Learning and Human Computer Interactions: Does Wii Bowling Transfer To Real Bowling?

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ABSTRACT
The Wii video game console has many games that include physical movements related to the actual activity being simulated. What this paper proposes to do is measure in controlled experiments the transfer of experience from simulated bowling to actual bowling on a real lane. Certainly simulation has been used by many organizations, for example flight simulators in the military, to lower total training costs. And clearly some experience is transferable, but how much? This is an experiment to quantify experience gain in a simulation environment as applied later to an actual task. Analysis will include a characterization of the simulation tool from the perspective of the Information Technology discipline of Human Computer Interaction.

Categories and Subject Descriptors
H.5 [**Information Interfaces and Presentation**]; H.5.1 [**Multimedia Information Systems**]; artificial, augmented, and virtual realities; H5.2 [**User Interfaces**].

General Terms
Measurement, Performance, Human Factors

Keywords
Presence, Bowling, Wii, Gaming Console

1. INTRODUCTION
Video game studies have found a general link between several skills, such as multitasking performance [8] and hand eye coordination [6]. These studies have been described as providing evidence that video games help solve laparoscopic tasks. Laparoscopic tasks can be translated as hand eye coordination. One highly regarded study indicates that surgeons who spend a great deal of time playing video games will make about one third fewer mistakes [7].

The Wii[1] console is one of the current generations of computer gaming consoles that seek to give a more immersive user experience than is possible with a typical push button controller. This console has a special controller, called the Wii remote that reacts to player's motions. The Wii can translate velocity and motion in three dimensions. Nintendo bundles the Wii console with Wii sports, a game consisting of multiple real life sports. These sports are tennis, bowling, baseball, golf, and boxing. The player is able to simulate the motions of each sport and those motions are translated into the game and are then visible on the playing screen. By doing so they are given feedback in which they can improve their abilities. The feedback is through scoring and practice rather than training [2].

Since the release of the Wii gaming console there have been numerous studies on its effects [1, 5, 10]. One of the Wii sports games that has been evaluated is Wii bowling. Doorfus [1] found that Wii bowling was positively associated with real bowling performance. They used two groups, a Wii bowling group and a real bowling group. Although they found that the Wii bowling group scored higher than a group which received no training in a real bowling test, the Wii group was given 2 games, with coaching, in order to practice while the bowling group was not given any additional practices. This study seeks to expand on this

[1] Wii is a registered trademark of the Nintendo and SONY Corporations.

idea by having bowling novices practice both Wii and regular bowling over four days and compare their results in a real bowling game to a control group which had no practice to help determine if practicing the physical task with a Wii teaches skills transferable to regular bowling.

2. RELATED WORK

Many aspects of human computer interface could be involved in this exploration of the Wii gaming system. Immersing a user into a virtual world is obviously not the goal of Nintendo or other virtual entertainment systems, but does beg the question, how much simulated reality is required to effectually benefit the user?

A brief look at haptic feedback, visual and presence factors are given here. Flight simulators vary in complexity from a PC based system using only simple graphics to full 6 DOF systems with G seats using air pressure to mimic motion [4]. The realism of a Virtual Reality (VR) system or virtual environment, noted as presence [11] may determine how effectively a simulation trains a user to use an actual system. The data in this experiment clearly shows that Wii does not accomplish this for bowling.

For Wii bowling, there is no haptic feedback, the controller does sense the user's arm swing and wrist spin resulting in a virtual ball that may hit the pocket resulting in a strike, spin the ball in to the gutter or anything in between. But the mass of a bowling ball and the resulting inertia felt in swinging this mass is not realized with the Wii controller.

Figure 1. Wii Controller

The size and weight of the Wii handheld console in relation to an actual bowling ball is of interest; in our scenario. The Wii hand grip controller measures 6.25 x 2.1 x 1.5 inches (16 x 5.5 x 4cm) and weighs 6.56 oz (186 gms). Our test subjects used 8, 9 or 10 lbs bowling balls; the largest bowling ball therefore, is 24.39 times heavier than the controller. When swinging the ball to bowl, this factor increases as a quadratic since the moment of inertia $I = mr^2$, where m is the mass and r equals the radius of rotation, in our experiment this is roughly the length of a test subject's arm.

Regarding the visual experience, the field of view (FOV) perceived by a user can be enhanced by motion based interaction. A larger viewing area however does not enhance the "learning, naturalness or intuitiveness" [3] of the experience. In our case, a 70" (178 cm) diagonal television was used with a Wii controller that senses a user's motion translating direction and spin to a graphical image of a bowling ball rolling down the lane. Our users mastered the game interface quickly as shown in their significantly higher scores on day 2 through 4, see figure 3.

Presence is a concatenation of many HCI factors, we've briefly examined haptic feedback and the visual interface in this case, The physical characteristics of the Wii controller don't match the expected proprioception (a sense that the body is moving with the effort required) of a bowling ball. Neither does the visual display, although large, provide a complete immersion into an actual bowling alley, which is also a function of the Wii graphics.

3. EXPERIMENTS

3.1 Participants

Twenty-five undergraduate students from a western university were utilized in this study. Participation was voluntary. Participants were enlisted from a variety of psychology and information technology classes, with the researchers specifically asking for participants with little or no bowling experience. Volunteers who had completed a bowling class or who had competed in a bowling league were not allowed to participate. Demographically, the subjects ranged in age from 18 to 27 with an even distribution of males and females.

3.2 Apparatus

The bowling was performed at the Brigham Young University – Hawaii campus game center bowling alley with automatic scoring. The Nintendo Wii console used was also part of the same game center. As with all bowling centers, participants are required to wear socks with game center provided bowling shoes. Although all participants were clearly instructed both verbally and by email to bring socks, many did not resulting in subjects with no socks being assigned as Wii bowlers. This event was used to randomly assign subjects to either the real bowling or Wii bowling group and explains why the two groups were not evenly divided.

3.3 Procedure

The study was designed to test regular bowling against Wii bowling as well as against a control group that did not participate in the daily practices. On the first day of the experiment, 16 students were divided into 2 groups, with 9 students randomly assigned to regular bowling training and 7 randomly assigned to Wii bowling training. Training consisted of a single full game of bowling per day for 4 days, with an additional day of testing wherein all participants played a regular bowling game. On that day, 9 control participants who had not been part of the experiment up to that time also played.

The selection of training for 4 days was a function of game center and subject availability and matched previous motor skill research conducted by our psychology department.

For each student, their relative experience with bowling was recorded as "Never", "5 or fewer bowling games per year", and

"More than 5 games per year", on average, to ensure that the groups used were, indeed, novices.

4. RESULTS

One subject's data was removed from the study because he consistently scored strikes and spares in almost every frame he played, although he said he had virtually no experience in the game, the success of which he rested on his years as a cricket player. Other subjects did not skew the data and were included.

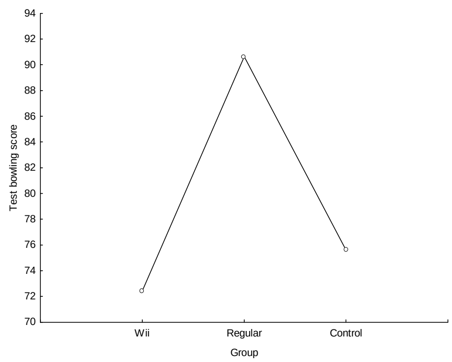

Figure 2. Comparison between regular bowling, Wii bowling and the control groups on their test bowling score.

An analysis of covariance was run between the three bowling groups (Regular, Wii, and Control) with Experience (never, 5 or fewer bowling games per year, and more than 5 games per year, on average) as the covariate to determine the effect of any experience in the participants' past. As Experience was non-significant as a covariate ($p>.90$), a regular one way analysis of variance (ANOVA) was run between the 3 groups. The results were $F(2, 20)=2.50$, $p<.05$, partial $\eta^2=0.20$. As can be seen in Figure 3, on the test day when all subjects played a regular bowling game, those who had practiced daily with regular bowling scored significantly higher than either Wii or the no practice Control Group. Least Squared Difference (LSD) post hoc tests substantiated this interpretation as the Regular Bowling Group differed significantly from the Wii Group ($p<.05$) and the Control Group ($p<.05$, one-tailed).

In addition, a mixed model repeated measures ANOVA was run on the five daily scores of the Regular and Wii Groups, (Figure 3) with the groups serving as the between subjects variable and the daily scores as the dependent. The results were $F(4,52)=8.23$, $p<.001$, partial $\eta^2=0.39$. As can be seen in Figure 3, the Wii Group outperformed the Regular Group in terms of their bowling scores within their own medium, but when tested in regular bowling the Wii Group underperformed the group trained in regular bowling. As expected the Wii bowling scores were significantly ($p<.05$) higher than the Regular bowling on days 2-4, but not on the test day where the cross-over occurred.

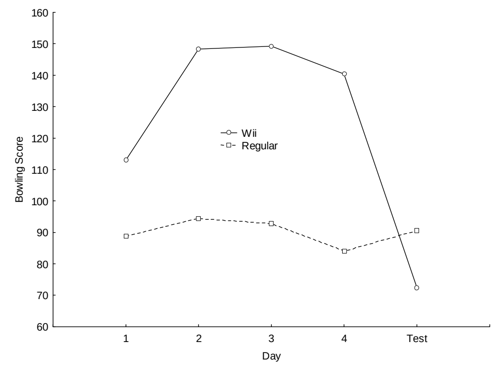

Figure 3. Repeated measure of regular bowling and Wii bowling groups on their bowling scores across the study.

5. DISCUSSION

Our results showed that the regular bowling group scored higher than the Wii bowling group and the control group scored higher than the Wii bowling group (Figure 2). However, we found that the regular bowling group scores were stable across the study. In contrast, the Wii bowling group scored higher after the first game and remained stabilized through game 2 to game 4. We interpreted this to show that the Wii Group adapted to the game, thus raising their scores. However, that the Wii Group scored significantly lower than the Regular Bowling Group on the test day seems to indicate that the skills that make one successful at Wii bowling may not transfer well to regular bowling. For our study, that the Wii Group did not differ from a group that had no practices was particularly troublesome to the hypothesis that the Wii simulation was teaching any transferable skills. As a final point, these statistically significant results and large effect sizes were achieved with a very small n, with the maximum group size of nine. Further studies with more participants are recommended so that the results may become clearer. It would also be interesting to examine the transferability of bowling and other physical skills from tasks performed with Microsoft's new Xbox 360 Natal interface, where posture and hand motions can be tracked in real time and which may lend towards more skill transferability as a result.

This experiment scratches the surface on determining how much reality is required to translate a user's VR experience to an actual task by creating a baseline. Future research should include an isolation of HCI functions to determine the threshold at which a VR experience actually translates to the real world. One example is to increase the weight of the Wii controller up to the weight of an actual bowling ball to determine if and when the tipping point between VR and reality occurs. This might translate to a formula or guide [9] on how "real" VR must be to provide an effective ROI for training systems.

6. ACKNOWLEDGMENTS

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