Eight Critical Needs for Personalized and Adaptive VR/AR: Results of an NSF Workshop

Sponsored by NSF
Grant #1660052

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Thanks to Wendy Nilsen, Ph.D. at NSF for the initial draft of some of these slides.

Credit: RayGun

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OF SCIENCE AND TECHNOLOGY

Virtual Reality Applications Center (VRAC)
$12m in funding; 35 faculty / 300 students

Human-Computer Interaction
Ph.D., MS, online MS, Certificate

Stephen Gilbert, Apr 12, 2019

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Mission Statement:

Performing research on the rapidly expanding interactions between humans and technology

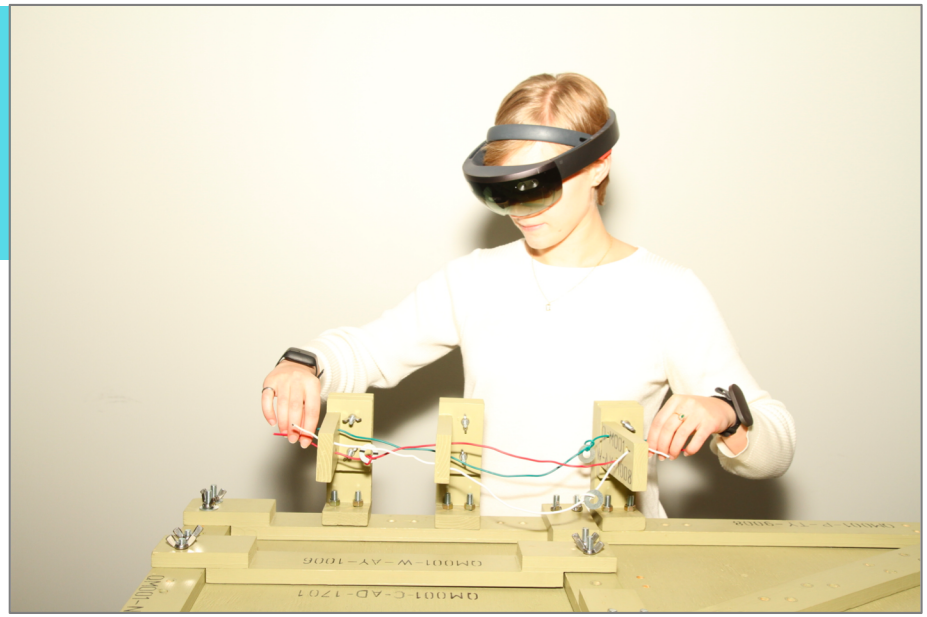
Stephen Gilbert, Apr 12, 2019

VRAC Strengths

Aiding decision making in the design of complex systems

Simple, yet powerful, software and hardware interfaces

Real-time simulation



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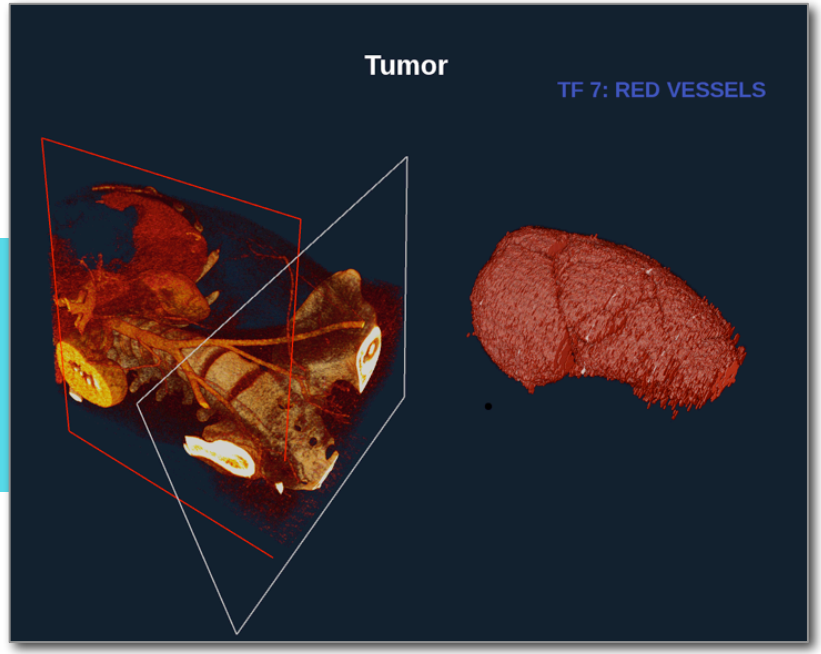

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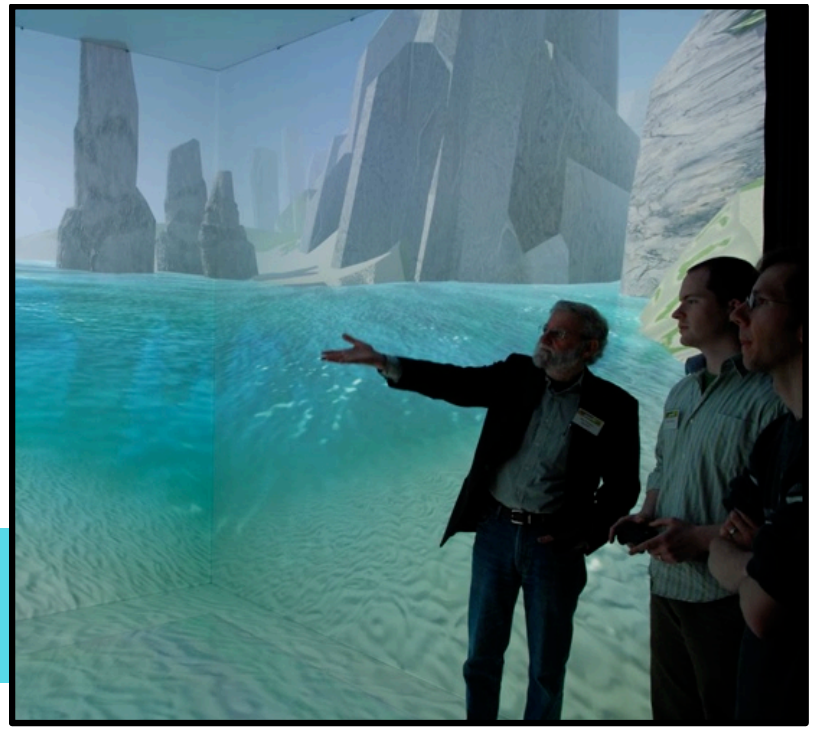

Visioning Workshop – July 2017

40+ academic, industry and government experts identified 8 scientific gaps in creating personalized and adaptive XR systems.

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Virtual Reality Applications Center

http://bit.ly/vrworkshop2017

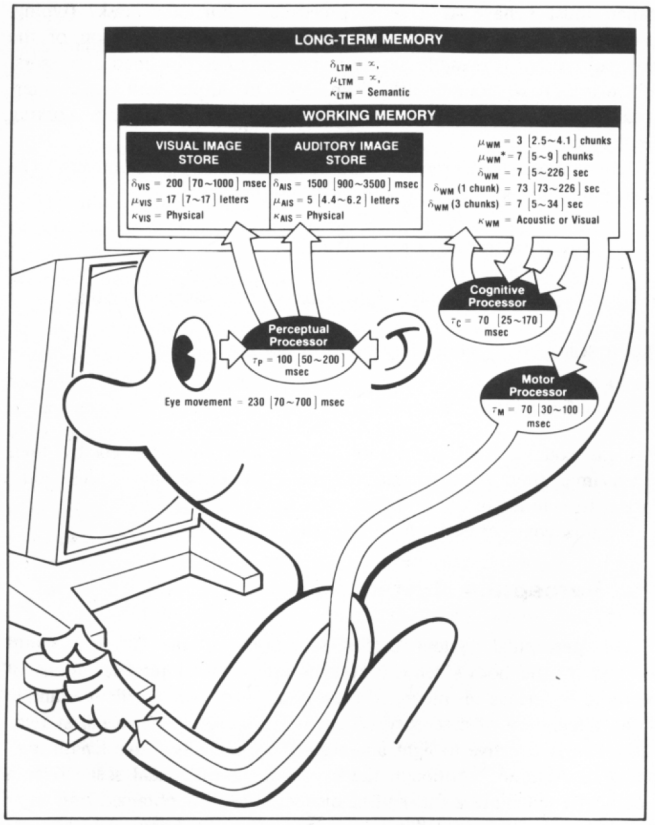
Goals

To **bring together professionals from various fields** in academia, military, and industry to **identify research areas** that will help produce the next generation of personalized and adaptive VR/AR systems and content.

Two focus areas:

1. **Perceptual systems:** How visual systems, auditory systems, and VR/AR content can adapt to optimize an individual's experience; and,

2. **Social, behavioral and cognitive patterns:** How VR/AR systems can assess an individual's knowledge and adapt to ease interaction, navigation, locomotion, and learning; as well as how VR/AR systems can adapt to and influence individuals' social behavior.



Card, Moran, & Newell (1986). The model human processor

Theme 1:
How does the system interact with your:

- body
- perceptual system
- sensitivities

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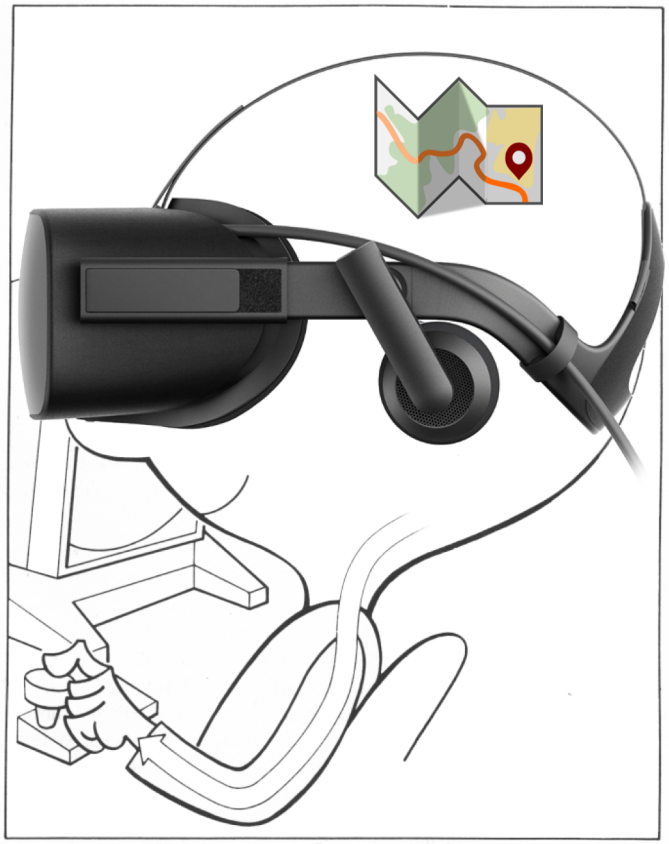
Theme 2:
How do you engage the virtual / augmented world?



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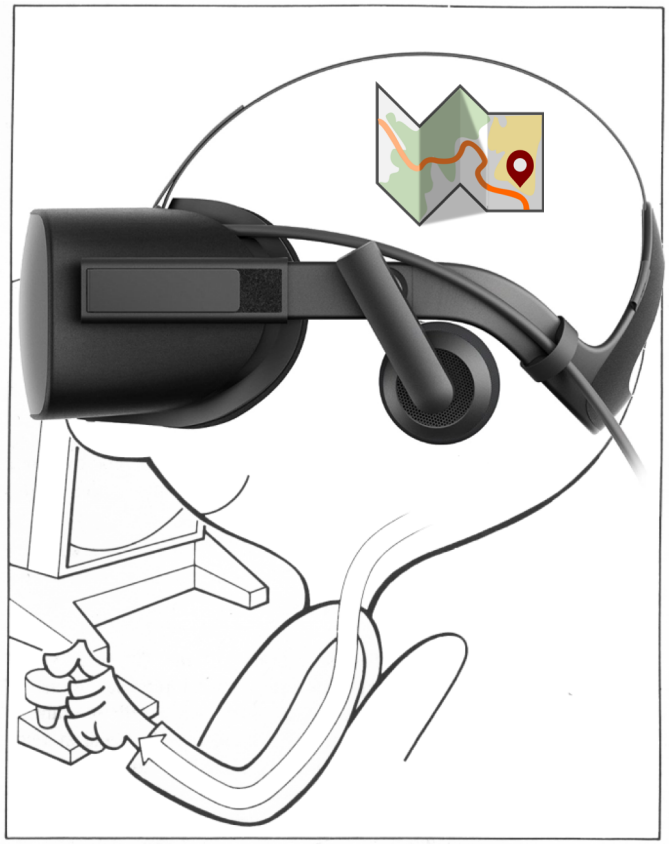
And other people in it?



Theme 1:
How does the system interact with your:

- body
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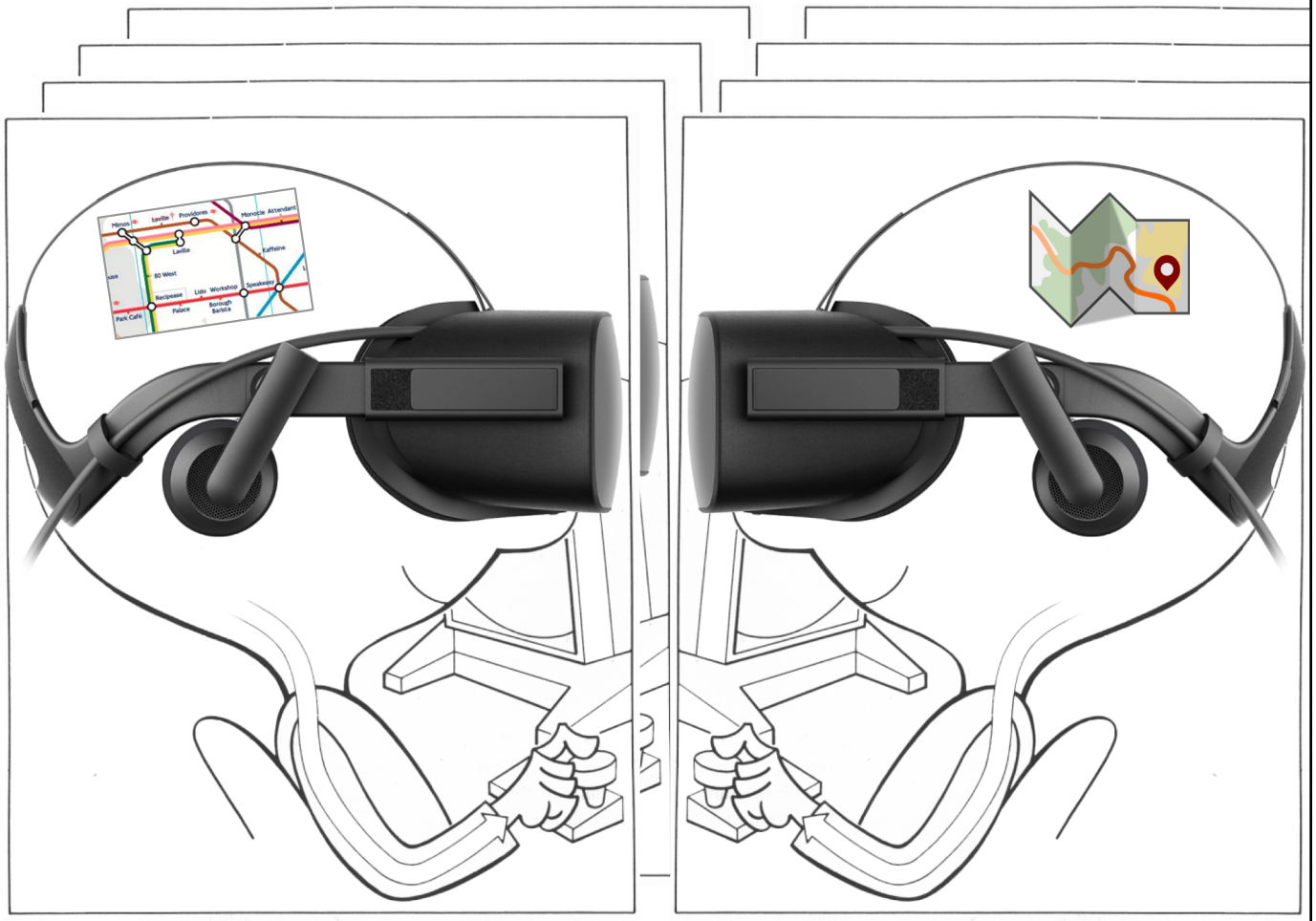
- sensitivities

Theme 2:
How do you engage the virtual / augmented world?

And other people in it?

And how does all of this change over time?



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User Story: Training for First Responders

Jessie,
Training Director

I like being able to port models of the real world in our system to create new virtual training scenarios.

Plus, I can personalize the scenarios based on the skills of my trainees.

I like the way the system adapts to how my trainees react, too…when one guy was getting a little panicked, it toned things down a bit until he caught his breath.

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User Story: Training for First Responders

Dynamic content generation

Human state measurement

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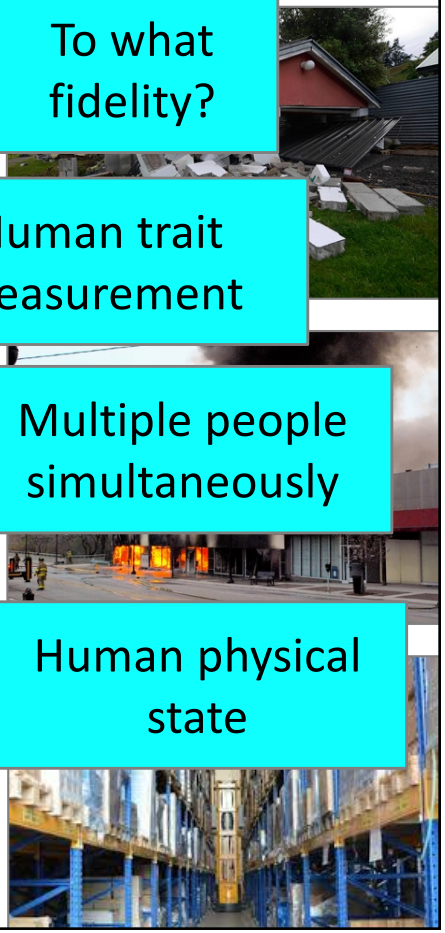
To what fidelity?

Human trait measurement

Multiple people simultaneously

Human physical state



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1 User-Centric Hierarchical Benchmarks

How do I measure if your VE is better than mine?

Hardware- and software-agnostic benchmarks should be developed for assessing the end-to-end user experience to determine how well systems support a user to complete a given task, e.g.,

- Detection
- Navigation (locomotion)
- Selection
- Manipulation

Benchmarking tasks might include:

- Visual acuity
- Contrast sensitivity
- Disparity acuity
- Localization in space (visual & auditory)
- 3D motion acuity
- Hand tracking
- Distance estimation
- Pointing
- Interception

2 Optimizing the Human-Machine Interface

How do I create natural interaction that requires low cognitive load but allows high mastery?

Optimization includes:

- Different types of user interfaces
- Different kinds of interaction tasks
- Match between task and setting
- Task-specific optimization

What are the universal aspects, and what requires personalization?

Operation in the real world requires:

- Intelligent sensing/modeling of the environment
- Algorithms for virtual objects in physical space
- Methods to specify flexible environments that adapt to the physical world
- Studies of how physical environments result in different user experiences and acceptance

3 Identifying User States & Traits

How do we read our users?

Understanding the emotional and physiological states of users in real-time is critical to developing and assessing adaptation and ensuring XR usability.

Also, these can be used to predict/detect cybersickness.

Potential states and traits include:

- Engagement, from mild interest to “flow”
- Presence, the sense of “being there”
- Frustration
- Boredom
- Confidence or self-efficacy
- Tenacity / Grit

4 Identifying User Physical State

How do we track users' bodies?

To create lifelike avatars that mimic user characteristics, we need:

- Data to generate a motion model of a person
- Data for accurate 3D visual and spatial audio

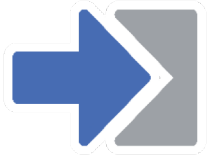
What new analytics and models are needed to generate real-time head related transfer functions?

How do we personalize to the individual visual system?

- Interpupillary distance
- Acuity
- Motion sensitivity

5 Dynamic Content Generation

How do I write content that can adapt to users?



Traditional content design either delivers a “one size fits all” solution. How can we create systems that dynamically adjust?

Existing solutions optimize user comfort by adapting content dynamics to lower optic flow rate, change acceleration dynamics or content density. But these adaptations negatively effect presence and engagement.

Are there an adaptation management rule sets or logic that can be developed?

How much agency should the user have over adaptive system processes?

How much should the system communicate its logic?

How can adaptation be assessed for its effectiveness, desirability and perceived optimization?

6 Cybersickness

How do I avoid making people sick?

People vary quite widely in the three variables of cybersickness:

- Sensitivity
- Adaptivity
- Decay rate

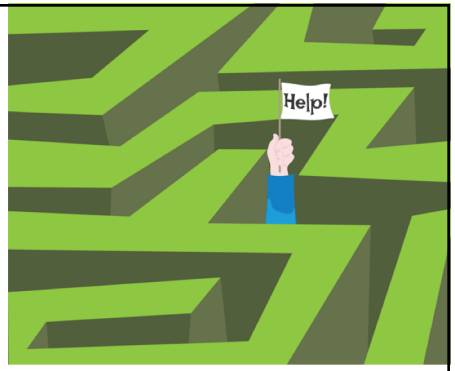
But how do these factors combine?

To what extent these are state vs trait variables?

How are these variables affected by the user context, environment and/or task?

7 Spatial Cognition

How do I make my system adapt to your navigation style?



Needed information:

- Assess and utilize individual's knowledge to adapt to personalize interaction, navigation and locomotion
- The effect of varying cues or adaptive geometry for varying speeds
- The effect of locomotion-speed-aware landmarks
- Teleportation as a tool to allow for rapid, precise movement AND maintenance/development of spatial knowledge WITHOUT inducing discomfort
- Detection of navigation/spatial problems or confusion

In group settings:

- Affording multi-user calibration or coordination across people
- Personalization for physically/virtually co-located users

Are different interaction techniques or spatial layout necessary for different users?

8 Social & Behavioral Factors

How does my system affect social dynamics and culture?

There is little knowledge about the impact of social behavior on XR and the impact of XR on social.

How can adaptive systems support these functions by gauging an individual's social intent and behaviors to deliver experiences that are more inclusive, safe, and comfortable?

Topics include:

- Anonymity
- Authenticity
- Privacy and security
- Legality of behaviors
- Malleability of appearance
- What is healthy social behavior in XR?
- Public vs Private control

9+ Ethics

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Blurred distinction
of what's real

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Addiction to escape

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Is that avatar really Maria?

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Is that avatar really Maria?

Changing people's behaviors by defining their avatars

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Is that avatar really Maria?

Is this the same VE I was in yesterday?

Changing people's behaviors by defining their avatars

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