

Introduction

- Action Observation, or the concept of observing and imitating movement as practice, has thus far yielded both positive and negative findings in motor skill-based studies.
- Multimodal Mixed Reality (MR) tool developed to teach drumming (shown in Figure 1)
- 20-subject study
- **Research Question:** Do the affordances of a multimodal MR-based tool using Action Observation techniques offer measurable benefit over standard practice methods?



Fig. 1: Action Observation mode via Quest 2 Passthrough

Current Work



Fig. 2: Virtual Co-embodiment mode via Quest 3 Passthrough

- Virtual co-embodiment, or shared control of a single avatar [1]
 - maintains high sense of agency [2]
- Learning retention
 - Experimental trials timed ~1 week apart
- Quest 3 for full-color MR (shown in Figure 2)

Conclusion remarks

- Potential advantages of MR- and/or haptic-based affordances observed
- New evidence in favor of MR-based Action Observation as a beneficial treatment for learning motor skills, within a field with previously observed mixed results

Future work will include an experimental study aiming to:

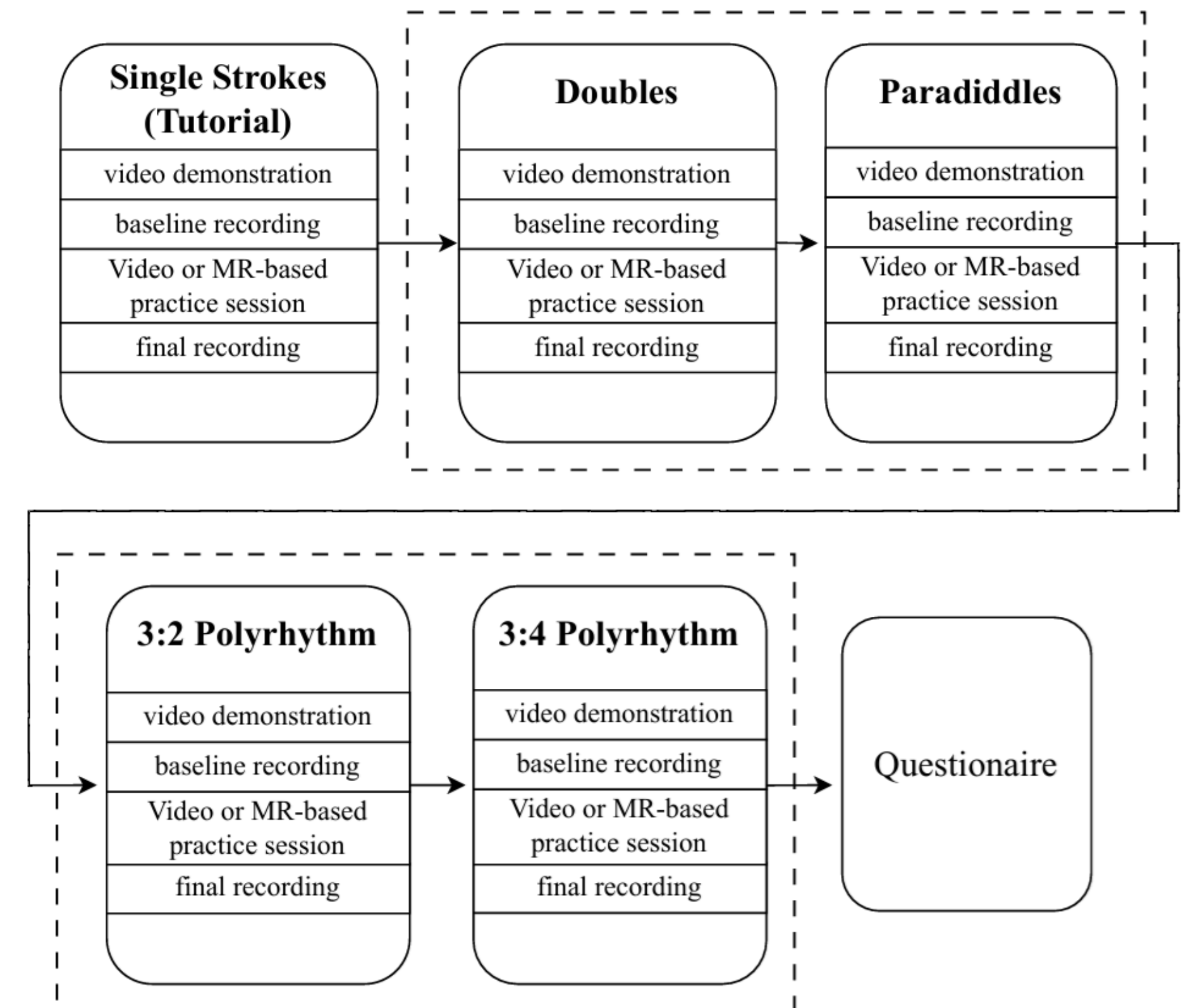
1. Recruit a higher number of subjects to see if results presented here can be recreated
2. Compare Action Observation and Video groups against a Virtual Co-embodiment group
3. Observe effects of the three practice methods in a comparatively longer use case (~1 week)

References

- [1] R. Fribourg, et al. "Virtual co-embodiment: evaluation of the sense of agency while sharing the control of a virtual body among two individuals." IEEE Transactions on Visualization and Computer Graphics 27.10 (2020): 4023-4038.
- [2] D. Kodama, et al. "Effects of collaborative training using virtual co-embodiment on motor skill learning." IEEE Transactions on Visualization and Computer Graphics 29.5 (2023): 2304-2314.
- [3] H. Takita, et al. "Effects of virtual co-embodiment on declarative memory-based motor skill learning." ACM symposium on applied perception 2023. 2023.

Apparatus and Methods

- Meta Quest 2 HMD + workstation running Unity (Figure 3)
- Passthrough view exposes users to their surroundings and virtual drums and sticks.
- Users mimic the virtual drumming and perform on two electronic drum pads.
- Vibration-based cues via Quest 2 controllers reinforce rhythms during practice (Figure 4).
- Realtime, MIDI-based feedback on user performance
- Reaper DAW used to record performances for further, offline analysis
- 5 rhythms, 4-phase experimental procedure:



- Two metrics were observed:
 - Metric 1: Δ of correct consecutive strikes between final and initial recordings
 - Metric 2: Δ of absolute time error between final and initial recordings



Fig. 4: User holding Quest 2 for vibrational feedback during practice

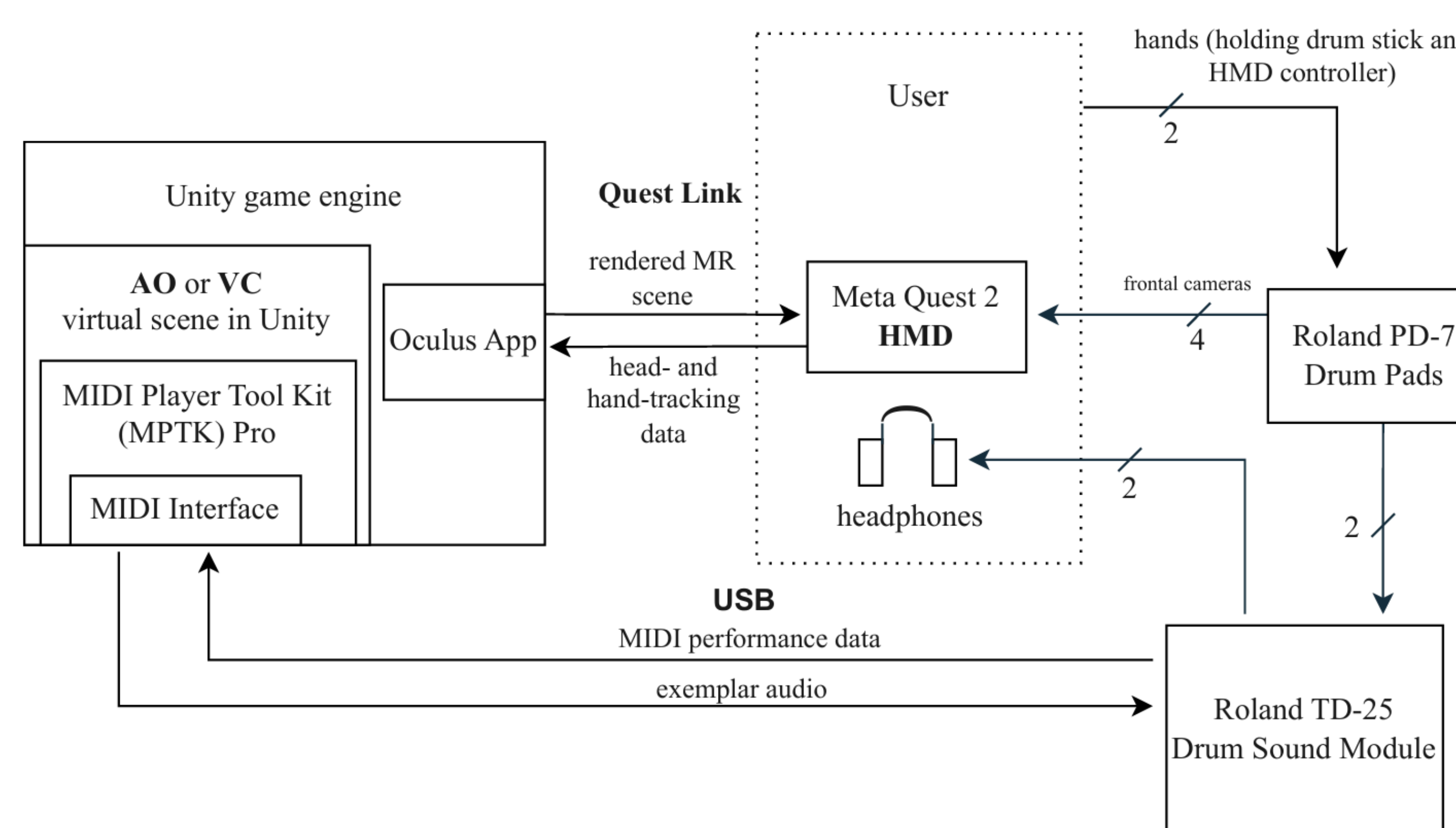


Fig. 3: System schematic

Experimental Results

- No significant effect of group was found for Metric 1 shown in Figure 5.
- For Metric 2, the MR Group had a greater reduction in timing error relative to the Video Group by 239 ms (z-ratio= 3.520, $p < 0.001$) shown in Figure 6.
- This observation indicates that participants benefited more from the MR treatment than the Video treatment.

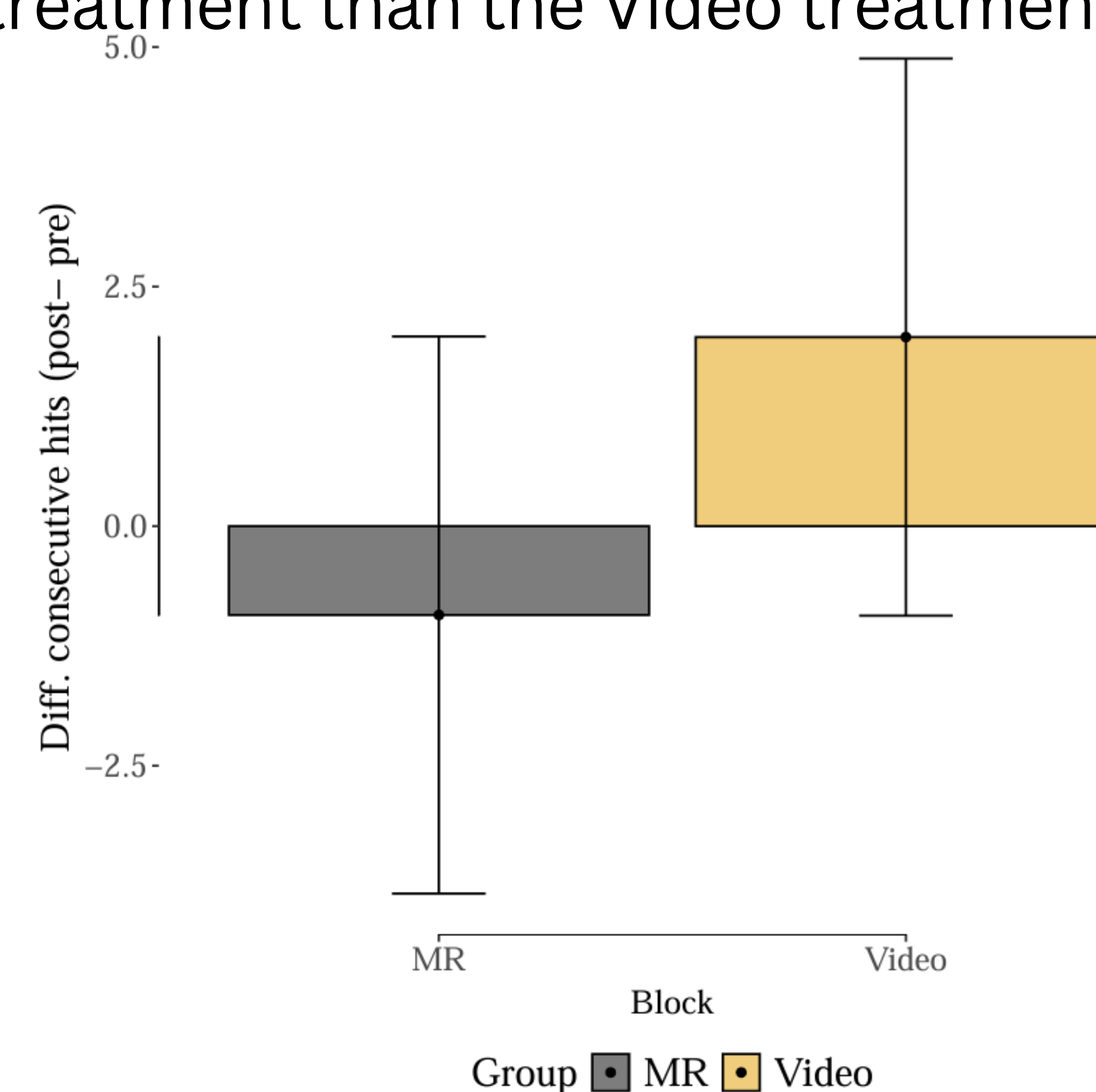


Fig. 5: Metric 1 for MR and Video Groups

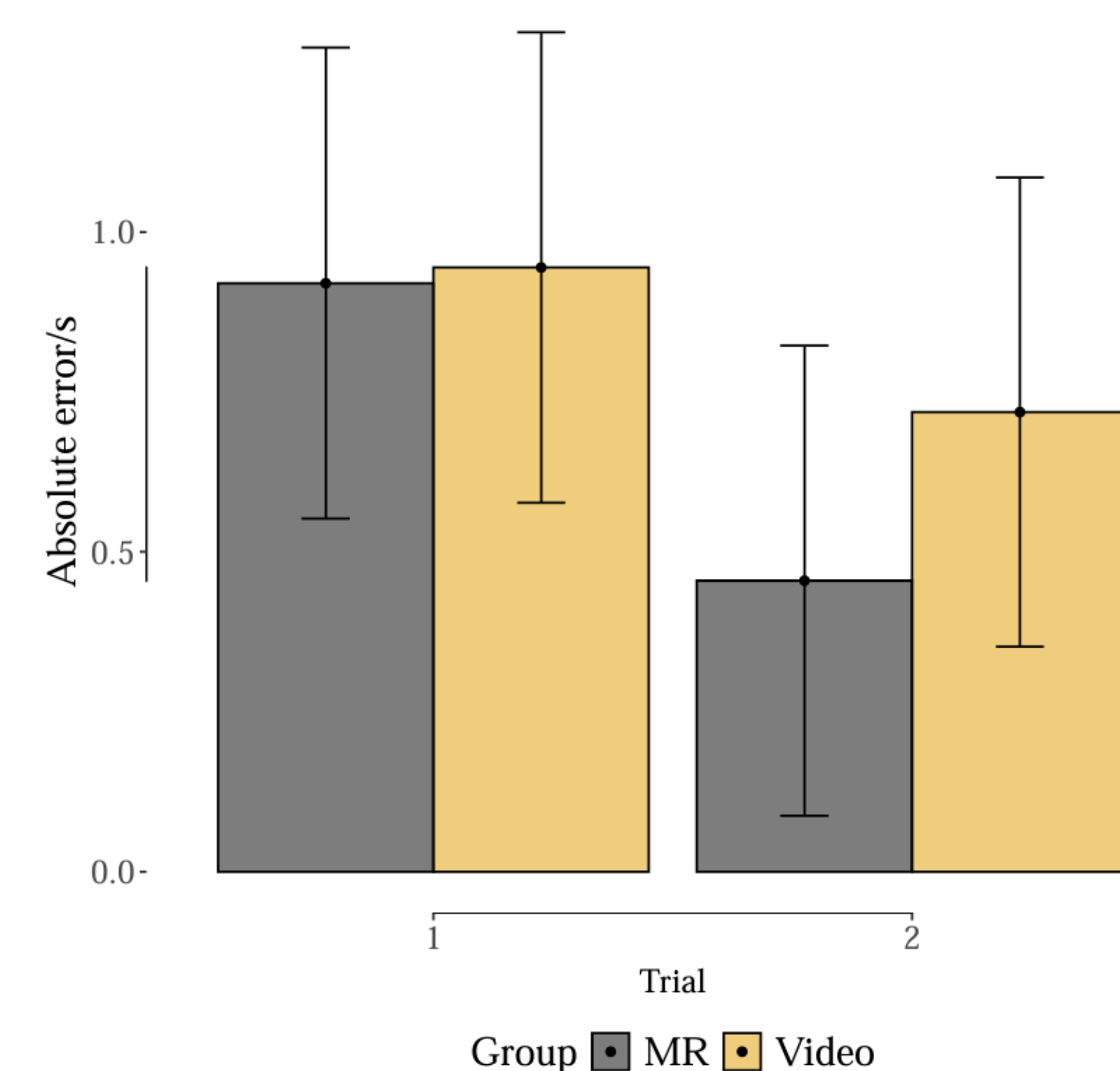


Fig. 6: Effect on Metric 2 of Trial and Group



full paper