

Introduction

- Humans are prone to systematic biases and inconsistencies in navigation, orientation, and spatial knowledge^{1,2,3}, partly because we lack an innate fixed sense of global direction.
- We update spatial knowledge using egocentric perception (e.g., “coffee house is currently to my right”) while moving through an environment.
- Previous research suggests training with wearable navigation devices that confer cardinal direction information can improve orientational performance.⁴
- But we don’t know:
 - the timescale of acquisition of these devices
 - how learning fixed directional information impacts landmark and/or configural spatial knowledge

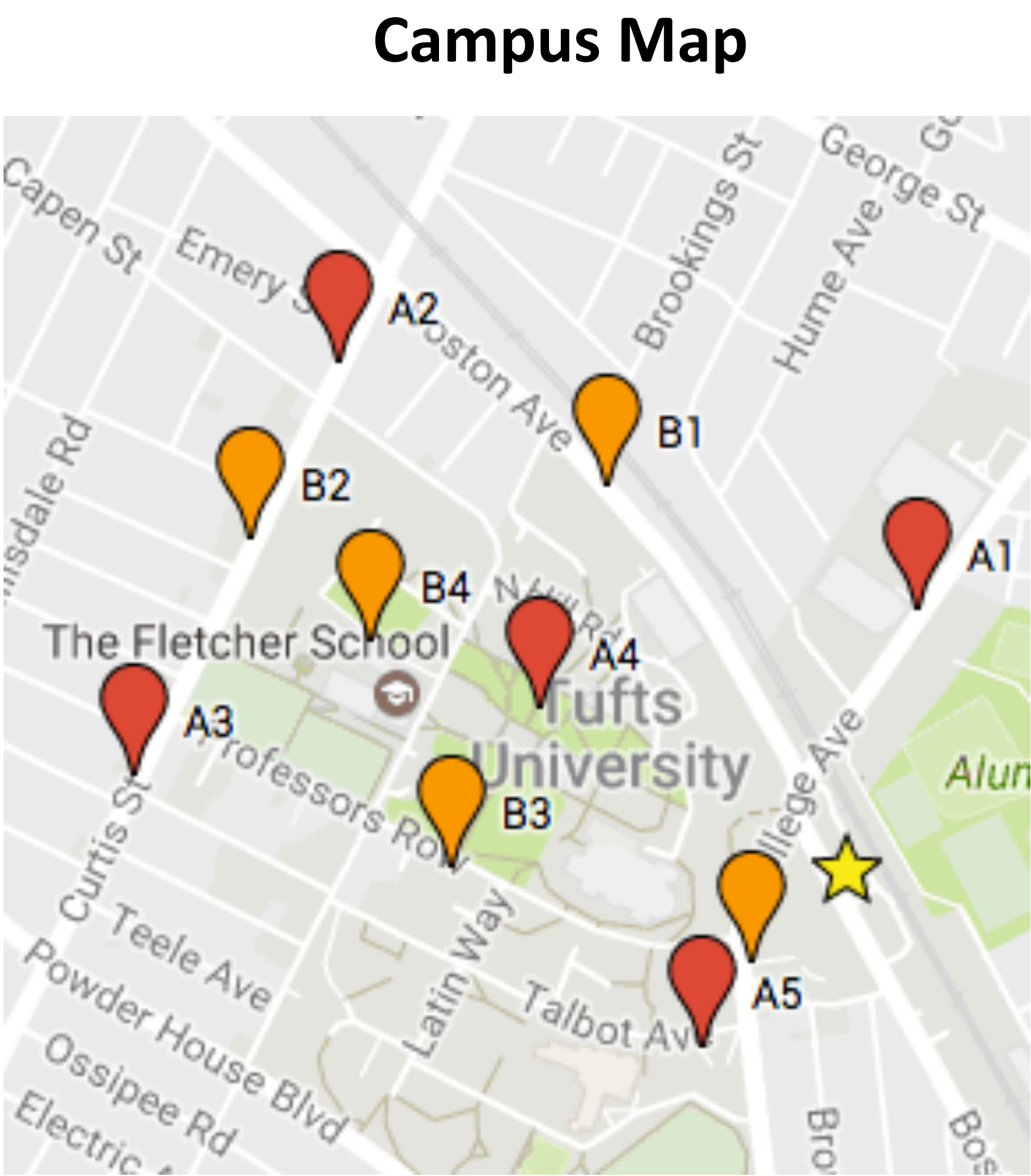
Research Questions

- How does training on navigational feedback methods affect orientational performance (i.e., accuracy on a pointing task)?
- In particular, what are the effects of a wearable, on-line, constant navigational feedback method compared with an intermittent, off-line feedback method?
- Can these feedback methods train orientation to cardinal directions, and does this training transfer to orientation to landmarks?

Methods

- Feedback Methods:**
- Heat Compass (HC):** wearable tactile technology, delivers directional information via heat on an armband
 - Verbal Feedback (VF):** experimenter provides verbal directional information
- Sample and procedure:**
- n = 40 (undergraduate students), 28 were women, $M_{age} = 20.6$ years
 - 20 VF, 20 HC

- 1 Pre-Test**
Walk around campus, point to a building and a cardinal direction at each location of a single route.
- 2 Training**
Learn feedback method. Walk around campus, receiving directional information from feedback method. Point to two cardinal directions at each location.
- 3 Post-Test**
Repeat step 1 at locations from other (spatially matched) route.
- Measurements:**
→ *absolute heading error*: smallest angle between expected response and observed response

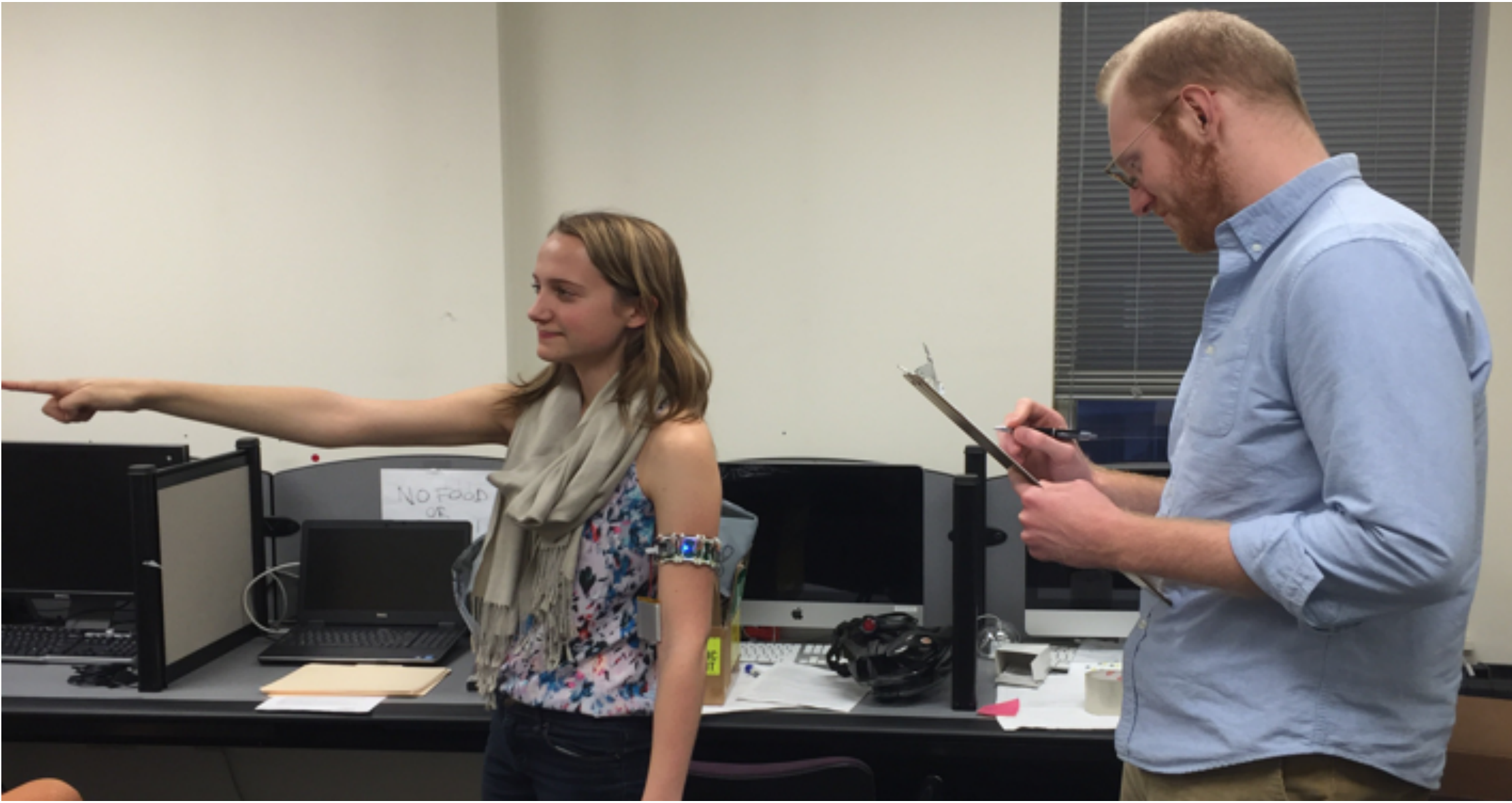


$$AHE = abs(R_E - R_O)$$

Training Feedback Methods

Heat Compass

Consistent directional information: for the duration of the training session, Heat Compass indicates North with the warm heating element.



Verbal Feedback

Intermittent directional information: experimenter demonstrates correct response for each requested cardinal direction at each location.



Feature Comparison

Features	Verbal Feedback	Heat Compass
information type	directional	directional
presentation	intermittent	constant
reference points	4 (N,S,E,W)	1 (North)
level of knowledge	familiar	novel

Data Analysis: Multi-Level Modelling

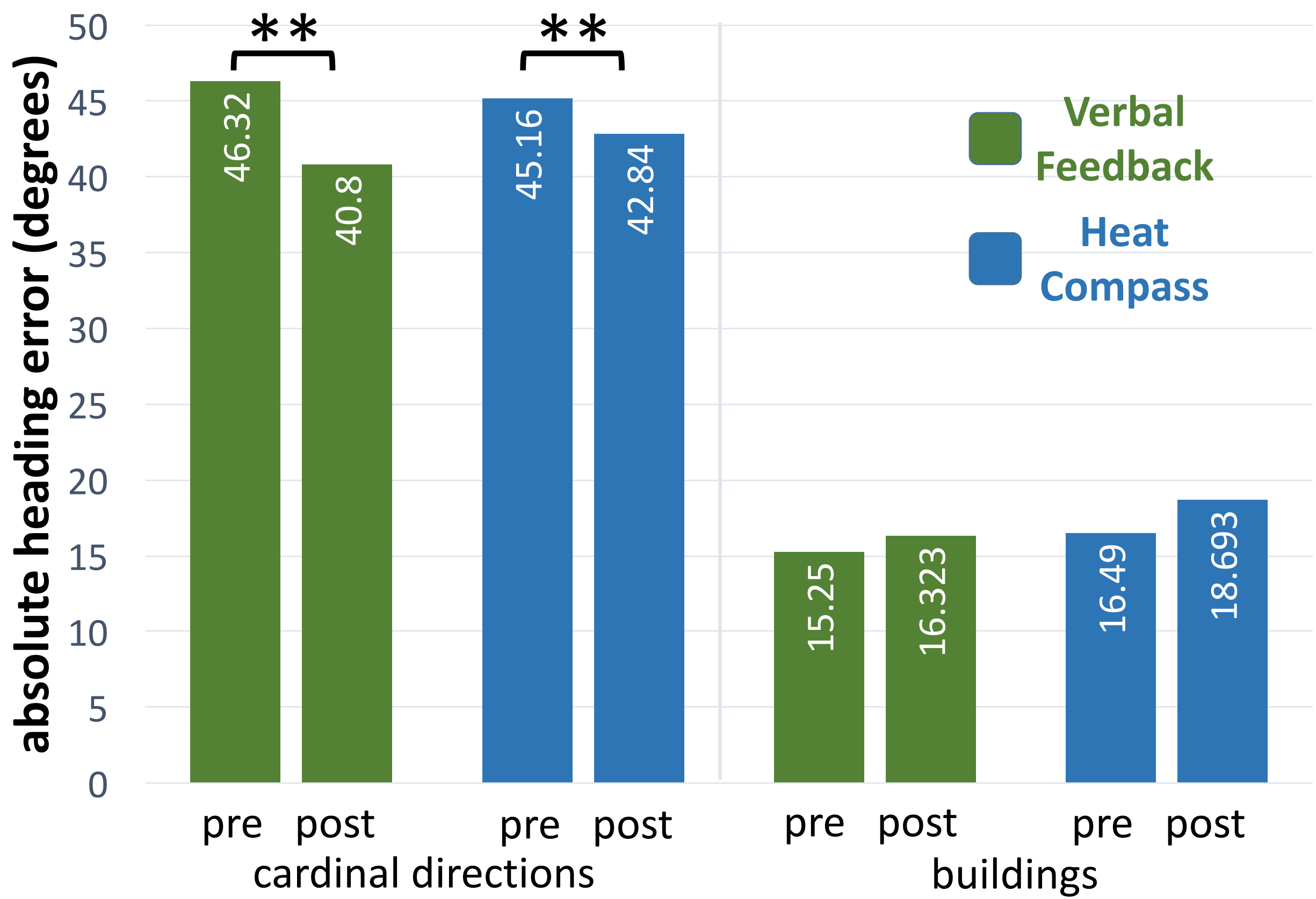
Constructed Multi-Level Model (MLM) to predict absolute heading error during testing. Used MLM due to nested (non-independent) nature of data:

- Level 1 (task-level) predictors:**
- Target type (building or cardinal direction)
 - Test session (pre-test or post-test)
- Level 2 (participant-level) predictors:**
- Group (VF or HC)

- Major findings:
- Participants point to buildings significantly more accurately than to cardinal directions
 - After training, participants in both groups pointed significantly more accurately to cardinal directions; pointing accuracy to buildings did not change

Results

Both methods led to improvement when pointing to cardinal directions, but not to buildings



* = $p < .05$
 ** = $p < .01$

Discussion

- These findings demonstrate people are more accurate at orienting to landmarks than to fixed global directions.
 - Possibly due to humans basing global orientation of spatial representations on salient route-perspective landmarks and objects⁶
- both feedback methods improved pointing to cardinal directions, but it appears **Verbal Feedback** led to more improvement than **Heat Compass**. Why?
 - Previous research on environmental representations:
 - less familiar location → rely on verbal/semantic descriptions
 - more familiar → rely on spatial representations⁵
 - So, we suggest the difference is training costs:
 - Verbal Feedback** is easier for people to process *and* a preferable and more familiar format for most people, whereas
 - Heat Compass** is a novel format, and thus will require more training to achieve comparable improvement

Future Directions

- Longer training with **Heat Compass**
- Compare with other control methods as well as navigational feedback technologies across different sensory modalities:
 - Vibrotactile Belt**
 - Auditory Directional Feedback**
 - Augmented Reality Visual Feedback**
- Using virtual environments to manipulate salient aspects of the environment

References

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