EXPLORATION AND PRIORS IN A NOVEL REDUNDANT HUMAN-MACHINE INTERFACE

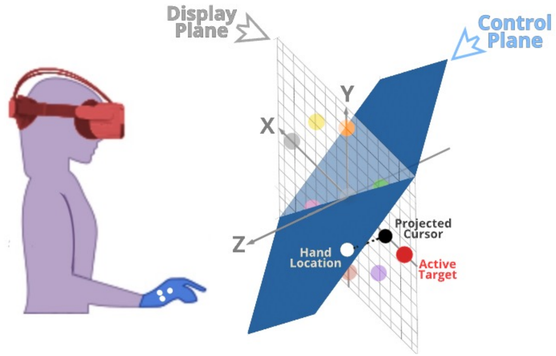
STUDENTS: VICTORIA PIERCE, LEO SCHOLL, HAYDEN RUNDLE, BRADY BORCHELT

MOTIVATION

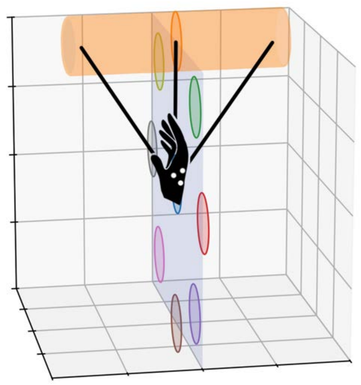
- Real motor tasks and most human-machine interfaces (HMI) involve more dimensions of control than of feedback ("redundancy") [1]
- Exploration is required to not get stuck in local minima
- Task beliefs ("priors") dictate initial strategies
- Better HMI design requires knowledge of how choice of visual cues and control algorithms can shape exploration

REDUNDANT HUMAN-MACHINE INTERFACE

- 3D hand movements projected onto a 2D plane in space to control a cursor
- Users try to move cursor from center to targets
- Control plane only apparent through cursor behavior



- Redundancy: Multiple different reaches can result in the same feedback
- Reaching directly along control plane is most energy efficient ("optimal")



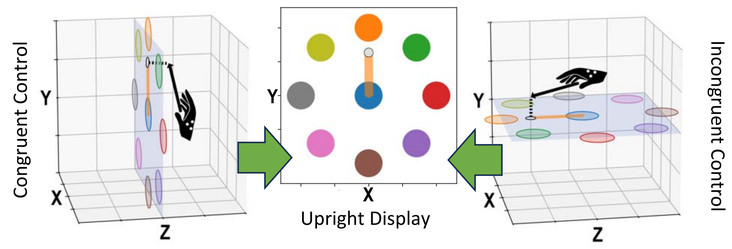
EXPERIMENT STRUCTURE

Control plane changes across sessions

Baseline → **Perturbation**

control plane depends on congruence group

same rotated control plane for both groups

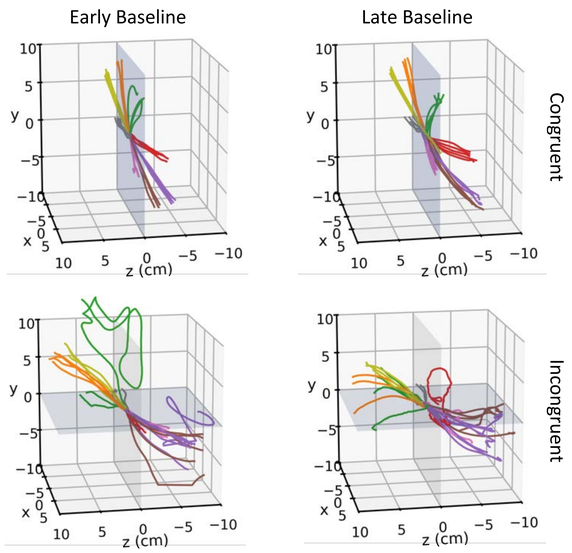


HYPOTHESES:

1. Visual cues (target orientation) influence initial strategies ("priors")
2. Incongruence between priors and control algorithms encourages exploration
3. Increased exploration results in more optimal final strategies

TASK DISPLAYS SHAPE EARLY STRATEGIES

- Pilot experiments: display condition (gray) always 'Upright'



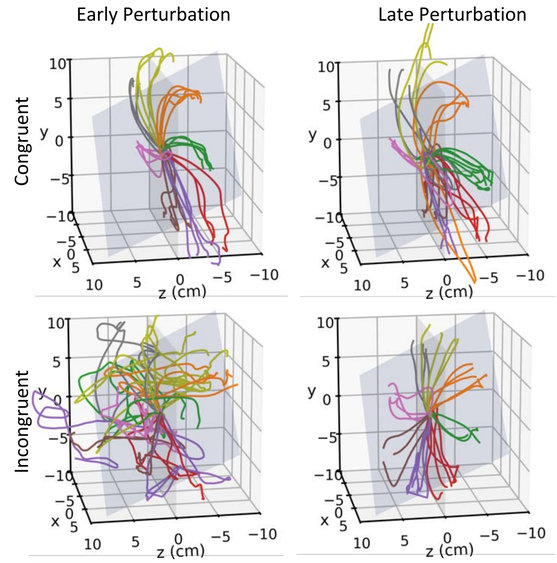
Congruent baseline control plane (blue):
- Stereotyped reaches
- Consistent strategy

Incongruent baseline control plane (blue):
- Variable reaches
- Biased toward display plane

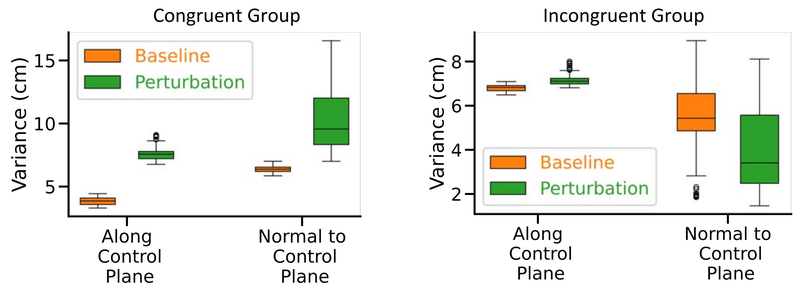
LEARNING IS INFLUENCED BY TASK DESIGN

- Persisted with suboptimal first strategy
- Exerted more physical effort

- Much more early exploration
- Found a more efficient final solution



Earlier experience with a mismatch between display and control planes:
- Higher baseline exploration
- More optimal final strategy



FUTURE WORK & REFERENCES

- Complete VR experiments
- Incorporate findings into a motor learning model to enable predictions

[1] Hossner, E.-J., & Zahno, S. (2022)
[2] J. Krakauer JW, Hadjiosif AM, Xu J, Wong AL, Haith AM. (2019).

ELECTRICAL & COMPUTER ENGINEERING
UNIVERSITY of WASHINGTON

ADVISOR: AMY L. ORSBORN

SPONSOR: NATIONAL SCIENCE FOUNDATION (NSF)