Guiding the selection of proper XR displays to Enable effective Ab-Initio Training

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Introduction

- Recap of:
  - Ab-Initio Pilot Training
  - Military Ab-Initio Training
- XR Training
- Headset Analysis
- Examples/Results of different headsets impacting training
- Future Planning

ERAU Ab-Initio Pilot Training

- Embry-Riddle Aeronautical University uses VR in pilot training
  - PILOT program for new private pilot students
    - VR procedures and basic flight maneuver training
  - Spatial Disorientation Lab
    - Training Visual and Vestibular illusions to instrument pilots

Military Ab-Initio Training with XR

- Air Force – Pilot Next Training (PTN)
- Navy - Project Avenger
- Army – Reconfigurable Virtual Collective Trainer (RVCT)

U.S. Air Force T-38 XR

U.S. Navy Project Avenger

U.S. Army RVCT

Goal of Presentation

- Explore how different XR headsets can affect training
- Considering:
  - Application
  - Training Goals
  - Resolution/Fidelity

Headset Analysis

- Conducted analysis of 23 candidate headsets
  - Used a Pugh Matrix evaluation approach
    - Primarily technical and procurement criteria

Varjo XR-3 Vari-Focus				
Technical Criteria	**Weight**	**Score**	**Weighted Score**	**Observations**
Near View	5	N/A	N/A	No interaction with near views on common commander station.
Mid View (Interaction with other hardware)	5	1	5	Advantage over current solution. User can look directly though and see RVCT hardware physical/virtual controls.
Far View (Image Quality)	5	1	5	Passes using Johnson criteria. Stereoscopic
Field of View	4	1	4	Larger than current solution
Refresh rate	3	1	3	Refresh rate is 90 Hz
Comfort and Weight	5	1	5	More comfortable.
Ease of Setup/Operation	3	0	0	Similar to current solution
Supports eye-correction	4	1	4	Support eye glasses
Subtotal			26	
Procurement Criteria	**Weight**	**Score**	**Weighted**	**Comments**
Cost	5	-1	-5	Significantly higher cost
Head Tracking Capability	2	0	0	Does not have internal head tracking capability. Requires external tracker.
TAA Compliance	3	0	0	TAA Compliant
			-5	

Augmented Reality

HoloLens 2   SA-92   SA-147/S   JVC-VS1W   JVC-VS2   Magic Leap 2   ThinkReality A3   TQSKY T1   ROKID Max AR

Video Pass Through

Valve Index   Varjo XR-1   XTAL 5k w MR   Varjo XR-3   XTAL 8k w MR   Varjo XR-3 VF   Varjo XR-4 AF

Virtual Reality Only

PiMax Vision 8KX   Varjo VR-1   NVIS 106391   GOOVIS Pro (P2)   GOOVIS G3 MAX   DPVR E4

Headset Comfort Examples

JVC-VS2

Varjo XR-3 VF

Extended Reality Trainers

Examples – ERAU Spatial Disorientation Lab

- SD Lab training:
  - 6 Visual and 6 Vestibular Illusions

- Original design used the Steam Valve Index Headset
- In Fall 2023, upgraded headset to Varjo Aero
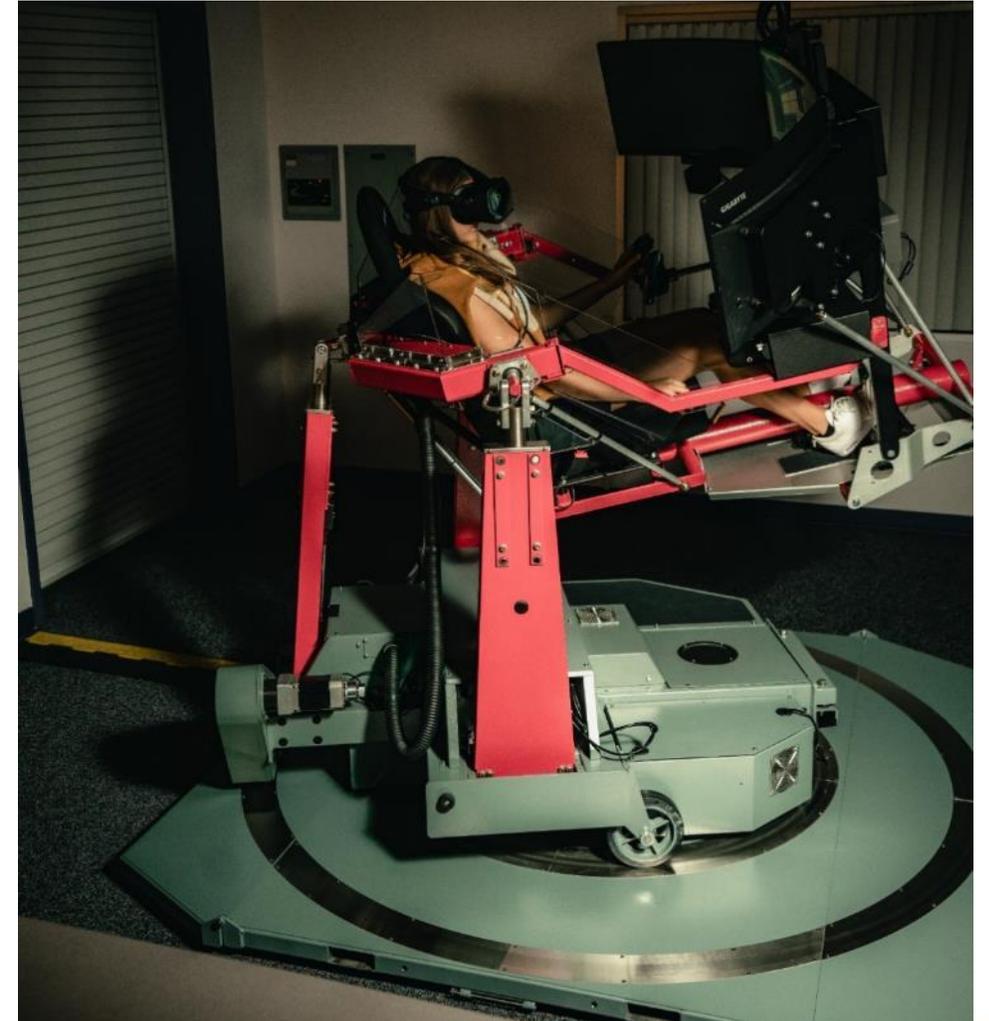
Video of Device in Motion

Measuring the differences

- Research plan was an experimental within and between subject design
- Pre-Training vs Post-Training Data
- All pilot experience levels

- Data Collected:
  - Knowledge score
  - Self-efficacy (self-reported)
  - Simulator Sickness
  - Satisfaction
  - Perceived Realism/Presence

Results

- Simulator Sickness Questionnaire
  - Participants rate 16 symptoms on their experience in the virtual world
    - Nausea, Oculomotor, Disorientation
  - Scale: None, Slight, Moderate, Severe
  - All were statistically significant decreases
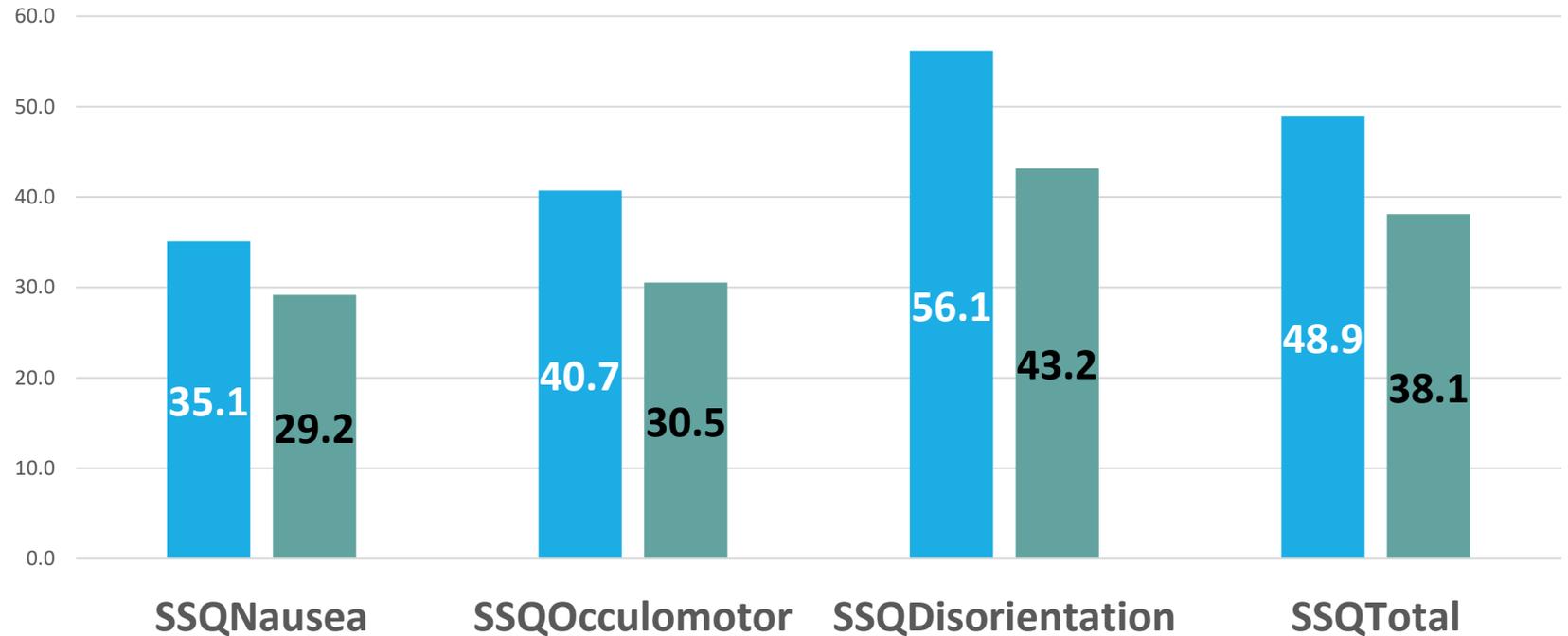
- Blue – Valve
- Green - Varjo

- Max Score Possible = 235.62

A bar chart comparing Valve (blue) and Varjo (green) across four SSQ measures:

Measure	Valve (Blue)	Varjo (Green)
SSQNausea	35.1	29.2
SSQOcculomotor	40.7	30.5
SSQDisorientation	56.1	43.2
SSQTotal	48.9	38.1

Results

- igroup Presence Questionnaire - Participants rate their experience in the virtual world
  - Varjo Headsets had a statistically significant increase in Involvement and Realism Scores

  - Involvement (max 6 points)
    - Valve M = 2.9, SD = 1.1
    - Varjo M = 3.1, SD = 1.0
    - $t(530)=-2.457, p=0.014$)

  - Realism
    - Valve M = 2.7, SD = 0.6
    - Varjo M = 2.8, SD = 0.6
    - $t(530)=--2.017, p=0.044$)
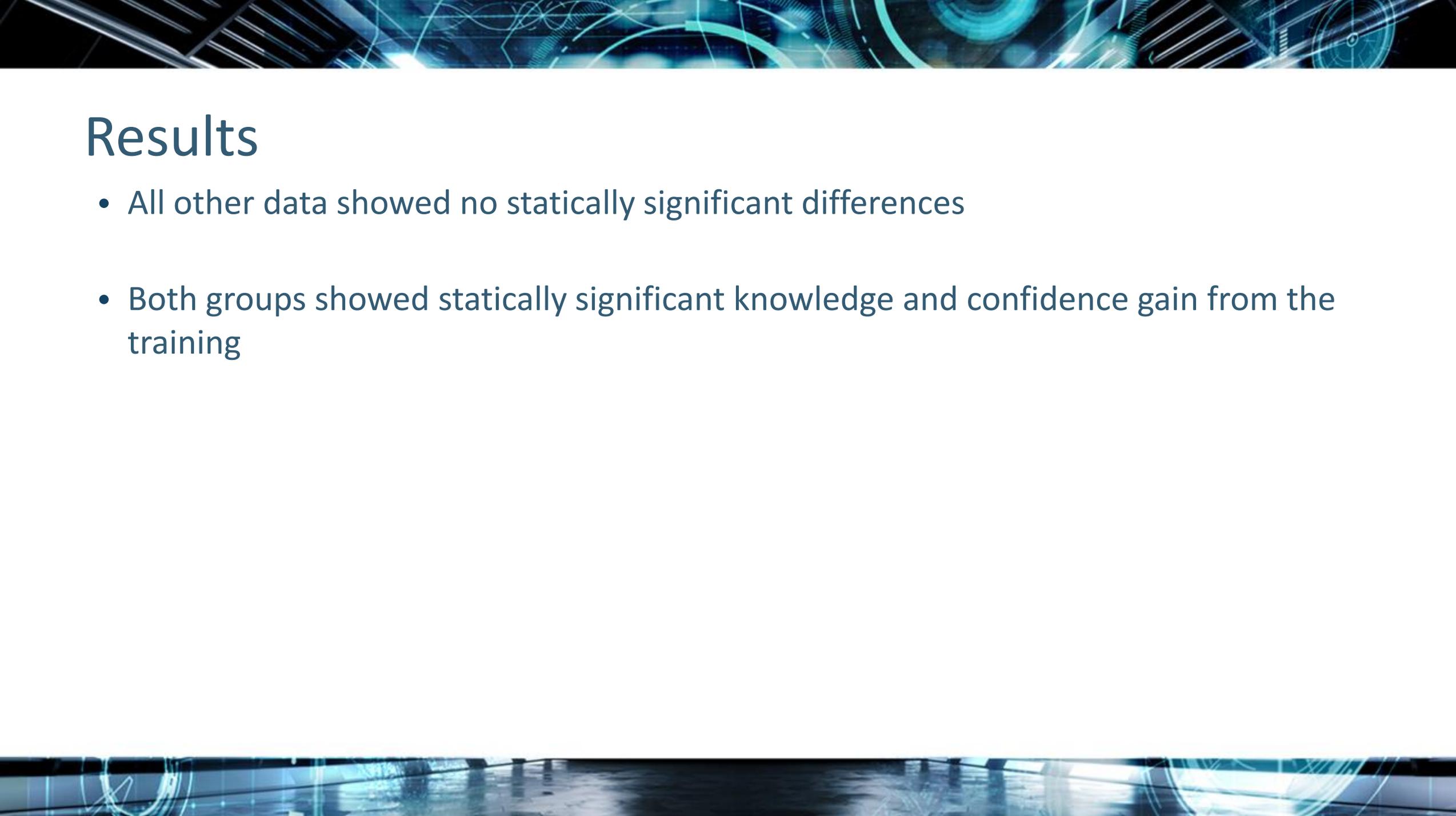
Results

- All other data showed no statically significant differences

- Both groups showed statically significant knowledge and confidence gain from the training

Future Planning

- How to plan for future headset updates
- What to consider?
  - Budget
  - Fidelity needs
  - Task/Skills that are being trained

Conclusion

- Technology continues to move at a fast pace and the selection of XR displays presents a difficult challenge
  - Some key considerations going forward
    - Focus on the use case
    - Ask what is your objective
    - Purchase ahead of your needs

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