GOALI: A Hybrid Method to Support Natural Interaction of Parts in a Virtual Environment

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Introduction

This research compared virtual bimanual haptic training versus traditional physical training and the effectiveness for learning transfer for a puzzle assembly. In a between-groups design, participants were assigned to either the virtual or physical training and trained by assembling the puzzle as many times as possible for twenty minutes. After training, participants were tested using the physical puzzle and were retested again after two weeks. Spatial ability as measured using a mental rotation test, was shown to correlate with the number of assemblies participants were able to complete in the training. The results of the intital test revealed that participants trained with the physical puzzle pieces significantly outperformed participants trained with the virtual puzzle pieces; however, when tested after two weeks, participants trained with the virtual puzzle pieces demonstrated improved performance, while preformance decreased for those trained with the physical training. This leads us to conclude that learning retention is better with virtual training.

Research Objective

Our research objective was to compare learning transfer between virtual and traditional training with physical parts.

Training Environment

The physical training environment consisted of a desktop and brightly colored blocks. The virtual training environment was also a desktop system with a 5DT position-tracked glove (no haptics), a Phantom Omni haptic device, head-tracked active stereo glasses and a stereo display. Virtual blocks were also brighly colored. Participants were given written instructions which used color as an identifying feature.

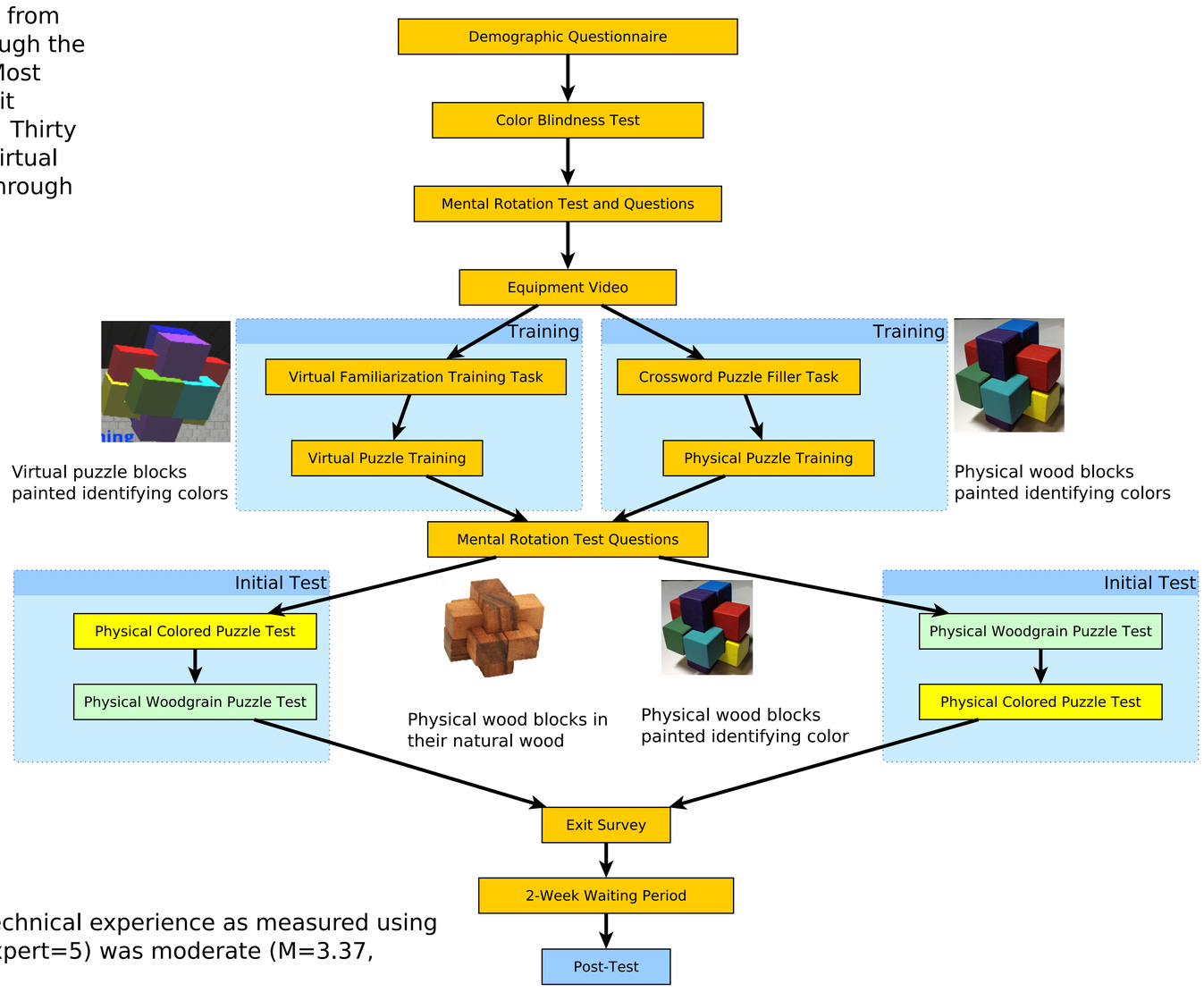
Figure 1: Physical Training

Figure 2: Virtual Training

Methodology

Sixty-three student participants from Iowa State University went through the study (Female: 22, Male: 41). Most participants received class credit compensation for participation. Thirty participants went through the virtual training and thirty-three went through the physical training.

Research Design



Results

Participants' self-reported technical experience as measured using a Likert scale (low=1 and expert=5) was moderate (M=3.37, SD=0.606).

The self-reported rating of training helpfulness using a Likert scale (not helpful=1 and very helpful=5) was high for both the physically trained (M=3.75, SD=1.07) and the virtually trained (M=4.03, SD=0.92).

While physical training significantly outperformed virtual training for the initial test, there were no significant differences in the post test. However, physically trained participants performed worse in the post test while the virtually trained participants performed better (Fig. 3).

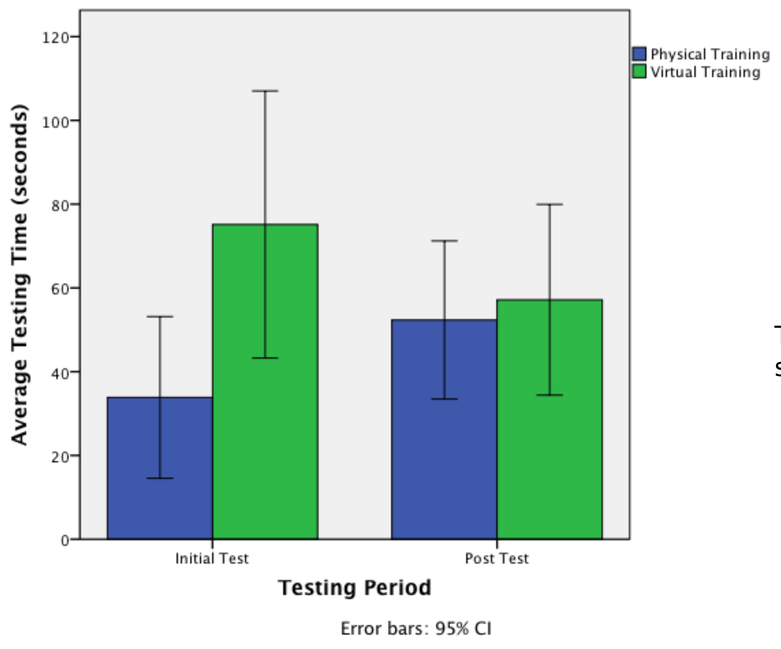


Figure 3: Average testing time performance for initial test and post test

Participants overall had high completion rates across training conditions (Table 1).

	Fastest	Slowest	Average	Completion rate
Initial test				
Virtual trained	14.86	595	75.13	70%
Physically trained	10.4	600	33.85	94%
Post test				
Virtually trained	13.93	290.4	57.16	53%
Physically trained	10.66	295.5	52.34	85%

Table 1: Performance Results (seconds)

There was no significant difference in performance when participants tested with colored puzzle pieces or wood puzzle pieces, even though they all trained with colored puzzle pieces (Fig. 4)

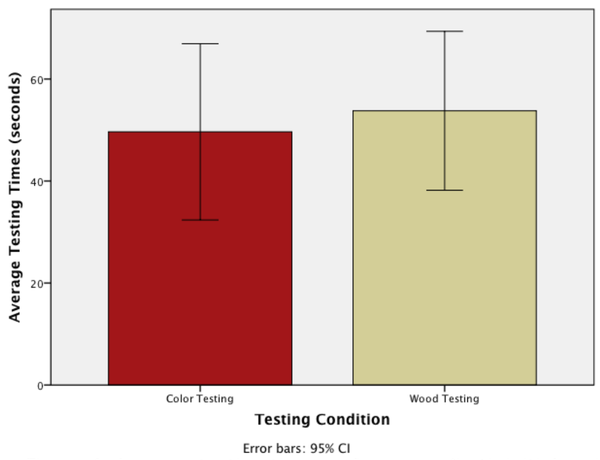


Figure 4: Average testing time performance (both initial and post test) for colored blocks and wood blocks

There was significant positive correlation between the mental rotation task score and the number of assembled puzzles completed in training (Fig. 5).

Figure 5: Mental rotation test score relationships to number of pieces assembled in training

Conclusion

While the virtual training was not able to outperform the physical training, learning retention for those who were virtually trained is encouraging. Given the significant correlation between spatial ability and number of assembled puzzles, expert users may be better able to take advantage of the available technology in order to learn the assembly. Future research will explore how participants with high technical expertise and high spatial abilities perform using virtual training techniques.