# The eXperience Induction Machine

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# The eXperience Induction Machine

- Immersive, mixed reality room
- Multiple users can participate and be observed in a digital space
- Simulate a digital environment while interacting in real life
- Recent research, comprehensive interaction

# Outline

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# Virtual Reality

- Immersive, multi-sensory system
- Blocks out the perception of the real world with a computer-simulated world
- Interactive virtual reality typically has unique controls
- Useful for a single user
- Prominent historical uses are medicine, education, industry, military and entertainment

# The Sensorama

- The first immersive, multi-sensory system was created in 1962 by Morton Heilig
- Non-interactive motorcycle ride through Brooklyn
- No practical use

# Mixed Reality

- Takes place in a mix of real life and virtual reality
- Loosely defined as a mixture exhibiting some properties of each
- Merges real world and virtual objects which interact

# Utilizing This Technology

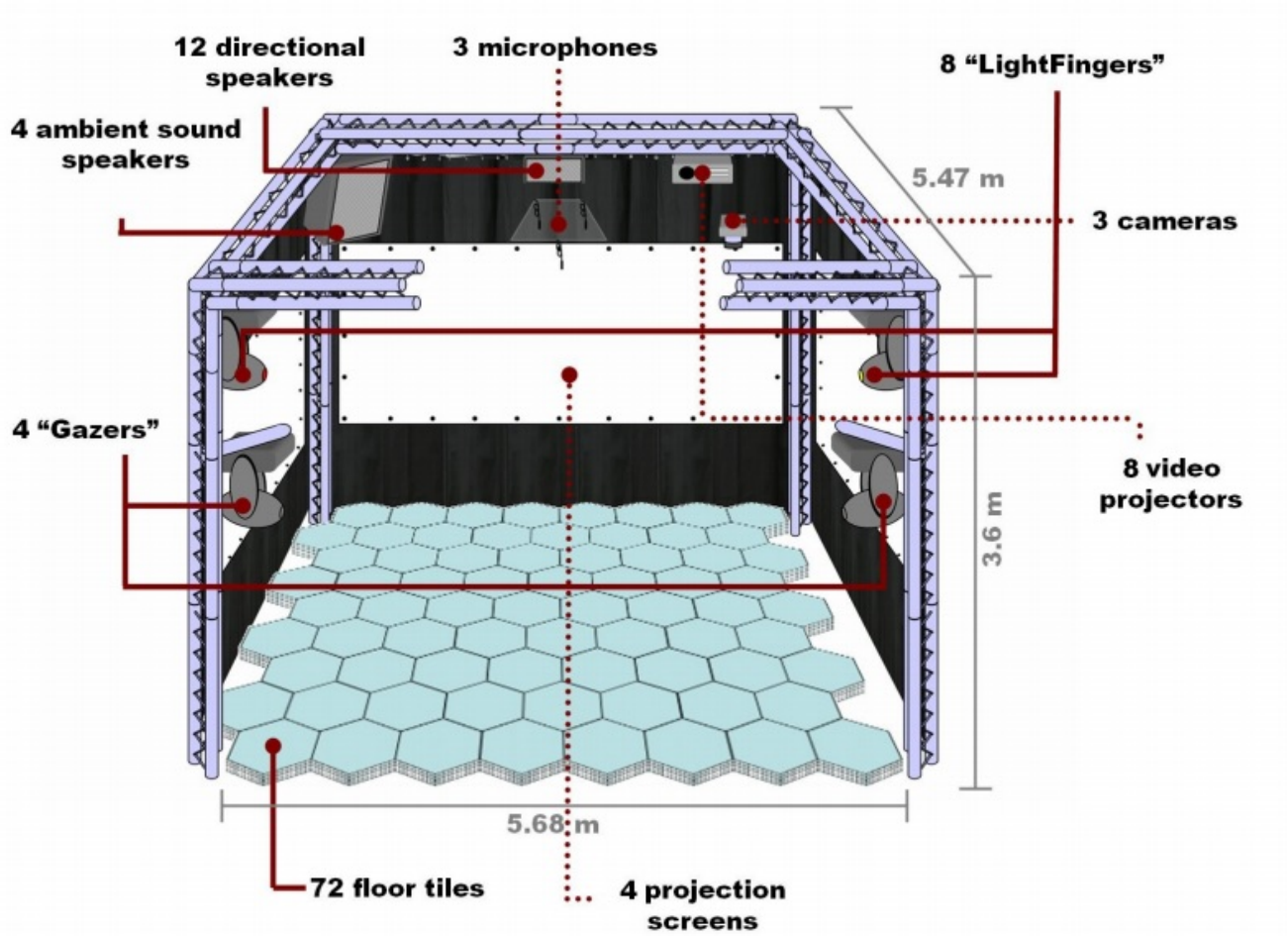
- What can we do with mixed reality environments?
- The unique interaction opens up how we approach applications in a whole new light

# Outline

# What is the eXperience Induction Machine?

- The XIM is an immersive room in Barcelona, Spain
- Originally constructed for psychological experimentation in mixed reality

# Devices


12 directional speakers
3 microphones
8 "LightFingers"
4 ambient sound speakers
5.47 m
3 cameras
4 "Gazers"
8 video projectors
3.6 m
5.68 m
72 floor tiles
4 projection screens

# Inside the XIM

# VR Server

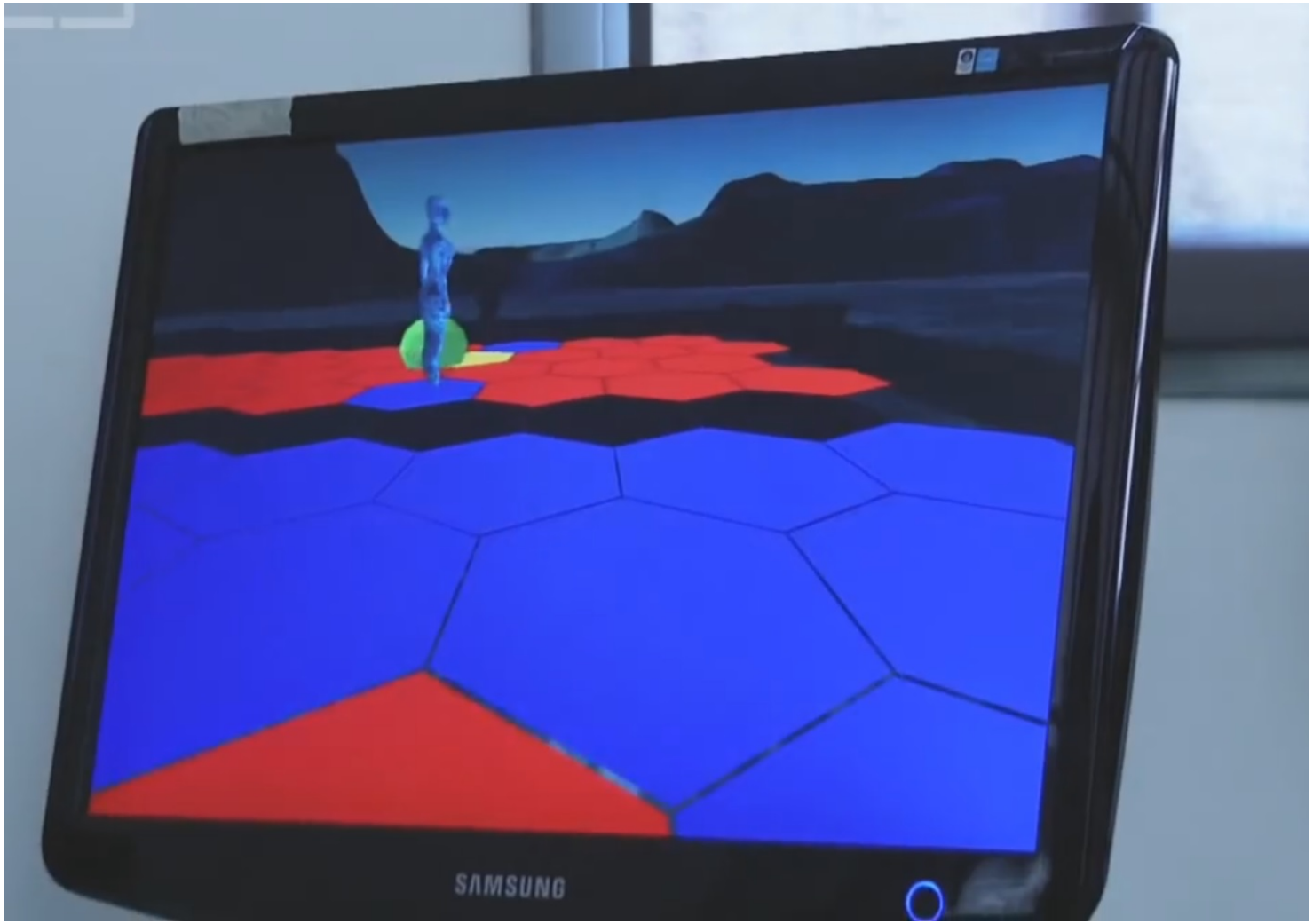
- Implemented using the game engine Torque
- An implementation of the virtual world that mirrors the real one
- The multi-modal tracking system sends information to the VR server
- One VR client connected to video projectors, another for remote users

# Avatars

- "Avatars" are the virtual representations of users
- An outside user can remotely connect to the server and have their own Avatar
- Avatars are positioned in the corresponding location in the virtual world

# Avatars

# Avatars



# Outline

# Researchers

- Single implementation of the XIM, only a few primary researchers
- A. Betella, E. M. Bueno, U. Bernardet, and P. Verschure

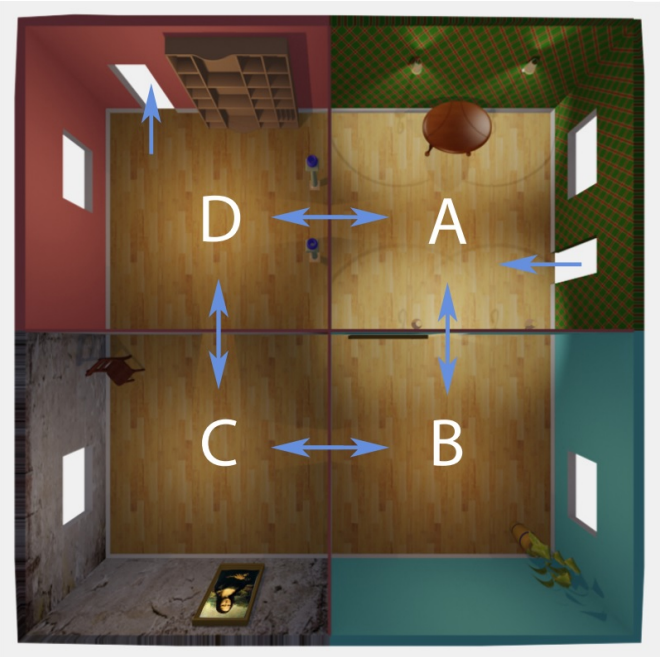
# Spatial Learning Experiment

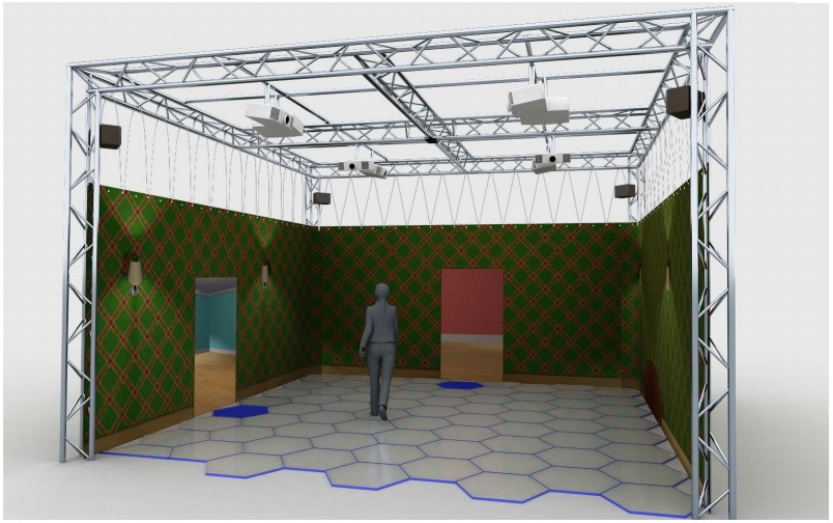
- Empirical investigation of mental processes in spatial learning
- Tested how free movement versus guided navigation affects spatial memory
- XIM was used as it allowed for a customizable environment

# The Experiment

- 10 subjects, 1 group of 5 for each method of navigation
- 4 rooms to be navigated through with various properties
- Each option lasted for 400 seconds, guided navigation had 90 seconds per room with 10 second transitions after each
- Test administered afterwards to see which group remembered more
  - Given a 2D printed map and 2D features, asked to correctly place all features

# The Rooms



# Results

- Guided navigation mean score only slightly higher, not statistically significant
- No real difference between methods
- This study demonstrates what XIM can do
- Environment is customizable

# Data Representation Experiment

- Using XIM to represent large datasets of neural networks
  - A neural network is an interconnected web of neurons
- Compared to using state of the art software, the Connectome Viewer
- Test difference between conventional viewing versus mixed reality

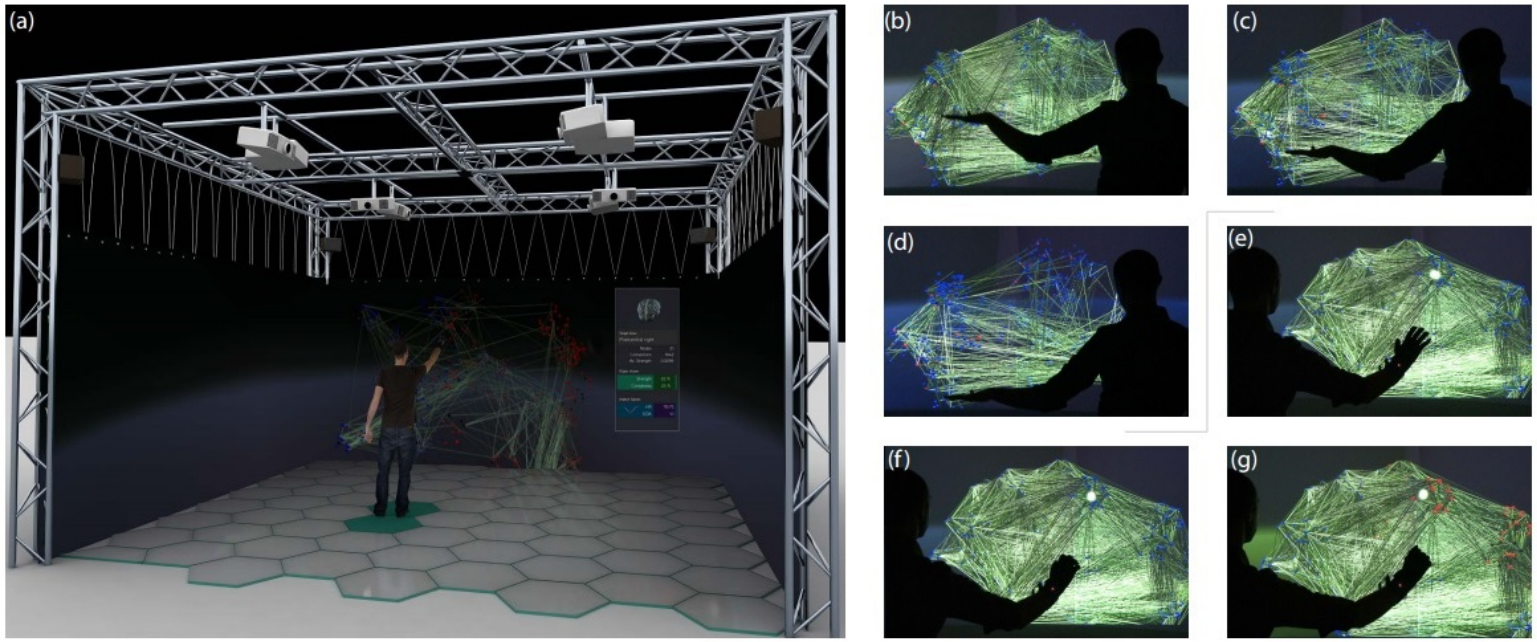
# The Experiment

- 20 subjects, 1 group of 10 for each method of viewing
- Subjects were graduate students who had successfully passed the class "Systems Design, Integration, and Control", had experience manipulating neural networks
- A 6-question test administered to see which group remembered more
- Drawing test administered, subject had to draw the structure

# XIM Devices

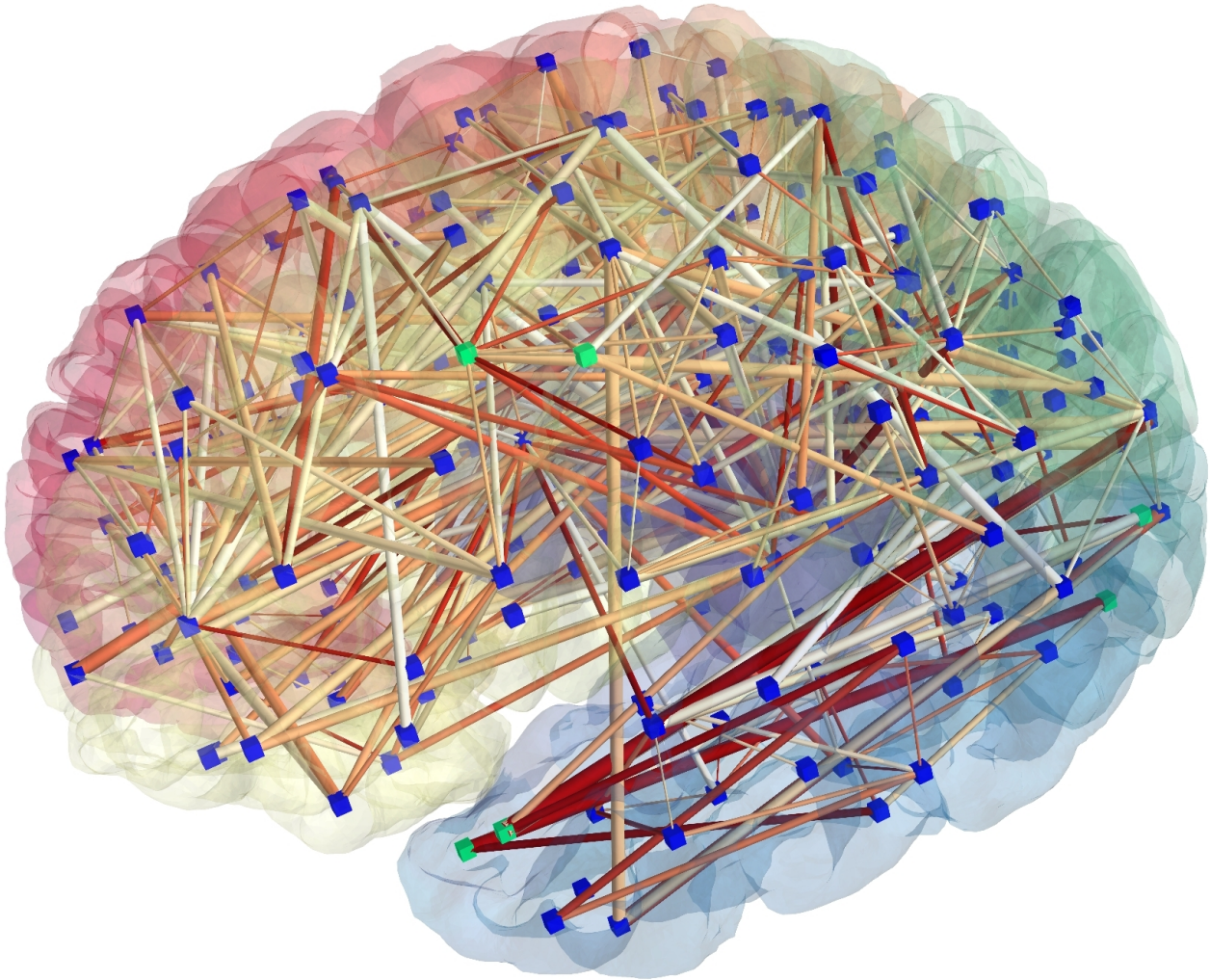
- The XIM also used the Microsoft *Kinect*$^{TM}$ and the sensing glove
  - Microsoft *Kinect*$^{TM}$ tracked user's hands and torso so map the former to a virtual cursor and the latter to the first person camera
  - Sensing glove detected single finger movements, such as grasping, for manipulation

# XIM Devices



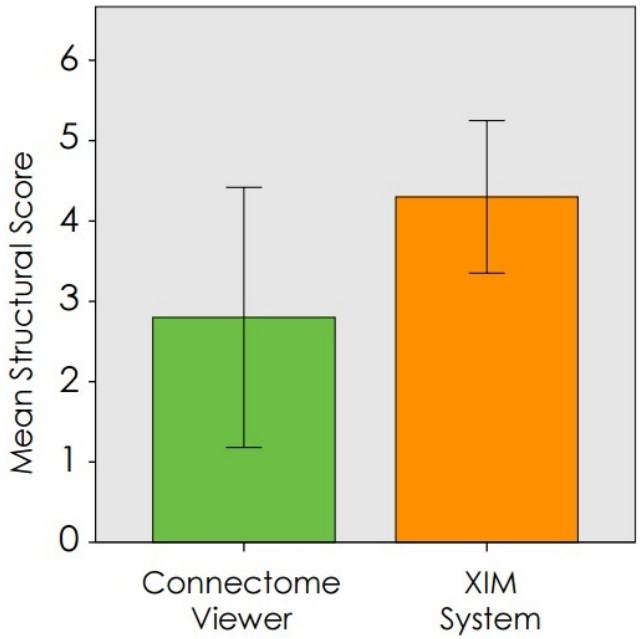

A user interacting with neural data inside the XIM (a). Neural network viewing can be filtered by the complexity or strength of neuron connections (b,c,d). Grasping data clusters is another form of manipulation (e,f) which can then be activated to display (g).

# Connectome Viewer



# Results

- Structural understanding questionnaire: (out of 6)
  - Connectome Viewer subjects had a mean score of 2.80 $\pm$ 1.62 standard deviation
  - XIM subjects had a mean score of 4.30 $\pm$ 0.95 standard deviation



# Results

- Visual understanding drawing:(out of 5)
  - Connectome Viewer subjects had a mean score of $1.5 \pm 0.97$ standard deviation
  - XIM subjects had a mean score of $2.5 \pm 0.7$ standard deviation
- These results conclusively favor the XIM
- Conclude that the usability and comprehension of 3D data in the XIM is effective
- This medium of visualization and navigation provides a clearer perspective of 3D structures

# Presence and Experience Experiment

- Given an educational tour of the XIM called Autodemo
  - Autodemo is given by a virtual Avatar
  - Information about XIM and hardware
  - Explains virtual space of XIM
  - Subjects play a game of "soccer", similar to the arcade game "pong"
    https://youtu.be/Aqi4aIlaZzk?t=1m15s

# The Experiment

- 18 subjects
- Tested on memory of the tour with 11-question recall test
- ITC-SOPI questionnaire

# ITC-SOPI Questionnaire

- Questionnaire designed to measure user experience of media
- 44 questions on a 5-point Likert scale
  - from 1 - "strongly disagree" to 3 - "neutral" to 5 - "strongly agree"
- Tests for:
  - Sense of physical space
  - Engagement
- Sense of physical space used to evaluate presence

  Questions such as: "I felt I was visiting the places in the environment", "I felt the characters/objects could almost touch me"

# Results

- Recall test: (out of 11)
  - Subjects had a mean score of 6 $\pm$ 2 standard deviation
- ITC-SOPI test: (out of 5)
  - Subjects had a mean score of 3.3 for engagement and 2.8 for physical space
- The new experience was not too distracting but engaged subjects
- Comparable ITC-SOPI results are:
  - Computer games with a 3.58 engagement score
  - IMAX 2D with 2.71 physical space score

# Conclusions

- We have a better picture of practical applications
- Psychological research
- Academic application with data representation
- Users are engaged and retain information presented
- The XIM and mixed reality could lead to a paradigm shift in research and information technology

# References


- Bernadet, Inderbitzin, Wierengar, Väljamäe, Mura, Verschure. Validating presence by relying on recollection: Human experience and performance in the mixed reality system XIM.
- Bernadet, Badia, Duff, Inderbitzin, Le Groux, Manzolli, Mathews, Mura, Väljamäe, Verschure. The eXperience Induction Machine: A new paradigm for mixed-reality interaction design and psychological experimentation.
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- Betella, Bueno, Kongsantad, Zucca, Arsiwalla, Omedas, Verschure. Understanding large network datasets through embodied interaction in virtual reality.

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Questions?