Evaluation of Pointing Ray Techniques for Distant Object Referencing in Model-Free Outdoor Collaborative Augmented Reality

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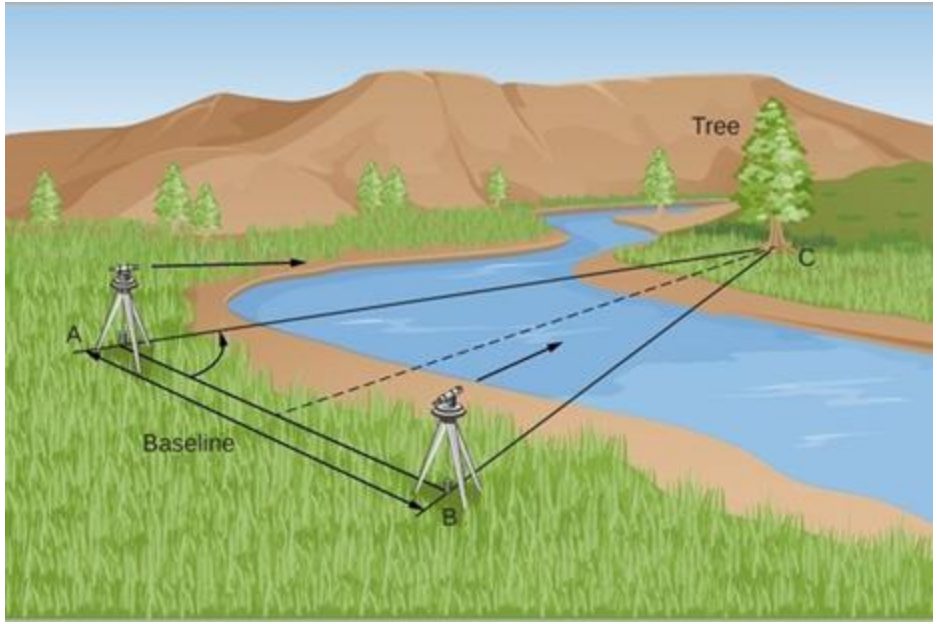
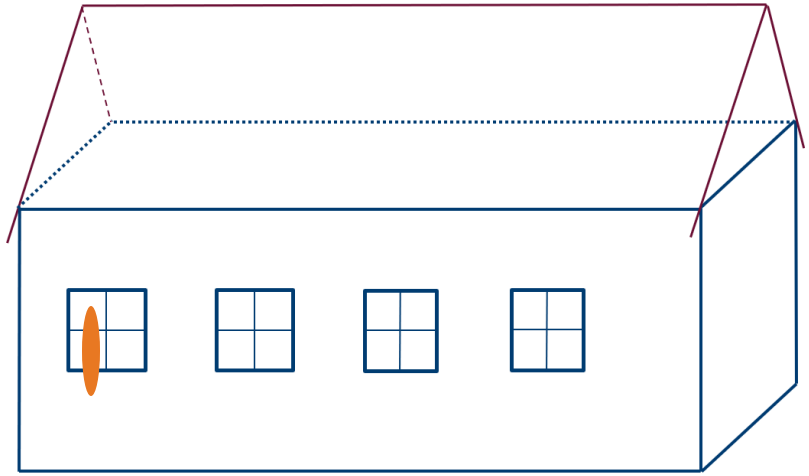
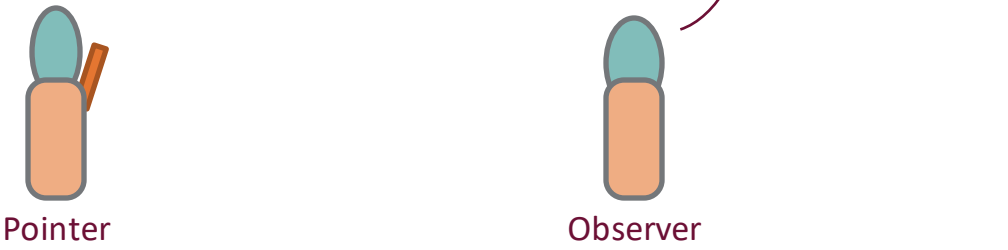
Introduction

Awareness is Important in Collaboration

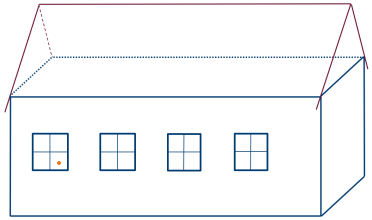


Laser Pointer in a Small Area





Laser Pointer in a Wide Area

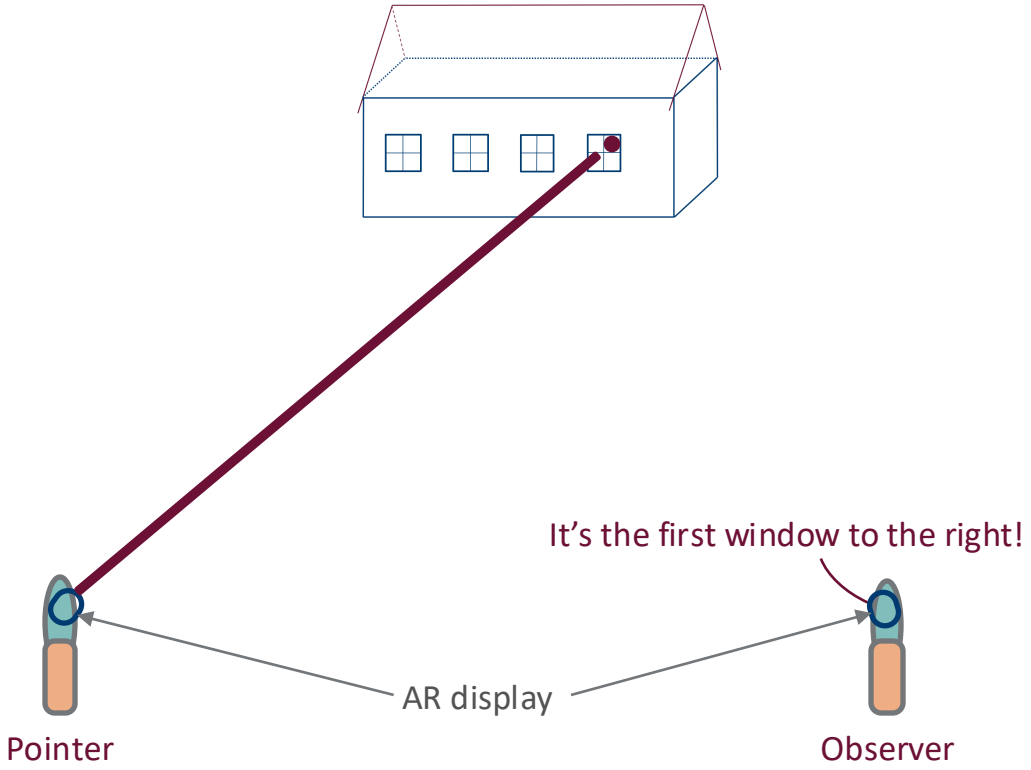


Pointer

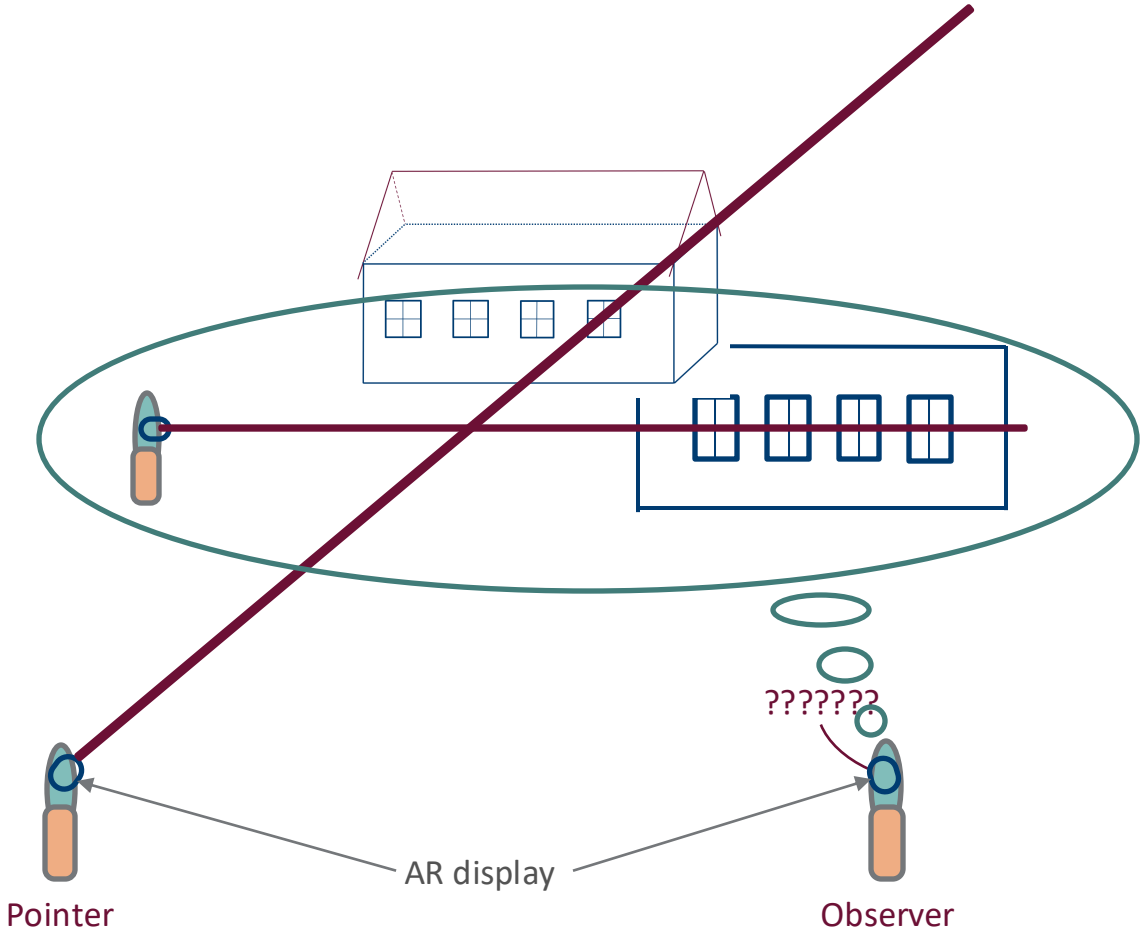
It’s the first window to the left…?

Observer

Pointing Ray in Wide-Area with Ideal AR

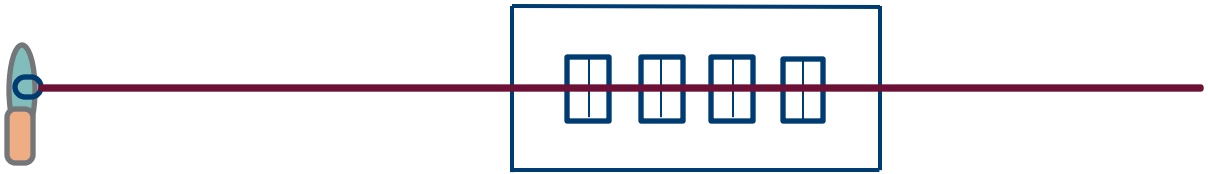


Pointing Ray in Wide-Area with Model-Free AR

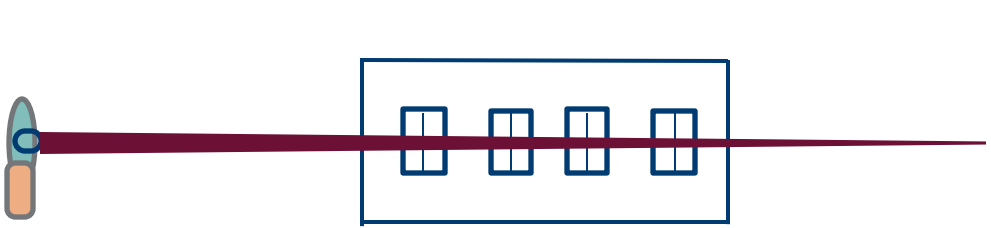


Ambiguities

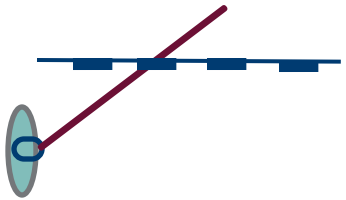
- **Visual Ambiguity (VA):** the ray appears to visually cross multiple objects in the environment.



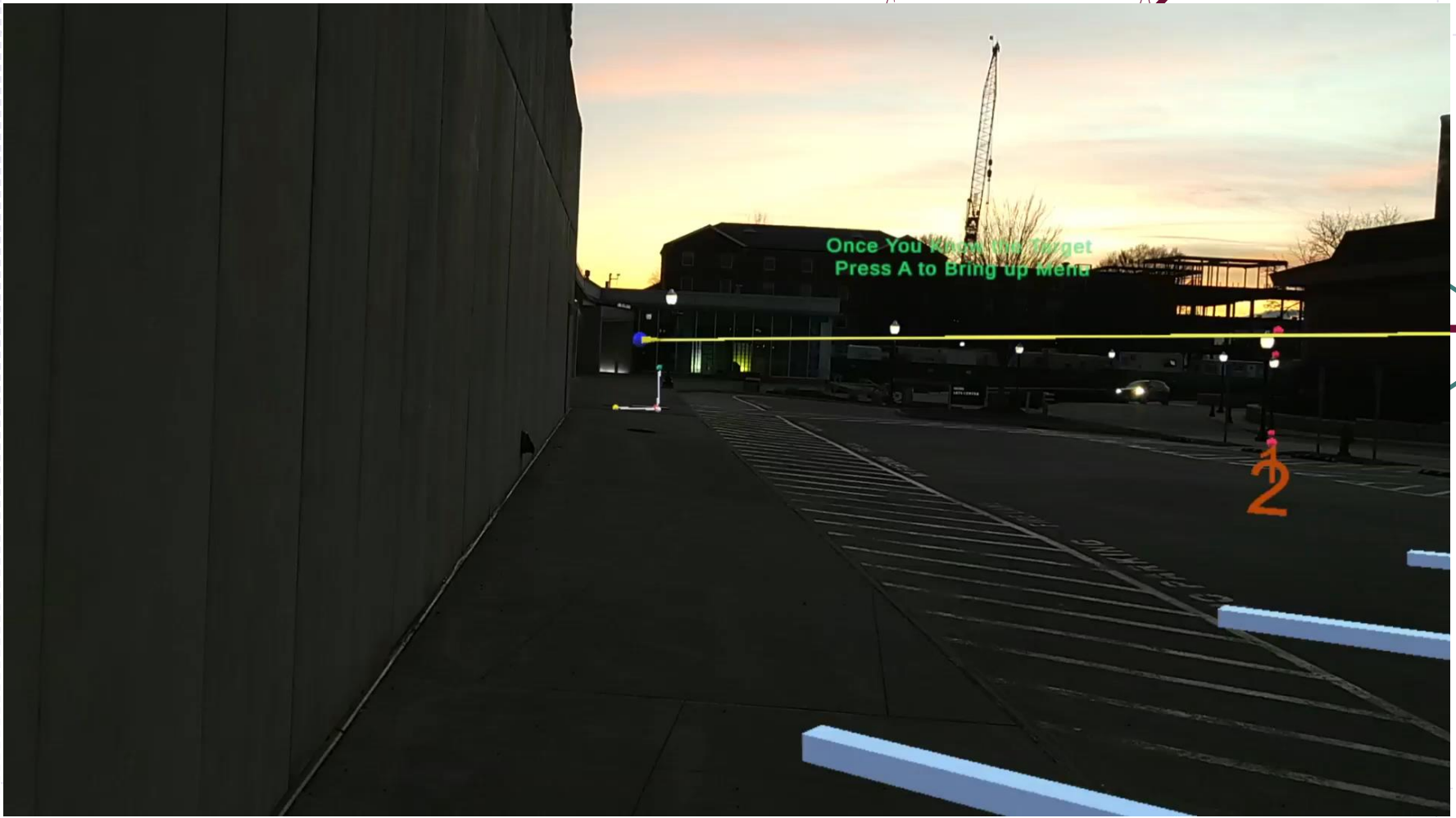
- **Spatial Ambiguity (SA):** even if the user can perceive ray orientation to some extent, they still cannot make correct spatial judgement when the target is surrounded by other objects.



(top-down)




CREATIVITY
Once You Know the Target
Press A to Bring up Menu
5
6
7


Once You Know the Target
Press A to Bring up Menu
2

AR Experiment

Research Questions

- **RQ1:** What is the effect of **Double Ray** technique on performance and subjective experience of the observer in model-free collaborative AR?
- **RQ2:** What is the effect of **Parallel Bars** on performance and subjective experience of the observer in model-free collaborative AR?
- **RQ3:** Is there a **significant decrement** of performance and subjective performance of the observer when using **Double Ray** technique?
- **RQ4:** What **trade-offs** does the pointer have to make to reduce the visual ambiguity for the observer?

Experiment Design

- 32 Participants, 11 females
- 7 lampposts as potential target
- Lampposts marked with virtual spheres to aid visibility
- Avatars for the participants
- Four techniques for target identification task

Experiment Variables

Independent Variables

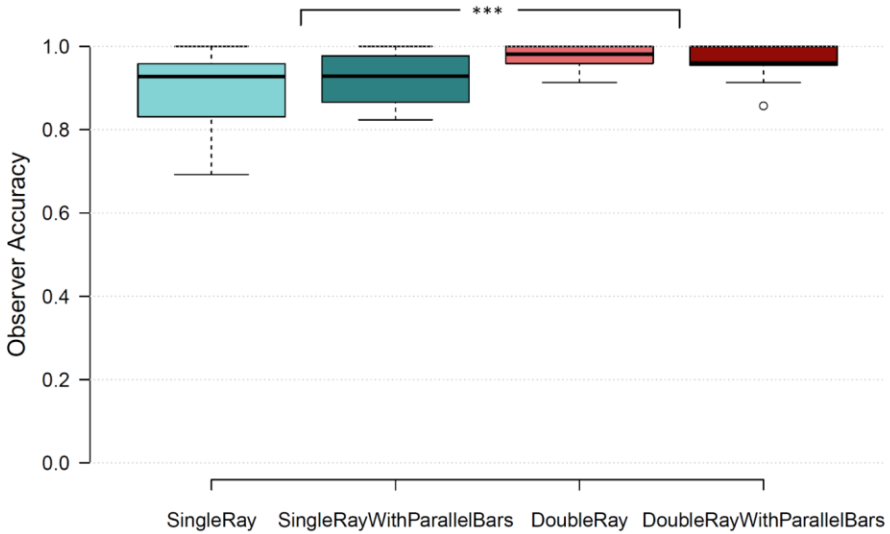
- **Number of Rays**: Single Ray vs. Double Ray
- **Orientation Cues**: Parallel Bars vs. None

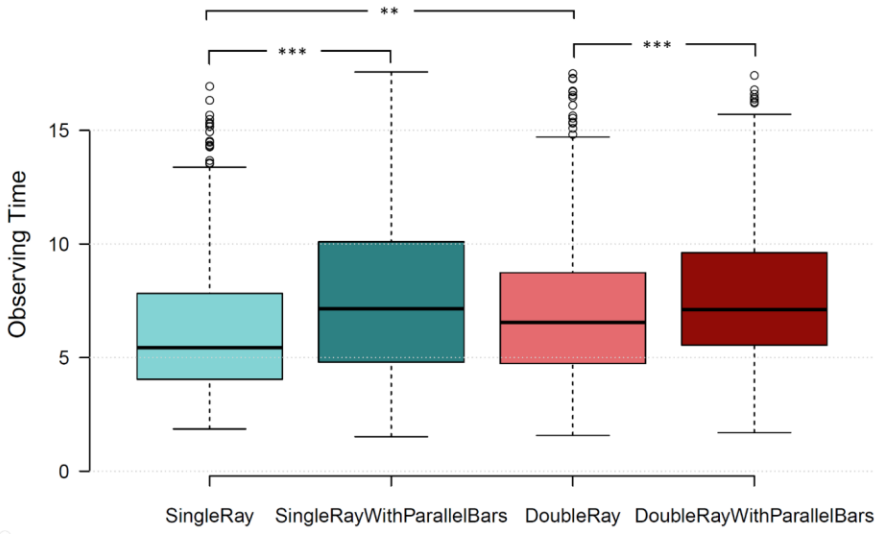
Dependent Variables

- Observer Accuracy
- Observing Time
- Pointing Accuracy
- Pointing Time
- Modified System Usability Scale (SUS)
- Raw NASA TLX

Results

RQ1.H1: The Double Ray technique will have significantly better overall performance and subjective experience than the Single Ray for the observer [Supported]

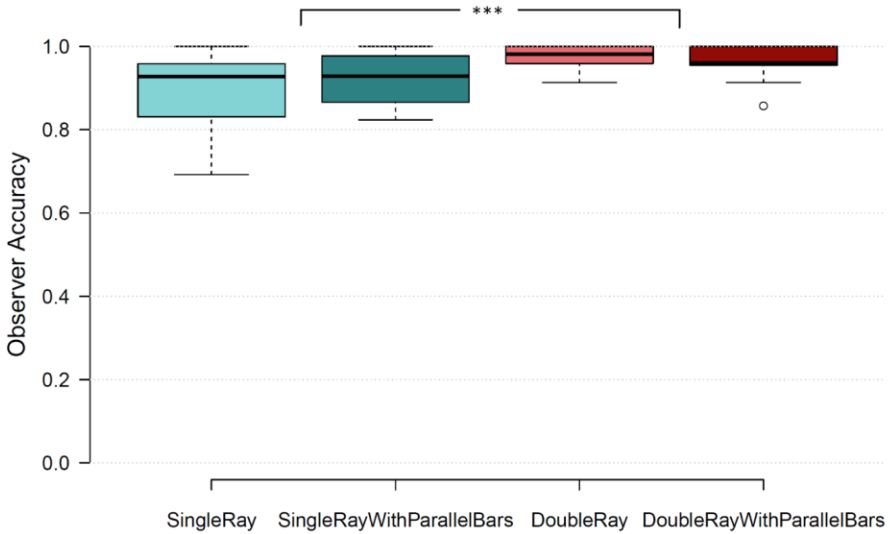


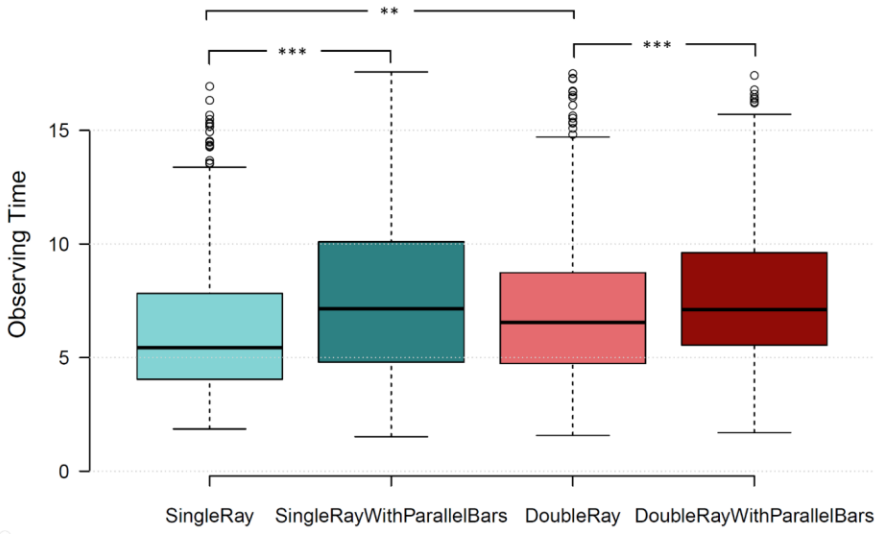


97% preferred Double Ray over Single Ray

Results

RQ2.H2: Techniques using Parallel Bars will be more accurate, but slower, than the techniques without Parallel Bars. [Not Supported]

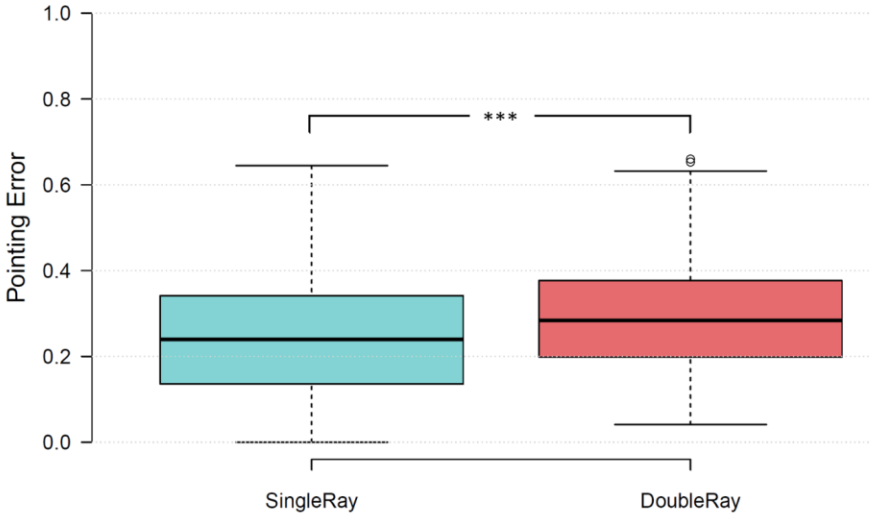


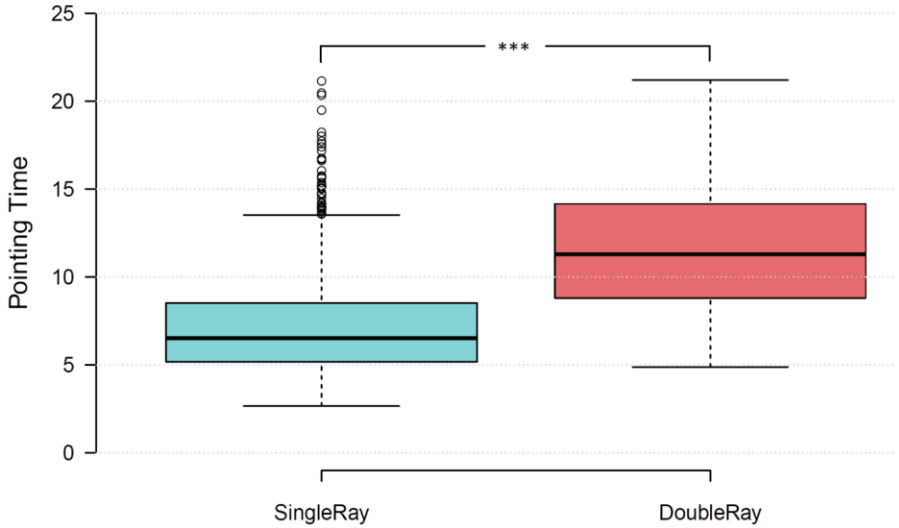


87.5% preferred Single Ray with Parallel Bars over Single Ray, 59% for Double Ray case

Results

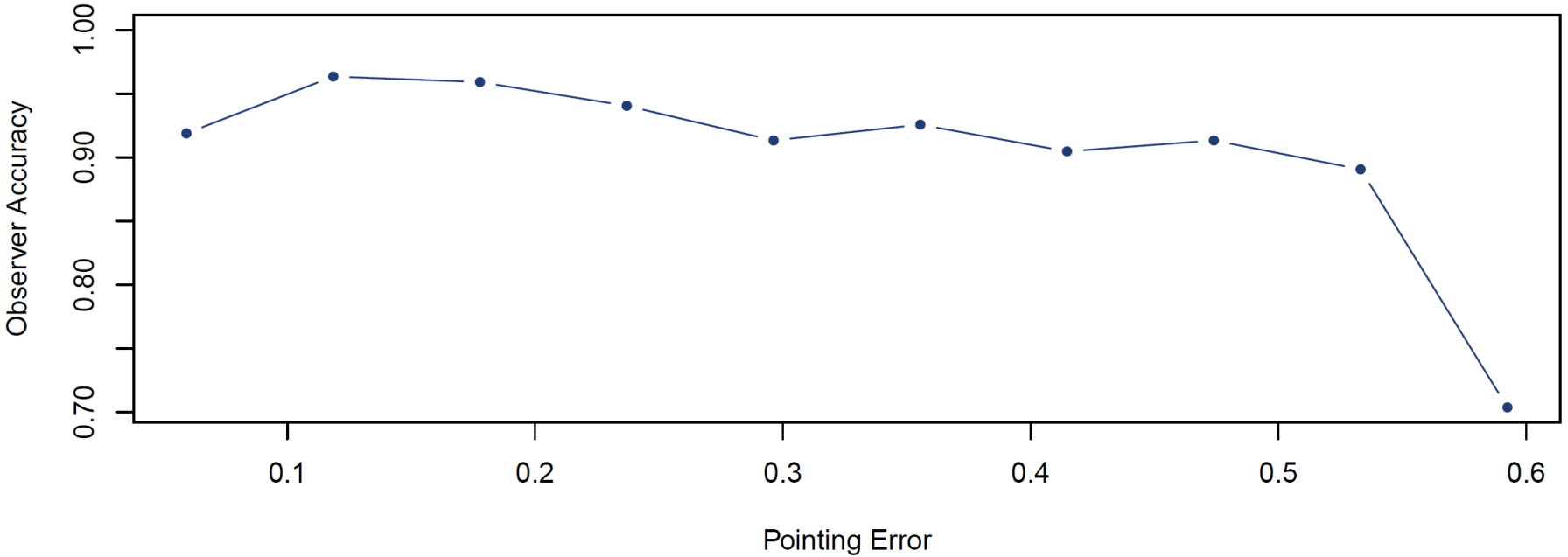
RQ3.H3: The Double Ray technique will have significantly lower usability for the **pointer**. [Supported]





Results

RQ4.H4: The extra cost in usability by the pointer will pay off in increased performance by the observer. [Supported]



Takeaways

- Double Ray was less usable for the pointer but contributed to better observer usability.
- Parallel Bars did not help with user performance, but participants still preferred it.

Thank You!

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