2020. "Toward Implementing the ADC Model of Moral Judgment in Autonomous Vehicles." *Science and Engineering Ethics* 26 (5): 2461–72.