

Evaluating Immersive Experiences

Developing Immersive Applications

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Learning Objectives:

- explain the key dimensions of presence, flow and cybersickness
- describe how to employ different quantitative and qualitative user research methods to evaluate presence, flow and cybersickness
- explain the role of affordances in immersive experiences

Developing for Immersion

DEVELOPMENT

IMMERSION

Design → User Experiences

Implementation → System Properties

Development connects:

- **System Properties** → what we build (hardware + software)
- **User Experiences** → what users feel (presence, flow, comfort)

Why it matters:

Immersion is shaped by both the technical system and human perception.

Video Segments Recap

- Immersion framework overview
- System properties and user experiences
- Evaluation methods and data collection

Video link:

<https://youtu.be/zNpo3Ue2Ui0?si=goWyTKAZMEVCKIm3&t=1>

Immersion as System Properties

Examples of properties we engineer:

- Display resolution, field of view, refresh rate
- Tracking accuracy and latency
- Rendering fidelity (lighting, textures, foveation)
- Audio spatialization and haptics

Video segment:

<https://youtu.be/zNpo3Ue2Ui0?si=goWyTKAZMEVCKIm3&t=269>

Key idea: these are measurable, technical parameters.

Immersion as User Experiences

Experiential constructs:

- Presence (being “there”)
- Flow (deep engagement)
- Cybersickness (discomfort, nausea)

Video segment:

<https://youtu.be/zNpo3Ue2Ui0?si=3tuKga3JRVnWcef2&t=347>

Key idea: these are subjective and measured via user studies.

Data Collection Methods

Qualitative:

- Interviews, think-aloud, observations, open responses

Quantitative:

- Likert questionnaires, physiological data, telemetry logs

Video segments:

- https://youtu.be/zNpo3Ue2Ui0?si=5XC6sv0mambyB_qy&t=412
- https://youtu.be/Xhb6aduKJd4?si=q1MFwU5ULJ_CQnWL&t=138

Best practice: combine both for richer insight.

Popular Survey Instruments

- Igroup Presence Questionnaire (IPQ)
 - <http://www.igroup.org/pq/ipq/download.php>
- Flow Scales (Mind Garden)
 - <https://www.mindgarden.com/100-flow-scales>
- Simulator Sickness Questionnaire (SSQ)
 - https://doi.org/10.1207/s15327108ijap0303_3
- Virtual Reality Sickness Questionnaire (VRSQ)
 - <https://doi.org/10.1016/j.apergo.2017.12.016>

Presence: IPQ Dimensions

- **Spatial Presence:** “I am in another place...”
- **Involvement:** “I lost awareness of my real bedroom...”
- **Realism:** “this dog looks real...”

Measurement: Likert-scale questionnaire after the session.

- **Link:** <http://www.igroup.org/pq/ipq/download.php>

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The Experience of Presence: Factor Analytic Insights

Abstract

Within an embodied cognition framework, it is argued that presence in a virtual environment (VE) develops from the construction of a spatial-functional mental model of the VE. Two cognitive processes lead to this model: the representation of bodily actions as possible actions in the VE, and the suppression of incompatible sensory input. It is hypothesized that the conscious sense of presence reflects these two components as spatial presence and involvement. This prediction was confirmed in two studies ($N = 246$ and $N = 296$) assessing self-reports of presence and immersion experiences. Additionally, judgments of “realness” were observed as a third presence component. A second-order factor analysis showed a distinction between presence, immersion, and interaction factors. Building on these results, a thirteen-item presence scale consisting of three independent components was developed and verified using confirmatory factor analyses across the two studies.

Presence is a construct, a variable with various levels and dimensions.

Biocca and Delaney (1995, p. 62)

I Introduction

When we work or play within virtual environments (VEs), travel through them and interact with virtual objects, it is common that a certain sense of being in the virtual environment, or *presence*, develops. Except for cinema, where

Source: <https://www.igroup.org/pq/ipq/index.php>

Presence: Place vs Plausibility

- **Place Illusion:** “I am in another place...”
- **Plausibility Illusion:** “this (event) is really happening...”

Insight: realism in graphics is not always required for plausibility.

- **Link:** <https://doi.org/10.3389/frvir.2022.914392>



A Separate Reality: An Update on Place Illusion and Plausibility in Virtual Reality

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We review the concept of presence in virtual reality, normally thought of as the sense of “being there” in the virtual world. We argued in a 2009 paper that presence consists of two orthogonal illusions that we refer to as Place Illusion (Pi), the illusion of being in the place depicted by the VR) and Plausibility (Psi, the illusion that the virtual situations and events are really happening). Both are with the proviso that the participant in the virtual reality knows for sure that these are illusions. Presence (Pi and Psi) together with the illusion of ownership over the virtual body that self-represents the participant, are the three key illusions of virtual reality. Copresence, togetherness between others in the virtual world, can be a consequence in the context of interaction between remotely located participants in the same shared virtual environments, or between participants and virtual humans. We then review several different methods of measuring presence: questionnaires, physiological and behavioural measures, breaks in presence, and a psychophysics method based on transitions between different system configurations. Presence is not the only way to assess the responses of people to virtual reality experiences, and we present methods that rely solely on participant preferences, including the use of sentiment analysis that allows participants to express their experience in their own words rather than be required to adopt

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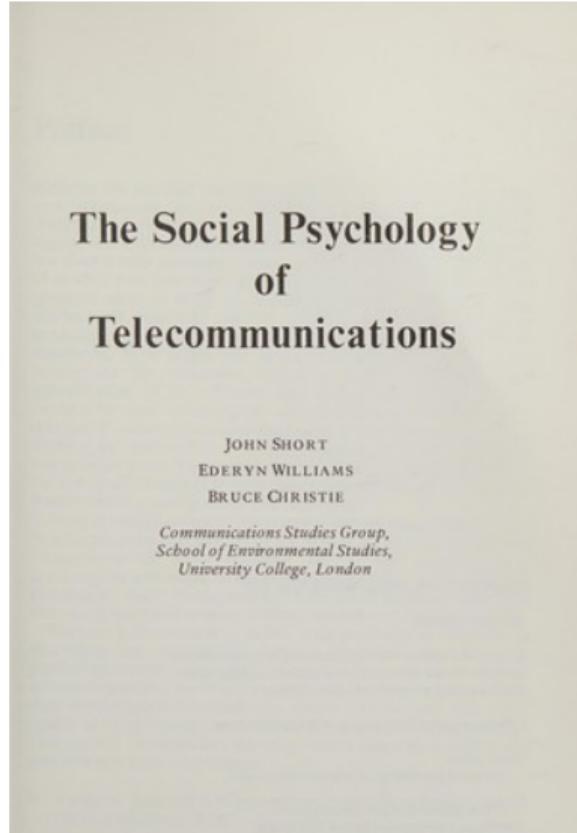
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Presence: Social Presence

- **Social Presence:** “degree of salience of the other person in the interaction and the consequent salience of the interpersonal relationships”

Key concept: feeling of “being with another” in mediated communication.

- **Seminal work:** Short, Williams, & Christie (1976)



Flow: Dimensions (FSS)

- Challenge-skill balance
- Action-awareness merging
- Clear goals
- Unambiguous feedback
- Concentration on the task at hand
- Sense of control
- Loss of self-consciousness
- Transformation of time

Goal: design tasks that keep users engaged without overload.

Cybersickness: What We Measure

Common dimensions:

- Nausea (queasiness, stomach awareness)
- Oculomotor strain (eye fatigue, headache)
- Disorientation (dizziness, vertigo)

Why it matters: cybersickness limits adoption and session length.

Affordances in Immersive Experiences

Affordances (Gibson) are what the environment offers for action:

- A chair affords sitting
- A cliff affords falling (danger)
- A tool affords manipulation

Key concept: Affordance is relational — a function of object features and user capabilities.

Example: In VR, a realistic looking virtual chair should afford sitting without instructions.

Summary

Today we covered:

- Immersion as system properties vs user experiences
- Qualitative and quantitative evaluation methods
- Presence (IPQ, place/plausibility)
- Flow dimensions and measurement
- Cybersickness dimensions and questionnaires
- Affordances in XR design

Next: Week04 – Development tools and WebXR recap

Further Reading

User Study Research:

- VR Locomotion User Experiences (CHI 2022)
- Think-Aloud & Physiological Data (CHI 2014)

Questionnaire Instruments:

- iGroup Presence Questionnaire (IPQ)
- Flow Scales (Mind Garden)
- Simulator Sickness Questionnaire (SSQ)

See WEEK02/WEEK03 pre-class material for complete list