Characterizing Augmented Reality System Efficacy to Drive Improved Medical Training

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WELCOME

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Research Question

What are the effects of AR training on performance outcomes and psychological states?

> **AR Psychological Suitability:**
> AR training system's ability to facilitate learning and human performance

Training System Efficacy

Degree to which AR training **system promotes skill development and transfer** through provision of task/environment sensory cues afforded by **AR system optics, display, and graphics**

Training Context Receptivity

Degree to which the **individual** trainee is receptive to AR training, **tasks** to be trained are receptive to AR training, and **environment** where training occurs is conducive and receptive to AR training

Designed a comparative analysis of three AR systems (2 immersive, 1 tablet) to help answer the research question and provide AR usage guidelines for medical training.
Study focuses on characterizing AR Psychological Suitability.

Mixed Model Comparative Analysis

Tablet

HoloLens

Magic Leap

Theoretical Increase in Training System Efficacy

Theoretical Increase in Context Receptivity

- **Low Receptivity:**
  - All virtual interaction, no haptics on manikin, little-to-no visual UI
  - Outdoor setting completely uncontrolled for lighting, temperature, noise, interference for minimized suitability
- **Medium Receptivity**
  - Mixture of physical and virtual interactions, moderate haptics on the manikin, moderate visual UI
  - Partially control environment via temperature and light
- **High Receptivity**
  - Effective integration virtual interaction, including haptics on manakin and task directed visual UI
  - Optimized temperature, light, noise, interference for maximized suitability for AR technology

Methods

- Between-subjects exposure to AR technology
- Within-subjects exposure to task and environment
- 171 participants with data collected on individual differences
- Pre-tests of knowledge, skill and psychological state
- 40 minutes of exposure to simulated medical situation (tension pneumothorax and massive hemorrhage)
- Measures of performance and psychological state during exposure
- Measures of workload and telepresence
- Post-tests of knowledge, skill and psychological state, psychology
- ANOVA, post hoc analysis, and correlations to evaluate AR system, task, and environment effects and variable relationships

Analyses on Dependent Measures

ANOVA reveals main and interaction effects of AR system design, environment, and task design on performance, psychology, and learning gains

Post hoc analysis on significant findings illustrates specific differences between technologies under task and environmental conditions.

- **Process Measures**
  - Attention allocation (eye tracking, secondary task measures)
  - Situation assessment (behavior assessment)
  - Presence/Immersion (behavior assessment)
  - Performance (skills error assessment)
- **Outcome Measures**
  - Psychological states (anxiety, memory, self-efficacy scales)
  - User state measures (stress, engagement from wearables)
  - Workload (rating scales)
  - Presence / Immersion (PQ / IQ scales, realism scale)
  - Performance (time, accuracy, behavioral outcomes, decision outcomes, situation awareness measures)
  - Knowledge / skill development (pre and post-test comparisons)

Expected tradeoffs

System Efficacy

Individual Receptivity

Task Receptivity

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Environmental Receptivity
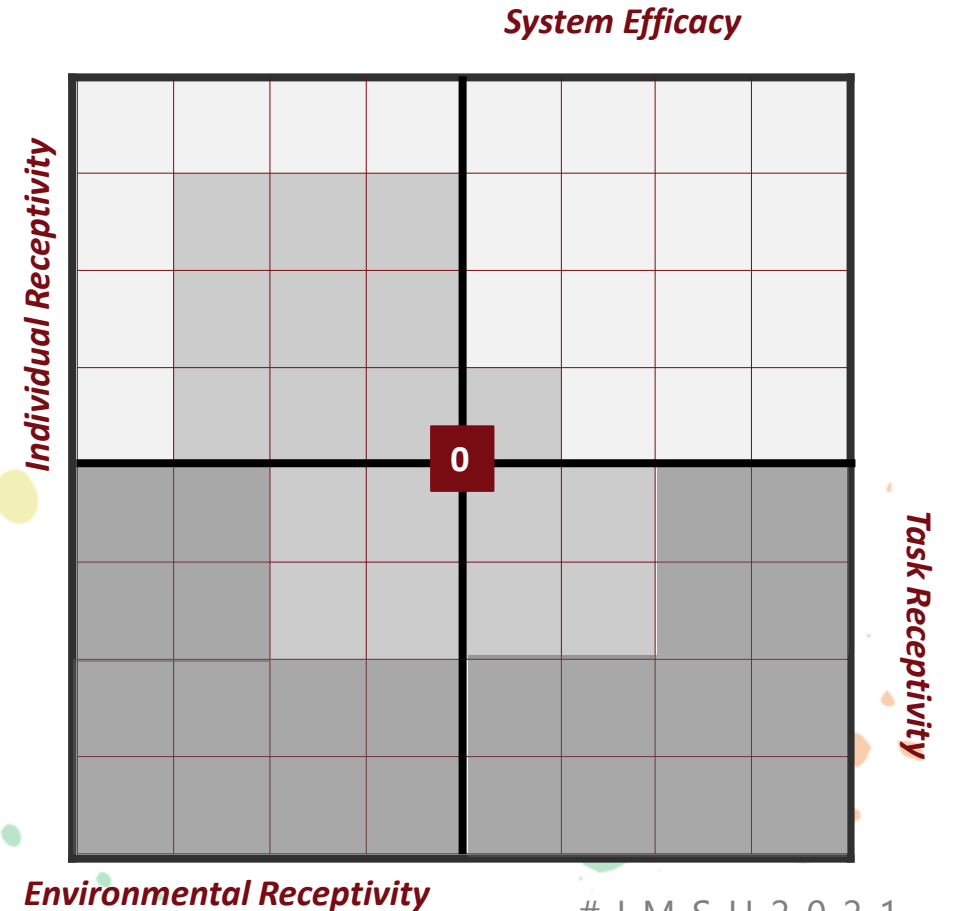
Conclusions

- AR affordances present opportunities for training and education enhancements, but designers and practitioners must understand potential negative psychological effects
    - Impact on human information processing during and after training
    - Influence of relevant factors – task, environment, human, system design, interface/interaction design
- Goals to examine relevance of proposed construct : *AR Psychological Suitability -* the ability of an AR training system to afford learning, human performance, and desirable psychological outcomes
    - Utility of characterizing, operationalizing, and defining useful measures of Receptivity and Efficacy
    - Relevance to other constructs: Presence, Embodiment,
    - Design guides to ameliorate concerns, exploit benefits, maximize potential with tradeoffs

QUESTIONS?

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THANK YOU!