Locomotive and Prism Recalibration of Children and Teens in Immersive Virtual Environments

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Motivation

Little is known about how physical and cognitive development affect perception and action in immersive virtual environments (IVEs), especially in regard to preteen (children aged 8-12 years) and teenage (children aged 15-18 years) youth. Differences in perception may have dire implications for the design of virtual reality (VR) applications.

In the current study, we assess how kids and teenagers respond to mismatches between their motor behavior and visual information presented by an IVE. We use modifications of two canonical recalibration studies to glean insight into calibrations across two functionally distinct systems of movement in a commodity level VR system.

Experiment 1 analyzed forward walking recalibration after exposure to an IVE with either increased or decreased visual flow. Visual flow during normal bipedal locomotion was manipulated to be either twice or half as fast as the participant's physical gait. Subjects were expected to underestimate distances after exposure to faster visual flow, and they were expected to overestimate distances after exposure to slower visual flow, assuming that children respond in the same manner as adults [1].

- 45 Participants
- Between-subject experimental conditions
    - 10 kids , 10 teens in fast condition
    - 11 kids, 14 teens in slow condition
- 5 minute exposure duration to induce recalibration
- Evaluated via blind walking task pre and post VR exposure to obtain distance estimations
    - 2m, 4m, and 6m target distances

Figure 1: A 10-year-old participant navigates the Hogwarts themed walking recalibration environment

Experiment 2 leveraged a prism throwing adaptation paradigm to test the effect of recalibration on throwing movement. The prism distortion was induced by rotating the visual field laterally around their vertical axis by 17 degrees within an HMD [2]. Participants tossed a tracked controller into a floating target, which was placed 2 meters away.

- 25 participants
- Within subjects experimental condition
    - 11 kids , 14 teens
- 3 test phases (pre-exposure, prism-exposure, post-exposure) in which prism distortion was only induced during the prism-exposure phase
- Evaluated by lateral displacement from target
    - 12 tosses to target per phase

Figure 2: A 10-year-old participant tosses the controller into the target space in the prism adaptation environment

Results

In **the first experiment**, our results show no differences across age groups, although subjects generally experienced a post-exposure effect of shortened distance estimation after experiencing visually faster flow and longer distance estimation after experiencing visually slower flow. This recalibration effect is similar to that seen in previous experiments with adults.

In **the second experiment,** subjects generally showed the typical prism adaptation behavior of a throwing after-effect error. However, the error lasted longer for preteens than older children, as can be seen by a difference in error at the 5th toss. This difference suggests that the aftereffect lasts longer for younger children.

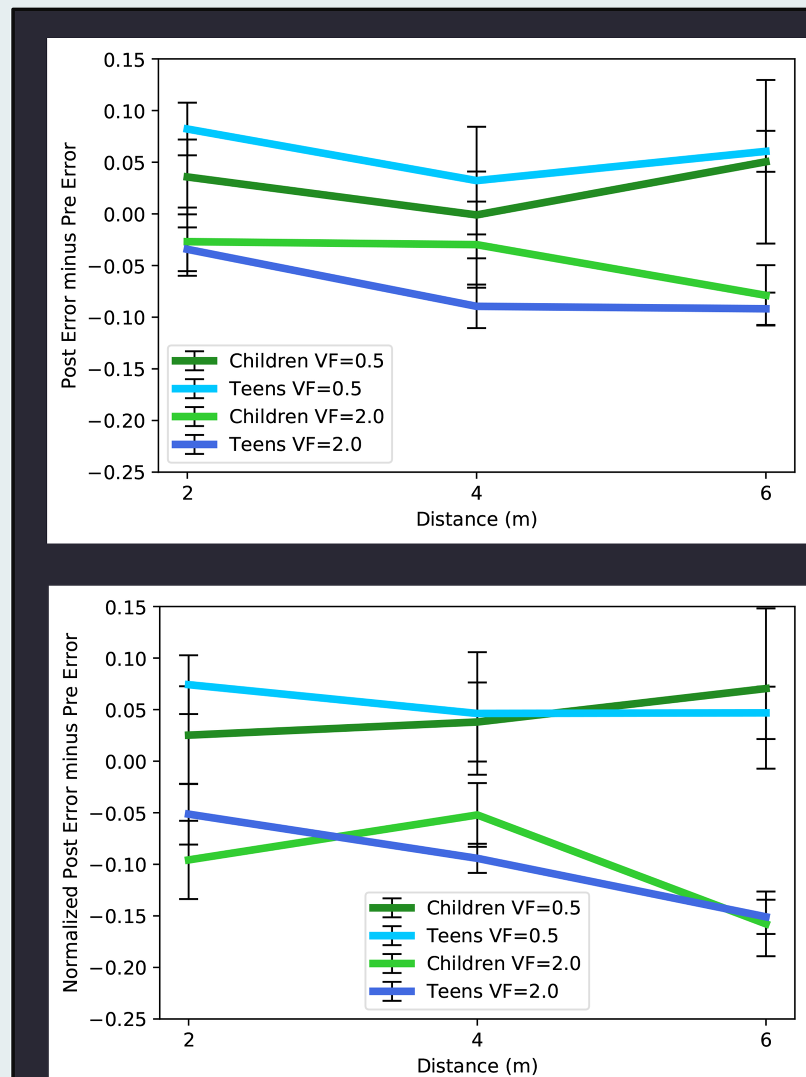

Figure 3: The results of walking recalibration in Experiment 1 expressed as a ratio of distance using the mean of post-exposure trials subtracted from the mean of the pre-exposure trials. Participants are shown to recalibrate in the opposite direction as their visual flow condition

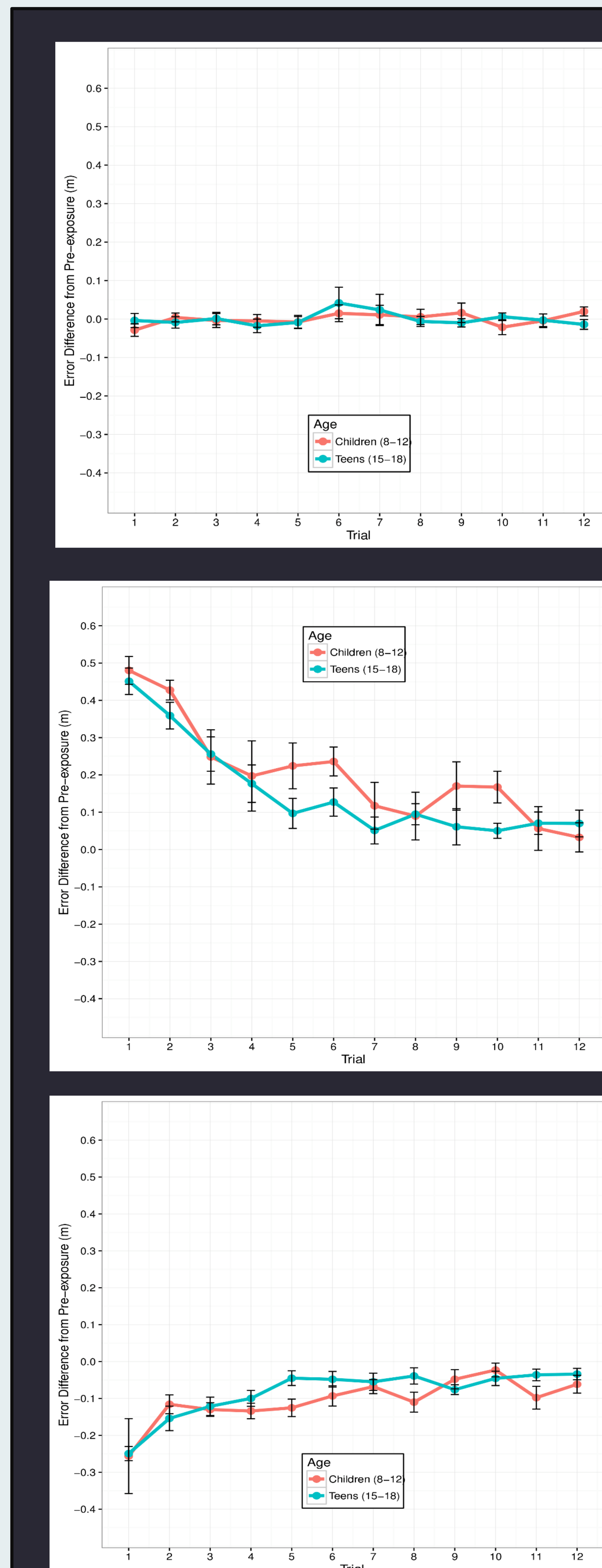

Figure 4: The average signed displacement error of each toss in Experiment 2. The pre-exposure, prism-exposure, and post-exposure test phases are shown to express recalibration effects.

Conclusions

Our study presents an excellent starting point for understanding the inner workings that affect children's perception in IVEs. While we observed no age differences in the effect of walking recalibration, younger subjects expressed a slower throwing recalibration effect in the prism adaptation experiment. In addition, we were able to successfully implement classic recalibration experiments using commodity level solutions.

Discussion

Children are avid adopters of technology, and they will undoubtedly be exposed to VR technologies for both learning and entertainment. Our results have implications for the design of virtual reality systems with children as a target audience. By using recalibration studies, we can evaluate how children respond to visual perturbations that are unique to VR. However, we must investigate further to uncover the full consequences of children's cognitive development on their experience in immersive media.

References

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