Through the Child’s Looking Glass:
A comparison of children and adult perception and action in virtual environments

Sarah Creem-Regehr
University of Utah
Vanderbilt University and University of Utah
Virtual Reality as Opportunity and Challenge

• Immersive virtual environments (VEs) balance experimental control with ecological validity

• Utility of VE for research and applications increases as users perceive and act as in the real world = perceptual fidelity
What do we know about perceptual fidelity?

• Distance and size perception
  • Virtual spaces appear smaller than matched real spaces

What do we know about perceptual fidelity?

- Distance and size perception
  - Virtual spaces appear smaller than matched real spaces
  - Improvement with new commodity-level HMDs

What do we know about perceptual fidelity?

• Distance and size perception
  • Virtual spaces appear smaller than matched real spaces
  • Improvement with new commodity-level HMDs

• Perceptual-motor calibration
  • Adaptation effects occur in VE and transfer to real world
What do we know about perceptual fidelity?

• Distance and size perception
  • Virtual spaces appear smaller than matched real spaces
  • Improvement with new commodity-level HMDs

• Perceptual-motor calibration
  • Adaptation effects occur in VE and transfer to real world

• Affordances
  • Perceived capabilities in VE often match real world
  • Avatar bodies influence judgments
Why Study Children in Virtual Reality?

• Children are avid adopters of technology
  • But very little known about effects in immersive VEs because of previous HMD limitations

• VEs provide a natural tool to facilitate spatial thinking

• Foundation of perception and action is needed first
  • Rapid changes in children: both in bodies and cognition!
Two Perception and Action Questions

• Are actions calibrated similarly in VEs across young and older children?

• How do children perceive affordances for crossing gaps in VEs?
Calibration of Locomotion

• Consistent relation between biomechanical information for walking and visual flow
• Recalibration in real world shown by decoupling this information
  • This is hard without VEs!

Rieser, Pick, Ashmead & Garing (1995) JEPHPP
Blind walking to targets

- Pre and post-test, walk to target with eyes closed
Recalibration of Locomotion

• Visual flow slower than walking
  • Overshoot of targets in post-test

• Visual flow faster than walking
  • Undershoot of targets in post-test

• Spatial updating of self-position as function of learned perceptual-motor pairing

Rieser, Pick, Ashmead & Garing (1995) JEPHPP
Locomotion Recalibration with VE

- Manipulate with Treadmill VE
  - Pre/post walking in real world
  - Adaptation on “Treadport”

Mohler, Thompson, Creem-Regehr, Willemsen, Pick and Rieser (2007). ACM TAP
Locomotion Recalibration with VE

Mohler, Thompson, Creem-Regehr, Willemsen, Pick and Rieser (2007). ACM TAP
Locomotion Recalibration with HMD VE

Modify System for Children and New HMDs

- Desire for engaging “game” fit into smaller tracked space
  - HTC Vive
  - 4 x 4 m space
  - Walk between 4 waypoints
  - 5 minutes

Locomotion Recalibration System
Locomotion Recalibration Experiment

• 45 Participants
  • 21 children (ages 8-12)
  • 24 teens (ages 15-18)

• Visual speed varied between-subjects
  • Visually faster
    • 10 children, 10 teens
  • Visually slower
    • 11 children, 14 teens

• Pre and post-test blind walking in real world within-subjects
  • 2, 4, 6 m (x 3, 9 trials total in each session)
Recalibration but no difference with age

Overshoot, Visually Slower

Undershoot, Visually Faster
Recalibration stronger for first post-trial only

Overshoot, Visually Slower

Undershoot, Visually Faster
Locomotion Recalibration Conclusions

• Children and Teens recalibrate locomotion in VEs!

• Commodity-level recalibration paradigms are viable
  • Effects are comparable to those seen in high-end solutions
Two Perception and Action Questions

• Are actions calibrated similarly in VEs across young and older children?

• How do children perceive affordances for crossing gaps in VEs?
Perceived Affordances

• Action possibilities in an environment, which are directly related to an observer’s capabilities (Gibson, 1979)
Perceived Affordances in VEs

Lin, Rieser, & Bodenheimer (2013). *Symposium on Applied Perception*

Jun, Stefanucci, Creem-Regehr, Geuss, & Thompson (2015). *ACM Transactions on Applied Perception*
Perceived Affordances in Children

• Will children show similar effects given rapidly changing bodies?
• In virtual worlds, most studied in a dynamic risky context such as crossing a street on a bicycle
  • 10-12 yr olds different than adults, less accurate timing and riskier decisions

Grechkin, Chihak, Cremer, Kearney & Plumert (2012) JEPHPP
Gap-stepping Estimates in VE

- Accurate scaling to actual step?
- Influence of standing on ground vs. at 15m height
- Differences due to risk perception, body-scaling, or perception?
Mind the Gap: Experiment

• 12 middle-childhood (mean 10 yrs)
• 13 adolescents (mean 15 yrs)
• 12 college students (mean 22 yrs)

• HTC Vive
• Platform on ground or 15 m height
• 10 gap widths x 2, random
  • Yes or no response, can you step over this gap? (no running, jumping)
• Fear and Falling questions at ground and height (0 – 100)
Crossover point and Ratios

- **Ratio** = Cross-over Point
  Actual Ability to Step

- Actual ability measured by asking participants to step across gaps in the real world after the experimental trials
Gap-crossing Results

Children underestimated stepping ability more than teens and adults

All ages underestimated stepping ability at 15m compared to on the ground
Difference in Children: Open questions

• Different decision criterion?

• Different ability to scale to actual step?

• Different perception of gap size?
Conclusions and Future Work

• We established feasibility of use of perception-action paradigms in new HMDs with children

• Potential to address both theoretical questions and applications

• Ongoing research in avatar body size effects and recalibration
Acknowledgments

Amy Needham  John Franchak

Richard Paris  Noorin Asjad  Joe Huang  Michael Butler  Gordon Cooper  Banning Day