The future of motor skill training using interactive and immersive virtual reality

Sunbin Song, PhD

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Future of sport, training & rehabilitation

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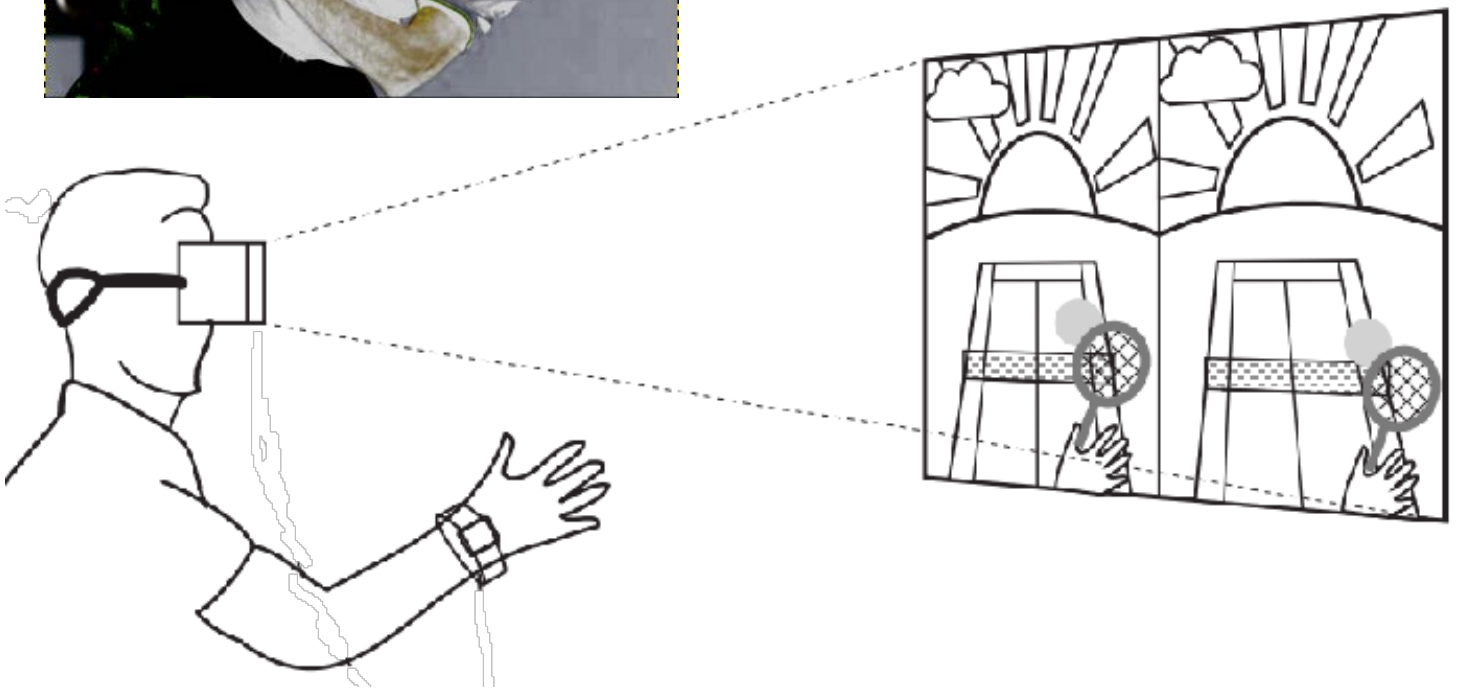


Immersive VR makes this future feasible

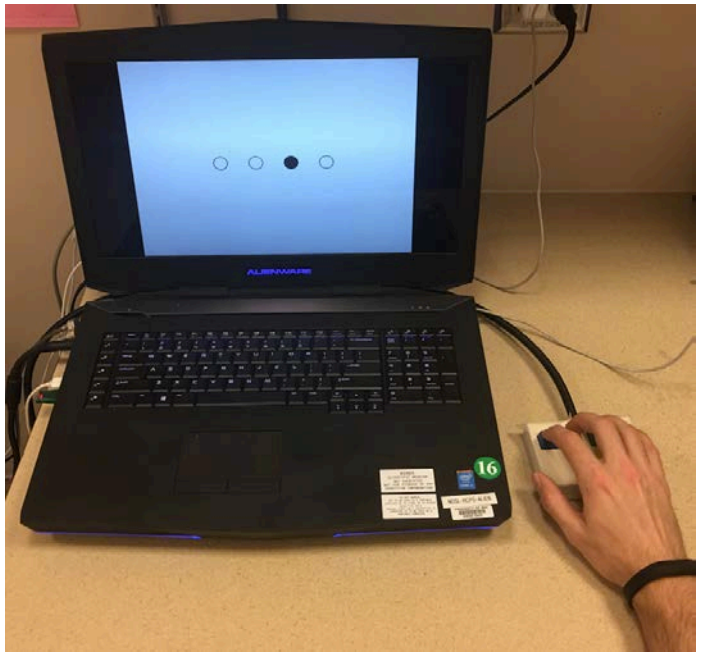
- A real-life task of daily living may be mimicked by interactive, immersive VR.
  - “Non-immersive VR” (not really VR) such as Nintendo Wii or Kinect based games as an add-on therapy have failed multi-center clinical trials to improve patient outcomes. Game learning may not generalize to real-life activities. (Saposnik et al., Lancet 2016)

- Immersive VR is cheap, getting cheaper, and can be home-based.
  - Most CAVE systems, devices and robots are expensive and not easily home-based.

How do we currently study motor learning?

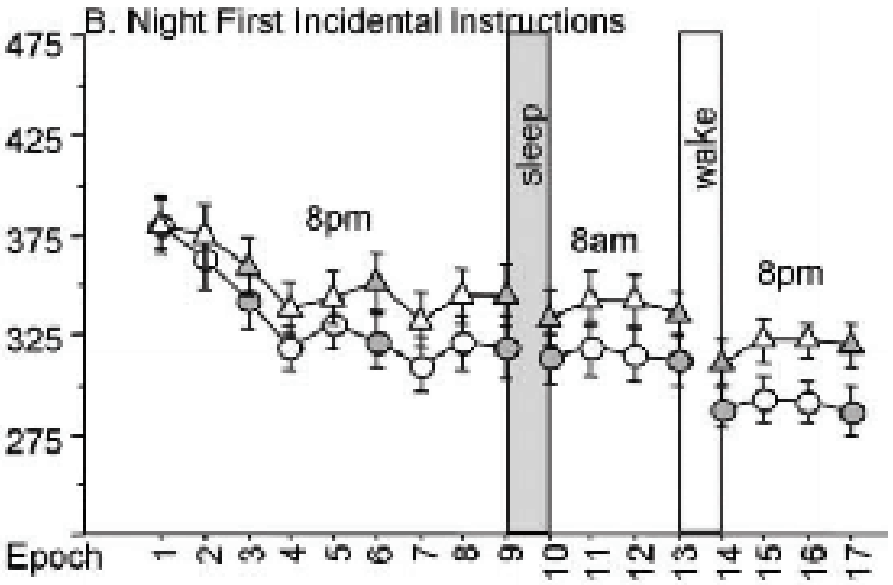
Motor sequences - Serial Response Time Tasks

Song et al., Nature Comm 2014

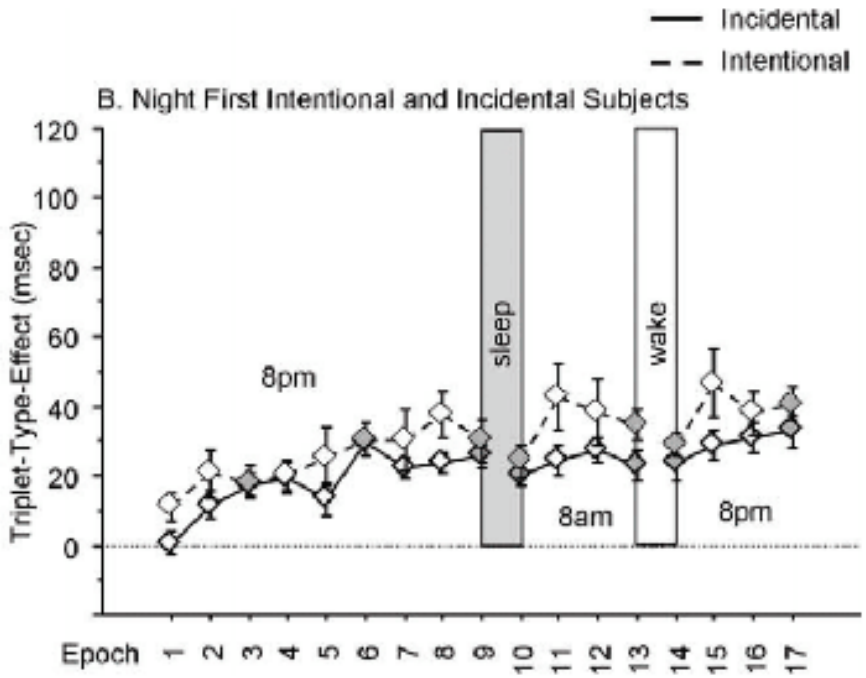


Why do we care about the old ways?
Behaviorally characterized for >40 years

General response time (RT) decreases

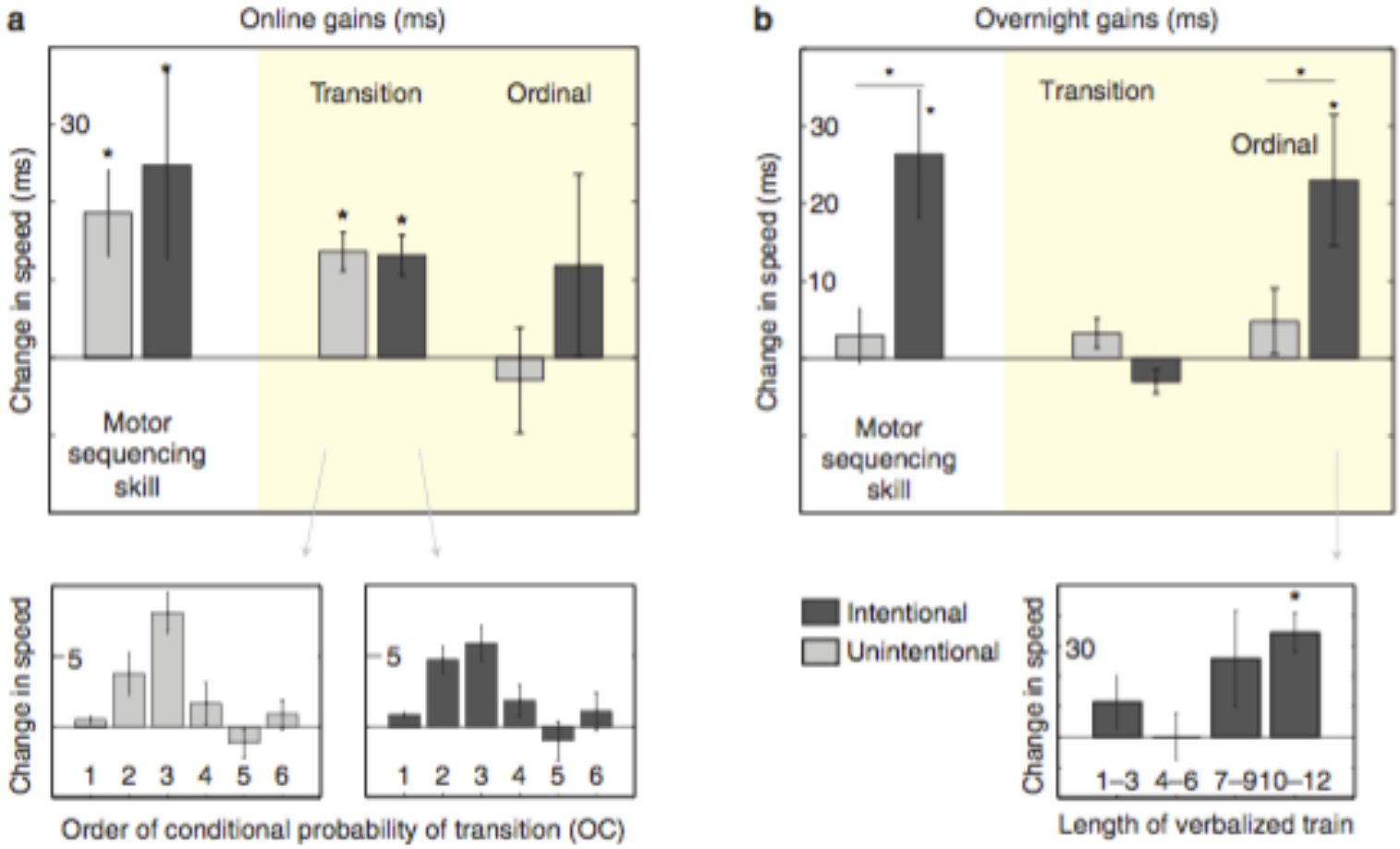


Sequence-specific RT decreases



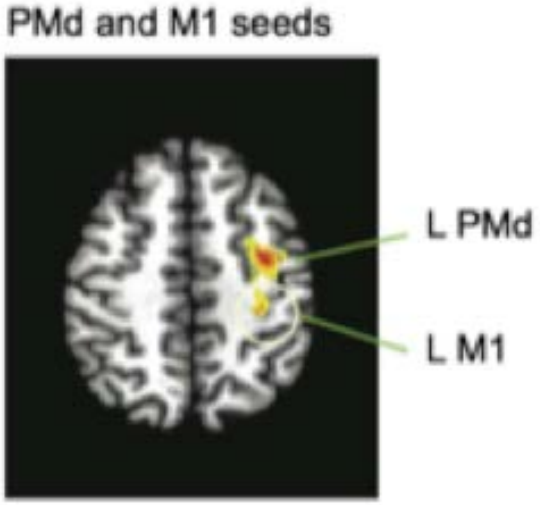
Song, Howard, Howard J Neurosci 2007

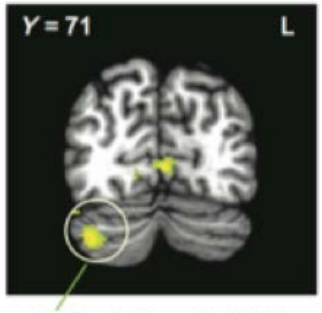
… including characterization of practice-dependent and sleep-consolidation stages and components

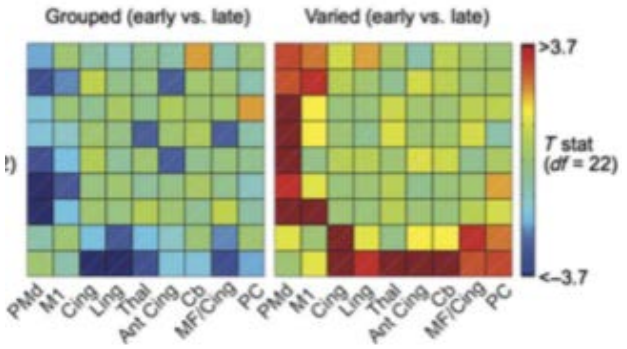


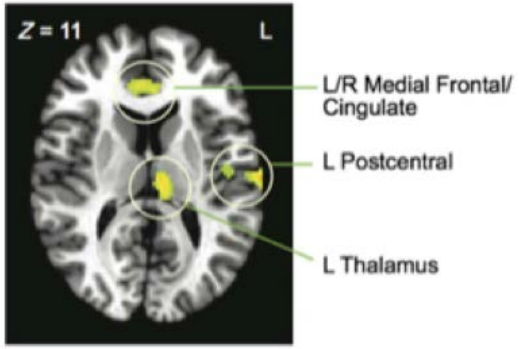
Song et al., Nature Comm 2014

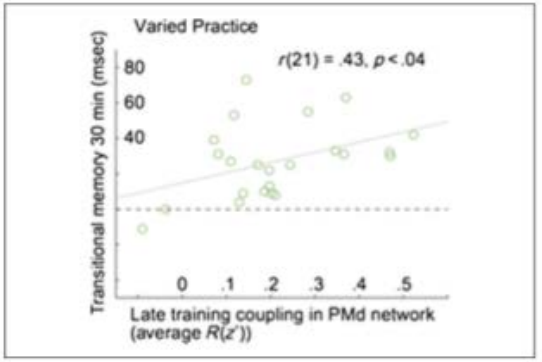
… and neural correlates

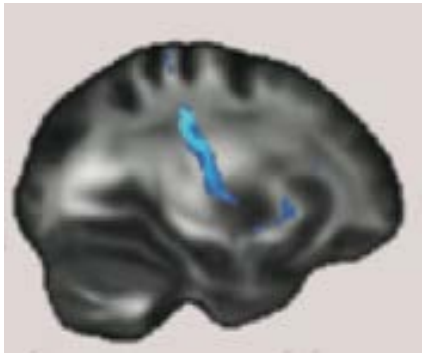






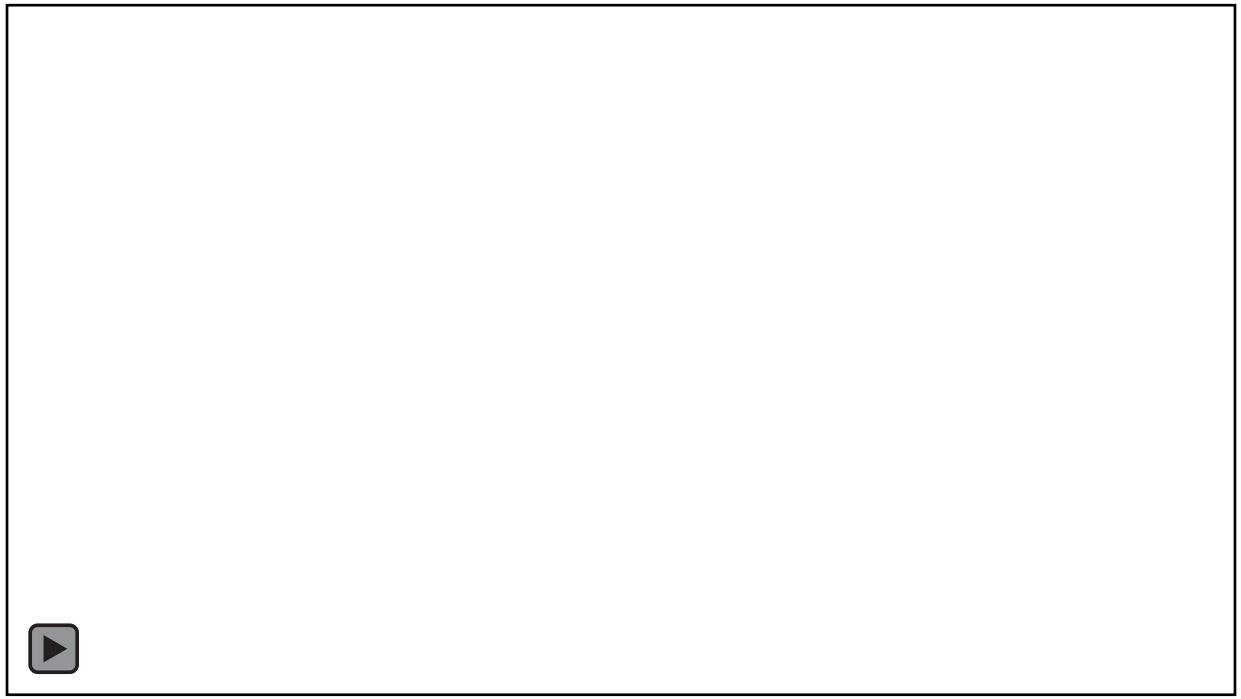




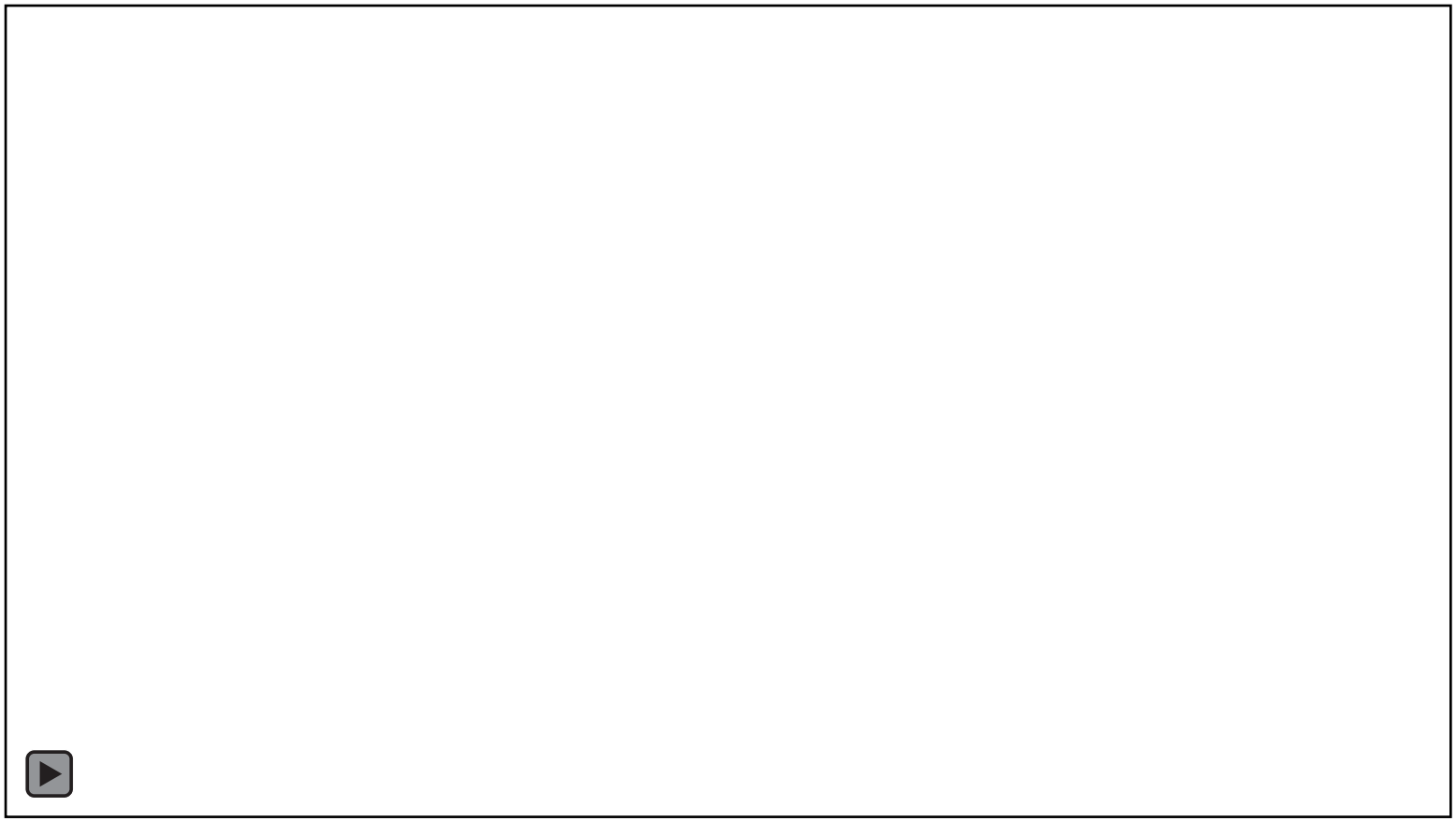


Song et al., JOCN 2015, Song and Cohen Cerebral Cortex 2013

vrSRTT “Ball Sorter” v. 1.0.5 demo



Example output movement trajectory



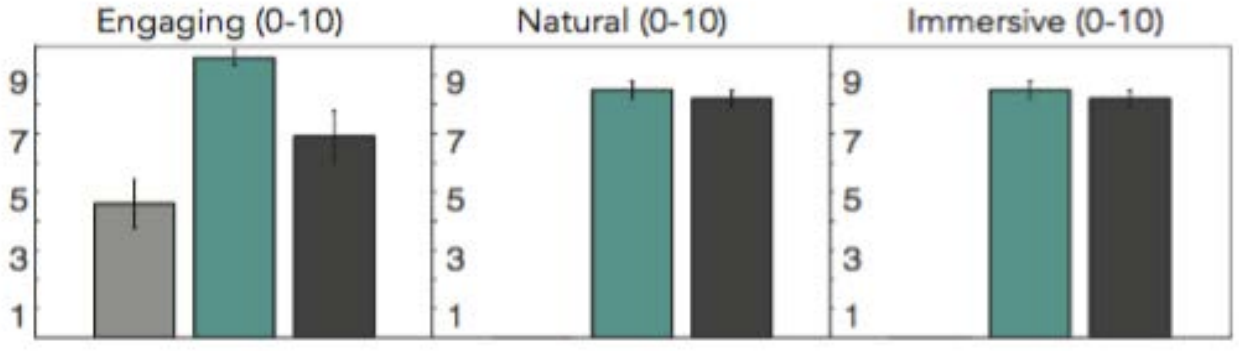
Experiment:
Compare traditional SRTT with vrSRTT ‘Ball Sorter’

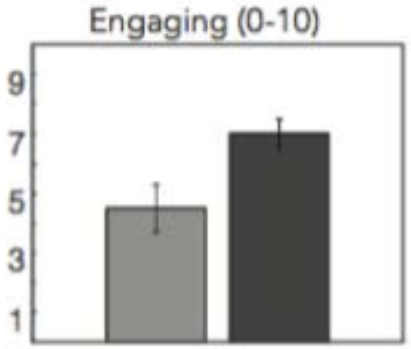
- N = 10, right-handed healthy young v.1.0.0

- N = 7, right-handed healthy young v.1.1.0

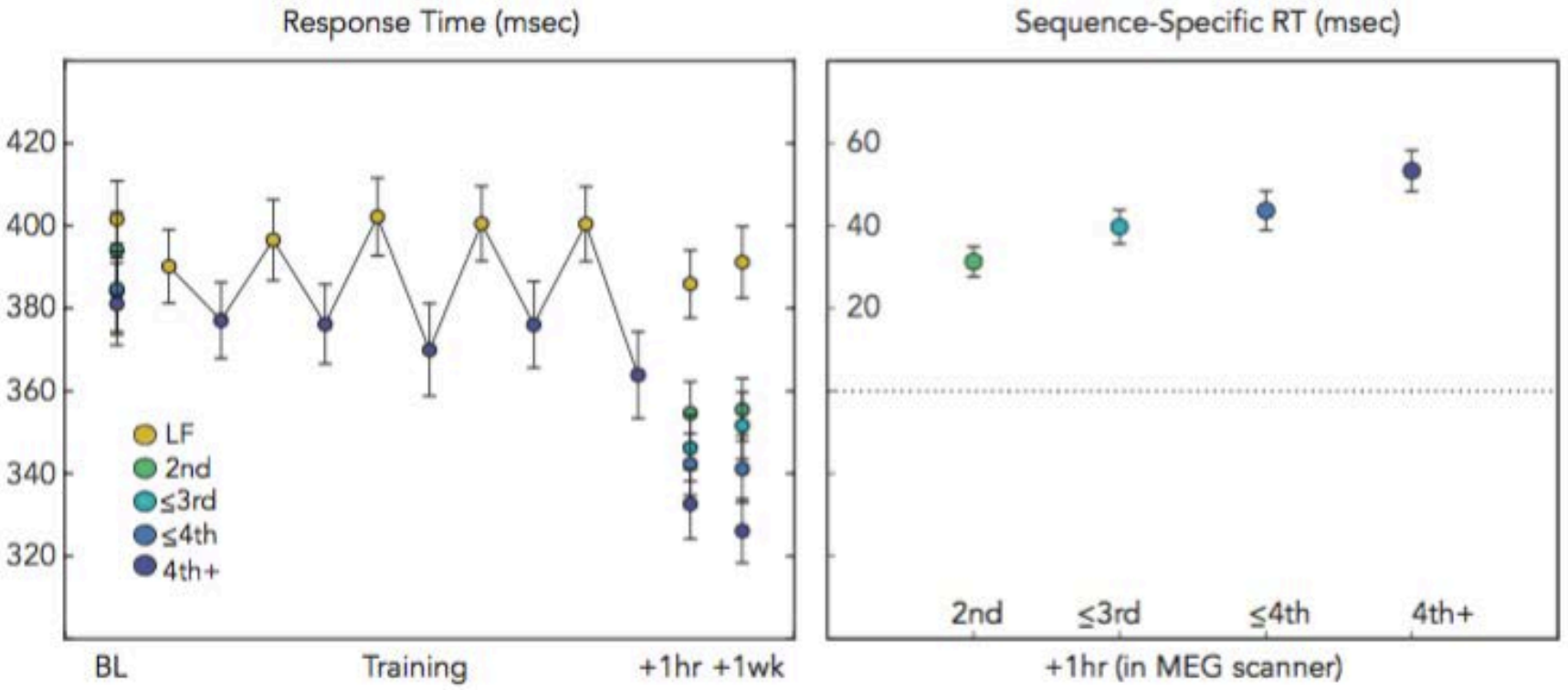
Traditional SRTT
vrSRTT ‘Ballsorter’

VR Funhouse
‘Whack a Mole’

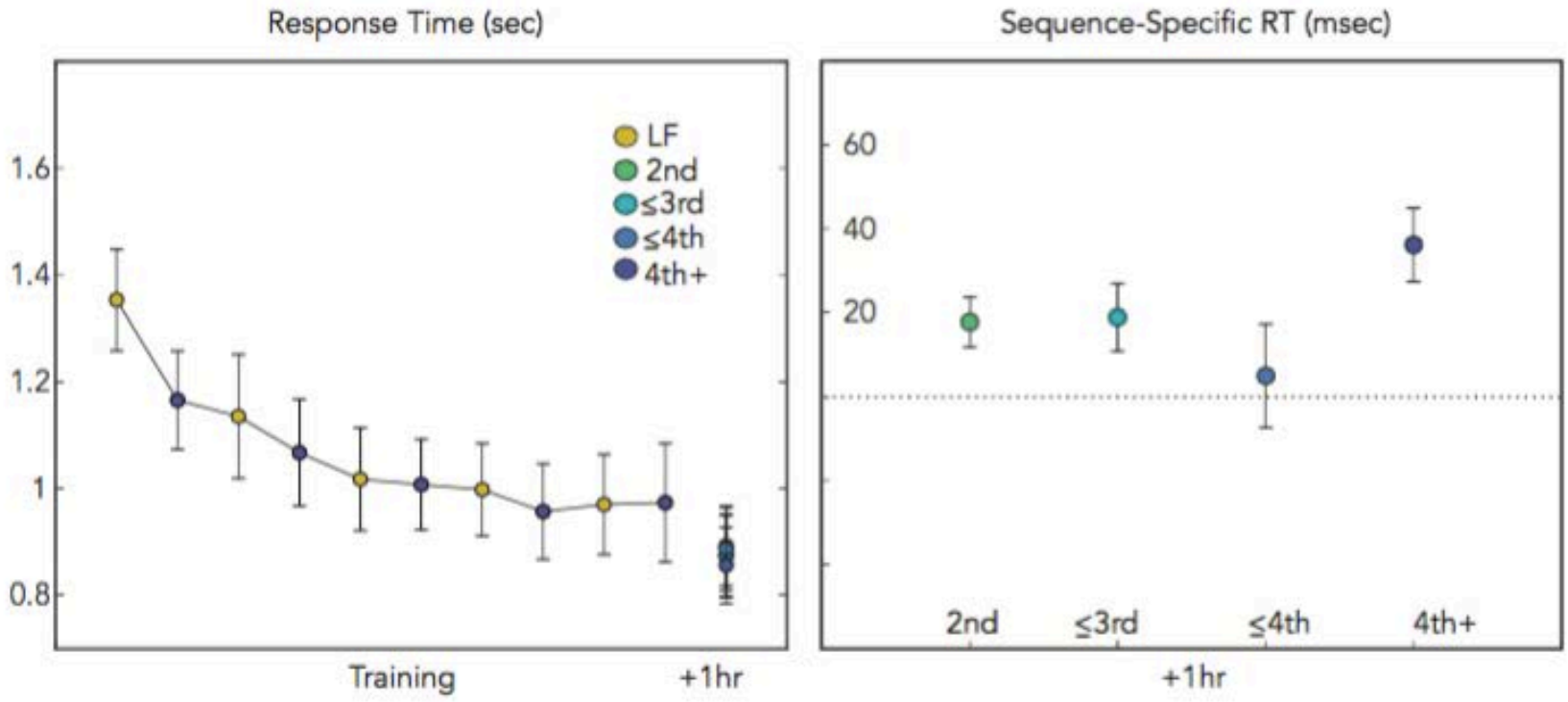




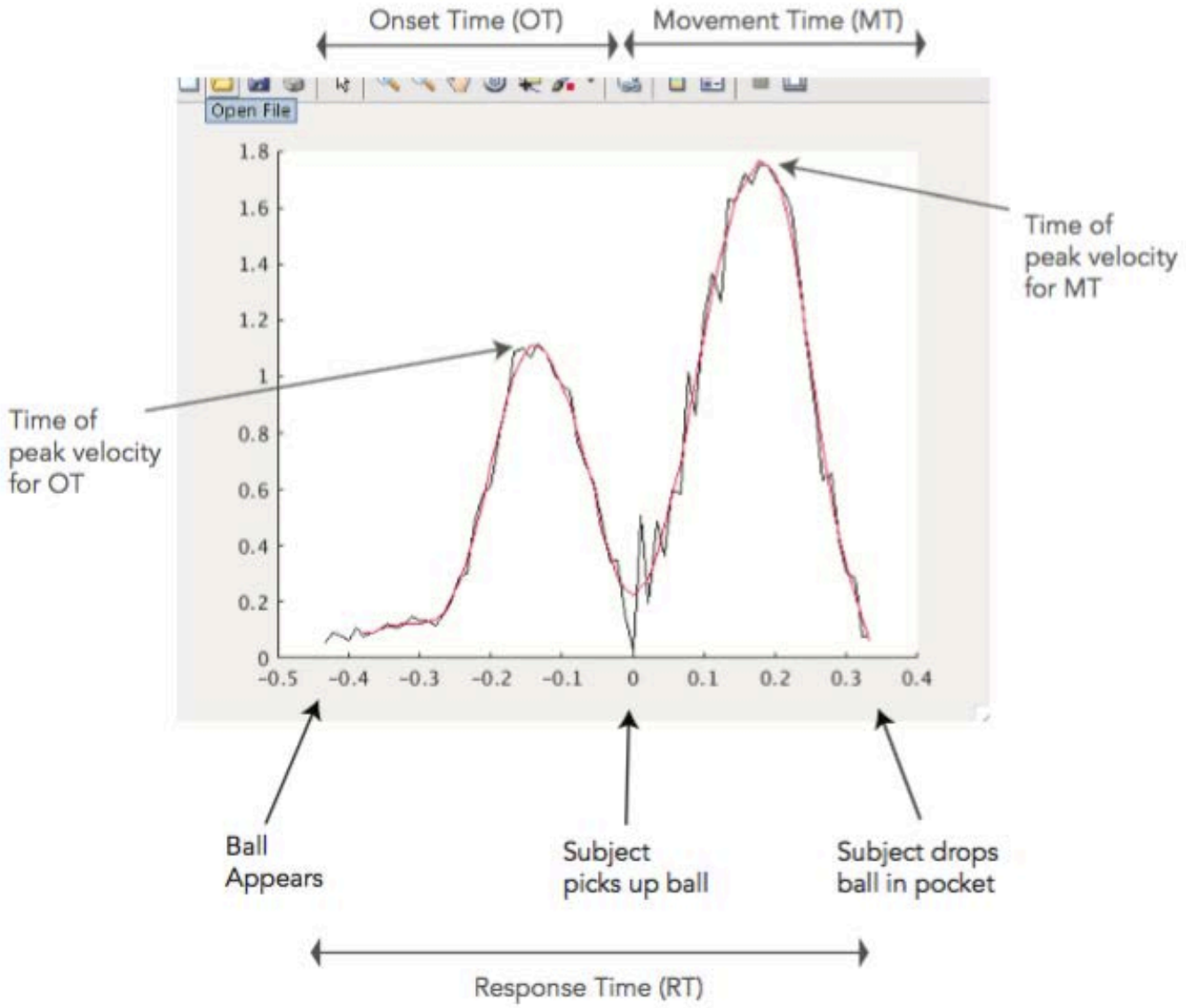
Traditional SRTT results



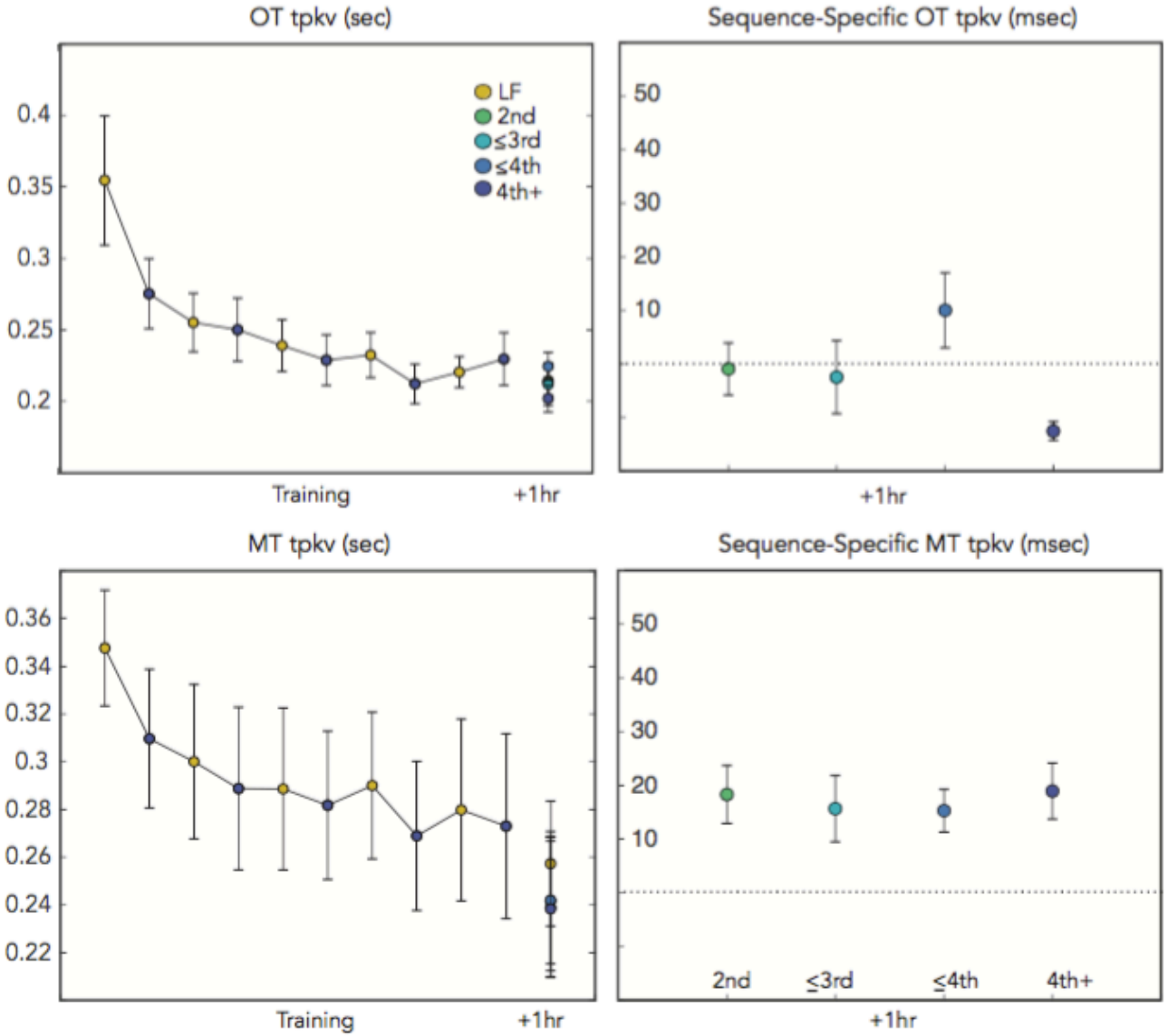
vrSRTT Ball Sorter v. 1.1.0



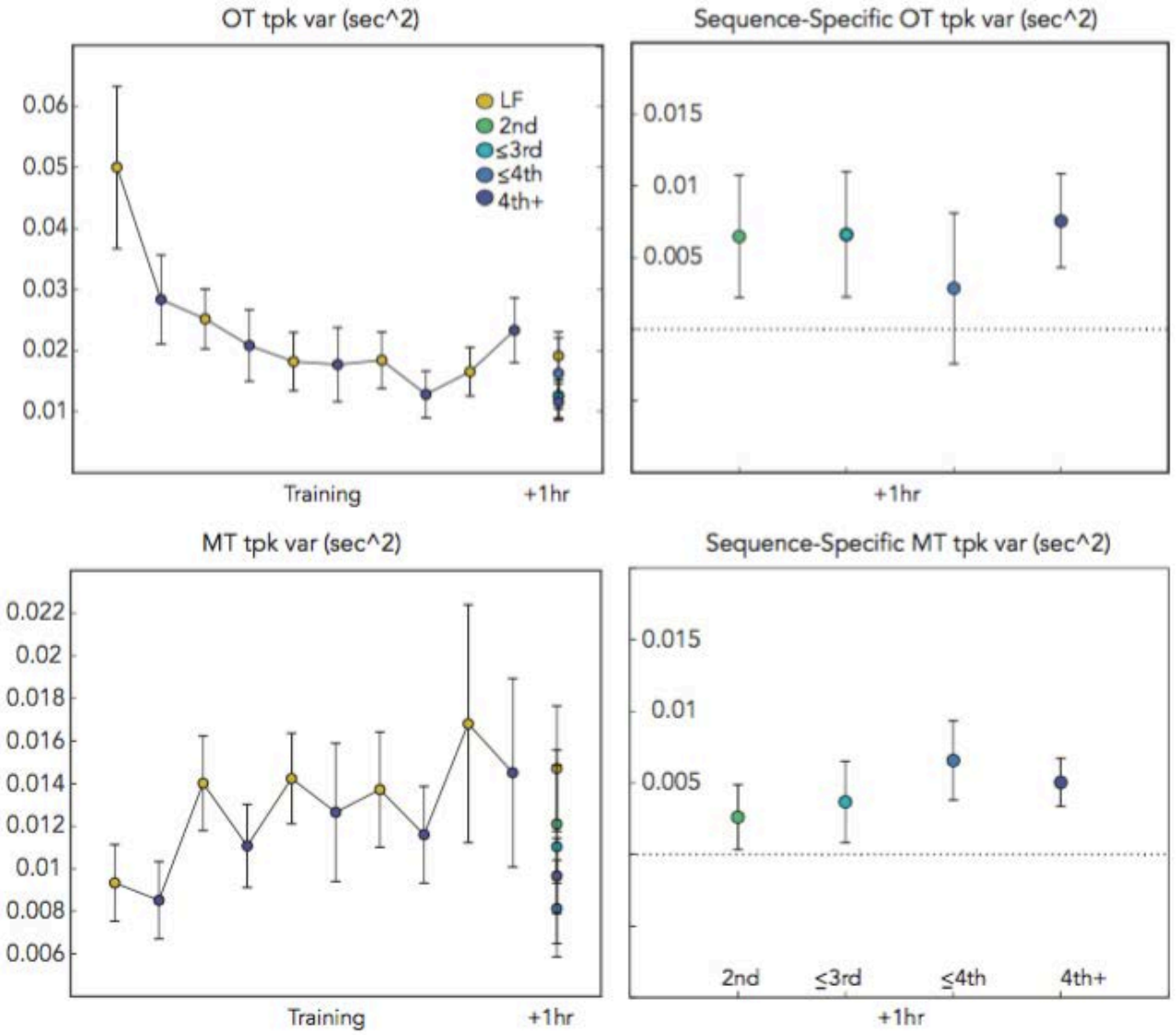
Velocity Profile of a Sorted Ball



vrSRTT Ball Sorter v. 1.1.0



vrSRTT Ball Sorter v. 1.1.0



Preliminary Conclusions

- Rapid versioning may allow us to isolate variables important for learning.
- Subjects learning a task involving virtual objects show evidence of learning in the same measures described in reaching tasks with real-life objects (faster RTs, shifts in time to peak velocity in MT and OT)
- Subjects can learn movement to movement transitions based on manipulation of virtual objects as seen by faster time to peak velocity in MT. Decreased variability in time to peak velocity for OT and MT
- 3D trajectory information useful for gaining insight into subtle aspects of sequential learning

Future directions

- Finish testing vrSRTT ‘Ballsorter’ v.1.1.0, integrate into analyses head movement data, head direction data, and hand rotation (pitch roll yaw) data.
- Integrate glove-based hand tracking and eye tracking.
- vrSRTT ‘tennis’ version – track stimuli in a continuous pattern
- MRI-compatible version of vrSRTT tasks (Neural correlates, Diagnostics)

Acknowledgements

John Ostuni & Virtual and Augmented Interest Group (VARIG)

Leonardo Claudino

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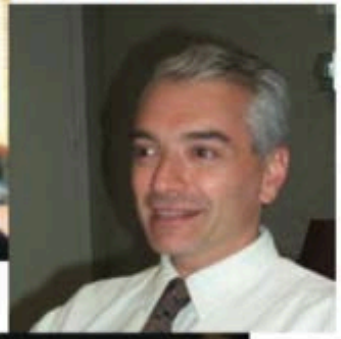
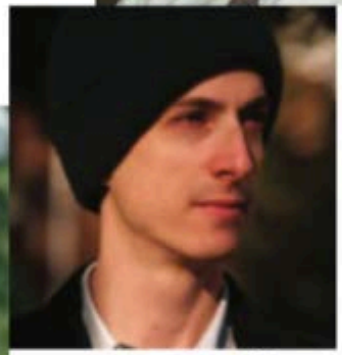
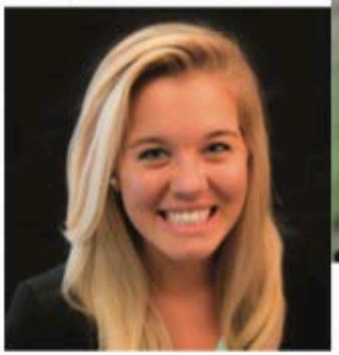




Brian Wolff

Mica Baldivieso

Mary Katie Vollmer



Human Cortical Physiology Section (HCPS)