The Effects of Virtualization on Connectedness, Presence, and Immersion:

A Mixed-Methods Comparison of Real, Mixed, and Virtual Environments

Niklas Groffner (Author and Presenter)

Faculty of Computer Science

and Business Information Systems

University of Applied Sciences Würzburg-Schweinfurt

Würzburg, Germany

Email: niklas.groffner@study.thws.de

IARIA

thws

Technical University
of Applied Sciences
Würzburg-Schweinfurt

- Master's Graduate in Digital Business Systems
- Faculty of Computer Science and Business Information Systems
- University of Applied Sciences Würzburg-Schweinfurt
- Research Focus: Socioinformatics and Digital Ethics

Niklas Groffner

niklas.groffner@outlook.de

Theory on XR

- Extended Reality (XR): Includes VR, AR, MR (Malterer, 2023)
- VR: Complete immersion in virtual worlds (Dörner et al., 2019)
- AR: Digital overlay of the real world (Dörner et al., 2019)
- MR: Combination of real and virtual elements (Efe, 2022)

Theoretical constructs

- Connectedness (Watts et al., 2022a)
  - With oneself
  - With others
  - With the world
- Presence (Slater & Wilbur, 1997)
  - Feeling of actual being there
- Immersion (Witmer & Singer, 1998)
  - Psychological involvement in an environment

Synergy of concepts

- **Immersion can increase presence** (Mütterlein, 2018; Servotte et al., 2020)
- **Presence and immersion strengthen connectedness** (McCreery et al., 2013; Young et al., 2022)

Methodological approach

Mixed methods approach

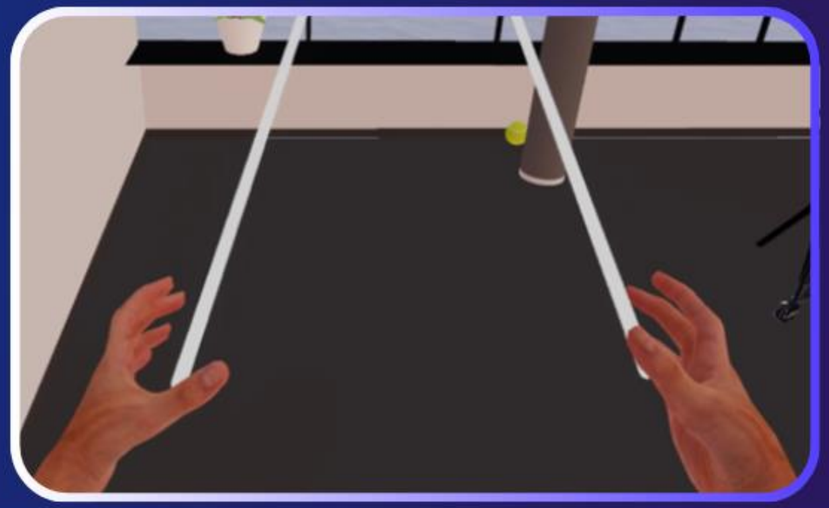
- Combination of qualitative and quantitative methods
- Goal: Comprehensive analysis of presence, immersion and connectedness

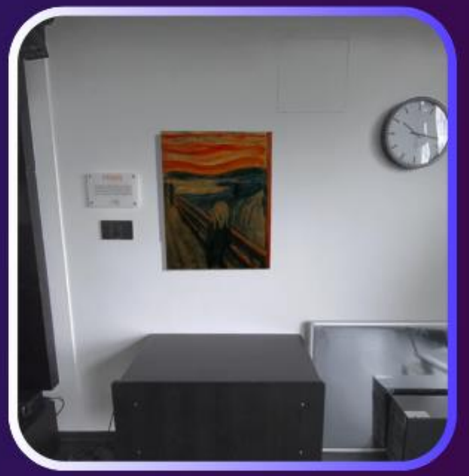
Hypotheses

- H_0: Degree of virtualisation (reality, MR, VR) has no influence on perceived connectedness
- H_1: A higher degree of virtualisation reduces the perceived connectedness

Qualitative methodology

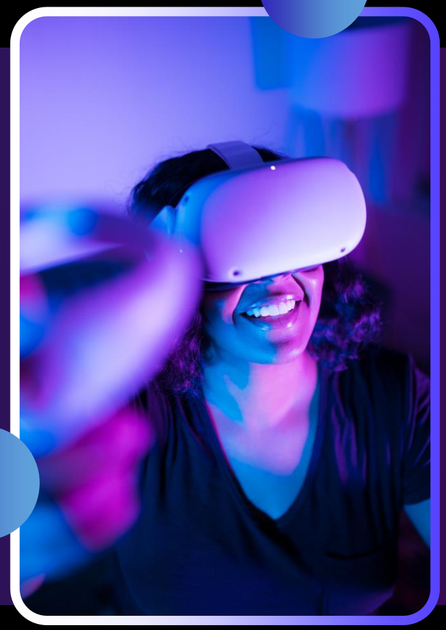
- **Tasks:** Find tennis balls, look at paintings, water plants
- **Questions:** Theory- & questionnaire-based
- **Sample:** 5 test subjects Aim: Survey of the perception of presence, immersion & connectedness





Quantitative methodology

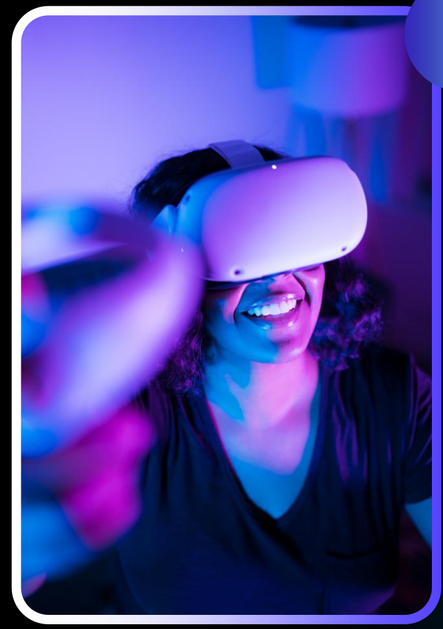
- **Experiment:** Reality (Reflection), MR (First Encounter), VR (First Contact)
- **Questionnaires:** WCS (connectedness), SUS (presence), Tcha-Tokey (immersion)
- **Analysis:** Shapiro-Wilk, t-test, Wilcoxon test
- **Aim:** Hypothesis testing



Results

- **Qualitative results:**
  - Connectedness decreases with increasing virtualization
  - Presence and immersion vary individually
- **Quantitative results:**
  - Significantly higher connectedness in reality
  - No significant differences between MR and VR

Interpetation
Connectedness



- Self-Connectedness: Enhanced connection through sensory feedback and altered self-perception.
- Connectedness with Others: Real environments enhance social feelings.
- Connectedness with the World: Real environments enhance connection through sensory and authentic experiences.

Implications

- **Theory** — Physical interactions promote connectedness, virtualisation influences connectedness
- **Education** — Favour real interactions, supplement VR/MR in a targeted manner (Carruth, 2017)
- **Industry** — Emotional well-being could be impaired by VR/MR (Voštinár et al., 2021)

Limitations

- Scenarios not XR-inclusive
- Measuring instrument not XR-specific
- Non-uniform scenarios

Future research

- Eliminating limitations Research on real operating conditions