EFFECTS OF VIDEOGAME EXPERIENCE ON LAPAROSCOPIC SKILL ACQUISITION

Sara L. Waxberg , Steven D. Schwaitzberg [*], Caroline G.L. Cao
Department of Mechanical Engineering, Tufts University
[*] Department of Surgery, Tufts – New England Medical Center

ABSTRACT

The apprenticeship model used to teach surgical residents is no longer adequate, especially in laparoscopic surgery training. The other alternatives available, such as simulators or animal models, can be expensive and difficult to implement. This study was conducted to explore the effect of videogame experience on surgical skill acquisition. We hypothesized that a week of videogame playing would improve performance on a surgical skills trainer and that performance on the videogame would reflect performance on the trainer. Thirty participants were tested in a between-subjects mixed design. Results were inconclusive. However, the use of videogames for training may be justified given the minimal cost. The idea of training surgeons using an inexpensive technology that is familiar, and that is fun and engaging at the same time, has considerable potential for the field of training in surgery.

INTRODUCTION

The traditional method of training in today's teaching hospitals follows the apprenticeship model. The apprenticeship model is now in question because of the recent increase in concern for patient safety and medical error raised by the Institute of Medicine report (Kohn et al., 2000). An unacceptably large number of 44,000 to 98,000 people die a year due to preventable medical error. The need for an alternate method of training residents has become apparent.

Other methods are presently available to hospitals, but are inadequate. For example, physical and virtual reality training simulators can reduce the possibility of causing harm to a patient while learning and allow the surgeons more practice through increased repetition (Seymour et al. 2002). However, simulators are expensive and can involve complex technology. Another alternative is using live animals. One study done by Taylor and Hammond (2004) found that a freshly killed pig could be used effectively to train urological and gastrointestinal procedures. Although, training in vivo can also be expensive and takes the life of an animal.

Recently, attention has been brought to focus on videogames as a possible alternative to simulators. According to Estallo (1994), videogame players have a higher IQ then those within the same demographic group that do not play videogames. Investigators from the University of California found that the use of videogames could be instrumental to acquiring abilities for spatial perception, cognitive development in scientific aspects, development of complex skills, and spatial representation (De Aguilera & Mendiz, 2003). Studies have shown that videogames can transfer spatial abilities to areas such as architecture (Cartwright, 2001) and can develop spatial abilities for 3-D features and simulated real world environments (Ball, 1978). Other investigators have shown that young adults that play videogames develop better hand-eye coordination than those that do not (Green & Bavelier, 2003). In a study done at Beth Israel Medical Center in New York, investigators found that doctors that spend at least three hours a week playing videogames made 37 percent fewer errors and were 27 percent faster in laparoscopic surgery (Conn, 2004).

The current generation of residents has been referred to as the "Nintendo Generation". These surgeons were brought up on videogames and computers and are highly familiar with technology. Therefore, using videogames as a source of training in laparoscopic surgery skills is a reasonable proposal. The use of videogames would be inexpensive as videogames are already present in 30-40% of today's households (Cassell & Jenkins, 2000).

Based on our past experience in studying surgical skills and training simulators, and in consultation with a videogame expert, we selected James Bond 007: Goldeneye as the prototypical videogame for testing our hypothesis. Being a first person shooter game, Goldeneye would allow the transfer of both spatial awareness and hand-eye coordination skills. The game required a translation of thumb movements to aim a gun on the screen, testing hand-eye coordination. It also required the player to navigate the virtual environment in the game, therefore testing spatial awareness. We hypothesized that experience in playing this videogame would transfer to the performance of surgical tasks, as measured in a training simulator.

METHODS

Subjects

10 undergraduate and graduate students (2 males and 8 females) from the Tufts University Medford Campus and 20 medical students (13 males and 7 females) from Tufts University Medical School participated in this study. None had prior experience with laparoscopic surgery. All had minimal videogame experience.

Apparatus

Laparoscopic Simulator. The surgical box trainer was modeled after the Fundamentals of Laparoscopic Surgery (FLS) system consisting of a box frame, laparoscopic tools, two trocars, an opaque plastic cover, an endoscopic camera with a light source, a 13" TV monitor, and four task setups (Fried et al., 1999). The monitor was placed to the right of the participant. The laparoscopic tools and camera were inserted into the box to simulate laparoscopic surgery.

Videogame. The videogame console consisted of a Ninetendo64 system with a standard controller, James Bond 007: Goldeneye game, and TV monitor.

Procedure

Pretest

All participants performed an initial session on the surgical box trainer (pre-test). They watched an introductory video which summarized the basics of laparoscopic surgery, gave an overview of all tasks, as well as in-depth description of the task objectives. Three tasks modeled after the FLS and a fourth spatial awareness task were performed. The tasks were as follows:

1. Peg Transfer: Pegs were acquired from one pegboard using one tool, transferred to the other tool, and then placed on a new pegboard and then repeated in reverse.
2. Cutting Pattern: Endoscopic scissors were used to cut out a prescribed circle from a piece of gauze.
3. Endoloop: A ligating loop was tightened around a specified section of a sponge appendage.
4. Spatial Orientation: A 2" cube was manipulated so that a specified side faced the camera in an order prescribed by the experimenter.

Post-test

Experiment 1 (10 Undergraduate and Graduate Students). The participants were divided into two groups. The control group (5 of the 10 participants) received no training between pre-test and post-test on the next day. The experimental group (remaining 5 of the 10 participants) played one hour of the videogame directly after the pre-test and one hour directly before the post-test. The videogame experience was guided by the experimenter who gave verbal instruction during the session following the games storyboard. All participants were asked to abstain from playing any other videogames during the duration of the experiment.

Experiment 2 (20 Medical Students). The participants were divided into two groups. The control group (10 participants) received no videogame training between the pre-test and the post-test (one week after the pre-test). The experimental group (10 participants) was sent home with a console, game, and controller and instructed to play at least one hour every day for seven days. They were asked to keep a record of their playing time, and if they used any external resources for the videogame. All participants were asked to refrain from playing other videogames outside of what was assigned to them.

Experimental Design

Each participant performed one trial of each of the four tasks on the surgical box trainer during the pre- and post-test. The order of tasks remained constant between all participants. Experiment two was conducted as an extension to the first experiment in order to explore the effect of videogame experience for those within the medical field. A between-subjects mixed design was used for both experiments.

Dependent Measures

Time to completion and the number of errors committed were measured and recorded for each task on the surgical simulator. The time to completion, percent accuracy; weapon of choice; the total number of shots taken; the number of kills; the number of head, body, limb, and other shots and percentages, and the level of completion were recorded for the videogame sessions. Results were analyzed using t-tests and Pearson's correlations.

RESULTS AND DISCUSSION

Experiment 1. Equal-variance one-tailed t-tests were conducted on the time and error measures on the physical simulator for Experiment one. There was one significant effect for the time taken to complete the endoloop task ($F(1,8) = 5.347$, $p = 0.025$). The average improvement in time by the participants that had the videogame training (66.878 s) was significantly better than those that had no training (2.996 s) (See Figure 1).

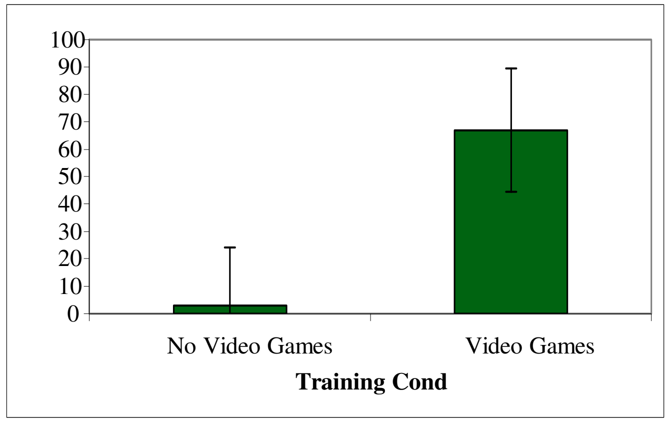

Figure 1. Endoloop task time improvement averages between conditions

After the removal of outliers, the peg transfer task time measure revealed a significant effect ($F(1,7) = 4.070$, $p = .0417$) with a greater improvement in time for those that did not have videogame training (92.49 s versus 47.23 s) (See Figure 2). All other measures were not statistically significant.

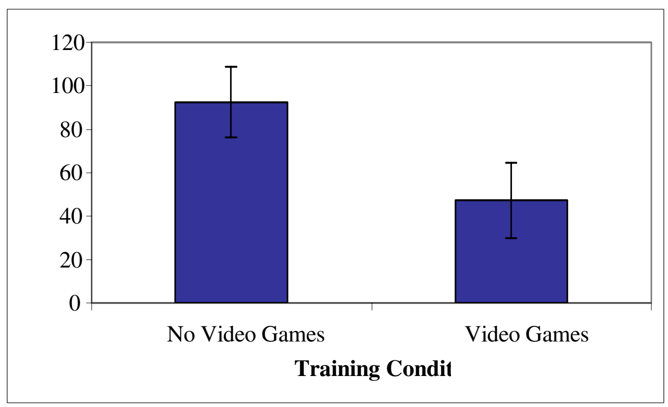

Figure 2. Peg transfer task time improvement between groups after outlier removal

A Pearson's correlation test was also conducted to see if performing well on videogames could be related to performing well on the simulator. Three measures were found to be fairly correlated. Time to completion on the simulator had a strong positive relationship with the percent of completed missions (r = .722) as well as the average time of completed missions (r = .675). A negative correlation was found between the numbers of errors committed on the simulator and the percent accuracy on the videogame (r = -.526).

It was hypothesized that training on James Bond 007: Goldeneye with a Nintendo64 console would result in a larger amount of improvement between sessions on a surgical skills box trainer. The results of the first experiment showed that the time of improvement on the endoloop task supported this hypothesis. This suggested that videogames can provide the training needed to shorten the amount of time taken on an endoloop task. The significant peg transfer results did not support this hypothesis. However, it is possible that because the videogame players had to exert themselves before the post-test, their degraded performance reflected fatigue. An abrupt change in control motion, from using the thumb to operate the game controller to a trigger motion of the hand and index finger to manipulate the surgical tool, could also be a possible explanation for the lower performance by the experimental group.

The idea that performing well on videogames might predict a good performance on the surgical box trainer was partially supported by the results from the Pearson's correlation test. If the participants finished their completed missions in a shorter time, then it was also likely that they would finish the simulator tasks quickly. The time on the completed videogame missions could be used as an indicator for how fast the participant would complete the simulator tasks with a 0.675 correlation score. If participants had a high percent of accuracy on Goldeneye, then their number of errors on the simulator was low (r= -.526). If they performed accurately on the videogame, then they performed accurately with fewer errors on the simulator tasks. This implies that it may be possible to predict how well a medical student will do in laparoscopy by observing how well he/she scores on a videogame like James Bond 007: Goldeneye.

Experiment 2. The results of the study with medical students were also analyzed using t-tests and Pearson's correlations. A borderline effect of total errors was found between groups (p = .054). However, the trend does not follow the hypothesis that videogames transfer the skills needed to improve on simulator tasks. Those that did not play videogames between test sessions actually had a greater overall improvement in time and errors, with an average of 222.2 seconds in time improvement and 2.25 fewer errors, compared with those that did play videogames, with an average improvement of 187.6 seconds and 0.6 more errors on their post-test.

A correlation of r = -.541 was found between the percent of completed missions and the total time taken on the simulator. This, arguably, shows that the more missions a participant successfully completed, the shorter the amount of time he/she took on the simulator tasks. So the more successful on the videogame, the faster the participant performed on the simulator. A correlation was also found between the number of shots taken per kill and the total time taken to complete the simulator tasks (r = .590). Though weak, this could imply that the larger the amount of shots that were taken to actually kill a target, the longer the participant took to complete the tasks on the simulator. This suggests that a person that took a long time to acquire a target in the videogame took longer to acquire and successfully complete the tasks on the simulator.

Several limitations of the study have contributed to the lack of significant results. For example, the scheduling of the post-test was not consistent. The undergraduate, graduate, and medical students had limited time during their school schedules. The time between pre- and post-test varied because of the time of day that they returned. Even though we did not limit the amount of play for a participant in the second experiment as long as they had at least one hour of game play a day, no one played more than an hour and a half each day. Perhaps the total amount of game play has to be over a longer period of time or longer each day to gain training benefits.

Another limitation may be the specific videogame itself. The results from this study suggest that a more standardized method of selecting the game used for laparoscopic skill training needs to be further explored. Perhaps there were aspects of the game James Bond 007: Goldeneye that may have hindered the transfer of skills such as gender bias. It is possible, that the three female participants out of ten in the experimental group, did not connect with the game due to its violent content and action oriented environment. A similar concept was discussed by Cassell and Jenkins (2000), who proposed that gender differences in choice of computer games for entertainment is a function of gender differences in information extraction from similar contexts. Therefore, it may be important to choose a gender neutral game for the purpose of training laparoscopic skills.

Contrary to our results, the recent study conducted at Beth Israel Medical Center found a significant improvement in time and reduction in errors on the Top Gun Basic Skills simulator (Conn, 2004). A significant improvement was found for surgeons who played at least three hours of videogames a week on three different videogames. The games used were not first person shooting games: Super Monkey Ball 2 was a game used that required the participant to direct a ball to a goal on a twisting maze of a path; Silent Scope was a target acquisition game where the participant must shoot as many of the targets as possible; and Star Wars: Racer Revenge was a hover craft racing game. Perhaps replication of this current work with a different game might produce a different result.

Although our study did not show that James Bond 007: Goldeneye can replace the present models used for training, there is a possibility for other videogames to justify the benefit of using videogames given the minimal cost. The idea of training the surgeons of today with an inexpensive technology that they are highly familiar with, and that would be entertaining and engaging at the same time, should be explored further.

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