

The will and the skill: The training effects of virtual reality and gaming

by

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The student author, whose presentation of the scholarship herein was approved by the program of study committee, is solely responsible for the content of this thesis. The Graduate College will ensure this thesis is globally accessible and will not permit alterations after a degree is conferred.

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TABLE OF CONTENTS

ABSTRACT.....	IV
CHAPTER 1. GENERAL INTRODUCTION	1
Gaming, Virtual Reality, and Training	1
Gaming Research – A History	1
Virtual Reality.....	3
Virtual Reality and Game Training.....	5
Efficacy, Confidence, and Willingness to Engage in a Task.....	8
Present Research	9
CHAPTER 2. METHODS	11
Design	11
Participants.....	11
Drop-Outs and Missing Data	11
Demographics	12
Materials	13
Skill Testing.....	13
Games	14
Self-Reported Efficacy.....	16
Control Variables and Suspicion	17
Procedure	18
Hypotheses.....	20
Analysis Plan	21
CHAPTER 3. RESULTS.....	23
Sample Size and Power.....	23
Outliers.....	24
Correlations of Variables of Interest.....	24
Hypothesis Testing.....	26
Preliminary Analyses	26
Main Analyses: Z-Scores and Residuals.....	27
Improvement of Performance	30
Change of Self-Efficacy.....	32
CHAPTER 4. GENERAL DISCUSSION AND CONCLUSION.....	36
REFERENCES	43

APPENDIX A. PAPER TARGET DISTANCE.....	49
APPENDIX B. AIRSOFT GUN.....	50
APPENDIX C. PAPER TARGET.....	51
APPENDIX D. PUTTING MATT	52
APPENDIX E. SCREENSHOT FROM BATTLEFIELD 4.....	53
APPENDIX F. SCREENSHOT FROM THE GUN CLUB VR.....	54
APPENDIX G. VIVE CONTROLLERS.....	55
APPENDIX H. THE EFFICACY OF SHOOTING BEHAVIORS SCALE.....	56
APPENDIX I. GOLF EFFICACY SCALE	58
APPENDIX J. PRE-TRAINING SURVEY	59
APPENDIX K. AGGRESSIVENESS SCALE.....	62
APPENDIX L. POST- TRAINING SESSION SURVEYS	64
APPENDIX M. INFORMED CONSENT FORM.....	68
APPENDIX N. GUN TEST SCORES BOXPLOTS.....	71
APPENDIX O. GOLF TEST SCORES BOXPLOTS	72
APPENDIX P. GUN AND GOLF EFFICACY SCORES BOXPLOTS.....	73
APPENDIX Q. IRB APPROVAL	74

ABSTRACT

The effects of video games and virtual simulations have long been researched, and we know that engaging in these games and situations can have a multitude of effects. Video games and simulations have been shown as effective learning tools for people training to become surgeons (Duque, Fung, Mallet, Posel, & Fleischer, 2008; Rosser et al., 2007; Seymour et al., 2002), fly planes (Dennis & Harris, 1998), drive (Ivancic & Hesketh, 2010), for military training (Williamson et al., 2011; Curry et al., 2016), golf practice (Pohira-Vieth, 2010), and can even have other uses such as training for physical therapy (Betker, Desai, Nett, Kapadia, & Szturm, 2007). However, do these effects translate to everyday gaming habits, and could they teach participants to shoot a gun or putt a golf ball? Moreover, are these effects altered at all by the introduction of virtual reality? We also know that willingness to engage with a task is determined by familiarity with the task, attitudes towards the task, and confidence in completing the task (also known as self-efficacy; Bandura, 1977b). This leads us to ask, does exposure to and practice of a skill in virtual environments (such as video games) increase one's self-efficacy? Discussed is a study where 100 participants engaged in a training module to model practicing shooting a gun or putting a golf ball, and that measured whether exposure to practicing these skills in a virtual environment (versus a 2D gaming environment) lead to greater reports of self-efficacy on those tasks. Results found that while practicing putting or shooting showed increases in specific task performance and self-efficacy, these were not moderated by how participants practiced these skills (in real-life, VR, VR, by a traditional video game setup). However, these results need further research due to concerns such as statistical power when looking at interactions.

CHAPTER 1. GENERAL INTRODUCTION

Gaming, Virtual Reality, and Training

The end of the twentieth century and the onset of the twenty-first has brought about scientific and technological changes beyond comprehension and at a rate almost cumbersome to keep up with. From computers, cell phones, the internet, and even mailable groceries, our lives are changing drastically every day with each technological improvement.

For years, the forefront of new technology has been in the realm of video games. From putting the first computers (at least computer chips) in people's homes to innovating interactive UI's, video games have consistently been a driving force behind technological advances, and even more subtly, our consumption of them. While psychological research (from all fields) has been done on the effects of video games and even technological use on our brains and behavior, we have some fundamental questions left unanswered.

Gaming Research – A History

We know video games are effective learning tools, as they give us unique ways of providing feedback and motivation (Gentile & Gentile, 2008). They even fit more classical models of learning, such as giving us role models to help us learn new behaviors (Bandura, 1977a). Observational learning is a powerful teaching technique, and one that occurs often. In fact, observational learning is so powerful that not only do we see it in groups such as kids (Bandura, 1977a; Wyre, 2017), but in other species such as octopi (Fiorito & Scotto, 2018), chimpanzees (Tomasello, Davis-Dasilva, Camak, & Bard, 1983), and rats (Heyes & Dawson, 1990).

Games are unique in our consumption of them due to their inherent interactive component. They offer consumers a more "active" approach than traditional visual or auditory media (books, movies, television) and research has shown us that learning is best when the learner is "active" (Atlas, Cornett, Lane, & Napier, 1997).

Research in the area of game learning is fairly substantial as well. We know that games can help increase a variety of training, including but not limited to, things such as surgery (Duque, Fung, Mallet, Posel, & Fleiszer, 2008; Seymour et al., 2002; Rosser, Lynch, Haskamp, Gentile, & Yalif, 2007), flight (Dennis & Harris, 2009; Gopher, Weil, & Bareket, 1994), prosocial skills (Flynn, Palma, & Bender, 2007), military training (Williamson et al., 2011; Curry et al., 2016), golf (Pohira-Vieth, 2010), and can even help teach physical therapy techniques (Betker et al., 2007; Flynn et al., 2007).

Video games have also (famously) been known to increase things such as hand-eye coordination, and visuospatial awareness (Green & Bavelier, 2003; Griffith, Voloschin, Gibb, & Bailey, 1983). Because of these, we assume that some of these training effects must carry into other areas.

However, as with any societal or technological advances, both positive and negative effects arise. Amongst the examples listed, concern about violent video games has increased, especially as they have continued to see innovation leading them to become faster, more accessible, and more realistic. The concern not only extends to their overall appearance but their realism in controls and elicited emotions as well. To quote a recent YouTube video, "Call of Duty can only get more real if it gives you actual PTSD" (Patrick, 2017). It is well documented that playing violent video games leads to increased effects in aggression, even cross-culturally (Anderson et al., 2011; 2017), and some

researchers have gone so far to make declarations that some of these games can act as, "murder simulators" (Grossman & DeGaetano, 1999).

While there has been significant debate about the effects of violent video gameplay on aggression, meta-analyses (Anderson et al., 2010; Greitemeyer & Mügge, 2014) shed light not only on if the effect is real (it most certainly is) but the pervasiveness of the effect, and the soundness of the science behind it. Anderson et al. (2010) clearly show (even across study design, and even across cultures) that violent video game play leads to (and predicts) increased aggressive behavior, aggressive affect, and aggressive cognition, as well as decreased empathy and prosocial behavior in participants.

With the consistent improvement and access to better graphical fidelity, and more realistic and responsive controls, the question now becomes if the players are absorbing any of the skills portrayed in these games, and if they are, how we could use this technology to train people, and what sort of effects this is having on the general population?

Virtual Reality

As noted earlier, gaming has become a unique art form and mode of entertainment because of its interactive nature. As technology has improved, so has our ability to interact with it. We also know that this interactivity facilitates identification with the characters (another predictor for learning) even if they are violent in portrayal (Konijn, Bijvank, & Bushman, 2007).

At the onset of the twenty-first century, we saw an increased rise in motion controls (the ability to control an electronic interface using our physical motion). Previous researchers have found that a greater transfer of skills occurs when the

controller is more realistic (Gentile, 2011; Pohira-Vieth, 2010; McGloin et al., 2015; Whitaker & Bushman, 2012), and motion controls have allowed some basic models for this (controllers that look like golf clubs, guns, swords, steering wheels, etc.). There is evidence suggesting that simple observational learning occurs in more traditional gaming contexts with a controller or mouse and keyboard as well (Bushman, 2018). In fact, the British military has used "commercial" gaming technologies to train their soldiers for several years (Curry et al., 2016).

The improvements for more accurate, and cheaper motion controls, as well as other revolutions in motion capture technology, have led the way to innovations in other technologies once thought as distant fantasy, such as virtual and augmented reality. While the dystopian views of these concepts found in popular culture (such as Ernest Cline's novel *Ready Player One*, and popular films like *The Matrix*) are likely still far off from being possibilities, the first wave of consumer-friendly versions of this technology have entered the household.

Recently, we have seen the wide release of the "big three" video game virtual reality head-mounted displays: HTC's Vive, the Oculus Rift, and Sony's PlayStation VR (the latter of which has made full-scale VR giving the cheapest it has ever been for consumers). Within the last couple of years as well, has also seen many name-brand technology companies push out "cheaper" virtual reality headsets, such as Samsung's Gear VR and Google Cardboard, which are compatible with smartphones.

Augmented reality has seen massive and similar innovation as well. Three years ago, at the Electronic Entertainment Expo (E3), Microsoft announced their plans to support augmented reality for their home video game consoles, known as the

"HoloLens." Originally a consumer version was originally slated for winter of 2019, though Microsoft has instead shifted its focus for the device on more industry applications. However, augmented reality has become standard technology as games such as Pokémon Go! have normalized the use of AR for cellular devices. Companies such as Ikea have begun introducing AR apps as well to help consumers picture what a piece of furniture will look like in their home, and the wine brand 19 Crimes allows you to interact with the artwork on their bottles.

With these technologies already making their way into our homes, research has begun to look into the effects and uses of them. However, one thing to note is that we are still in what one could call the "*Pong* phase" of these technologies. While yes, the video game *Pong* was revolutionary, no one was imagining that the virtual game of paddle ball would lead to something such as *Call of Duty: World War II*, where its opening moments feel as if you are suddenly in control of the film *Saving Private Ryan*. What we can do in the space of VR hasn't been fully realized, so the importance of understanding its basic effects are important as the development of the technology continues.

Virtual Reality and Game Training

Some preliminary research on training in VR has been done with varying effects. The military has already begun trying to construct virtual environments to train soldiers and have been able to construct realistic environments using hardware and software commercially available from the major video game companies (Williamson et al., 2011). In 2002, researchers found that virtual reality training increased skills in the performance of laparoscopic cholecystectomy and found that students who trained to do the surgery using a virtual reality program performed just as well as students who trained more

classically (Seymour., Gallagher, Roman, O'Brien, Bansal, Andersen, & Satava, 2002). These results have been tested and retested numerous times (Grancharov, Kristiansen, Bendix, Bardram, Rosenberg, & Funch-Jensen, 2003) to find similar results. However, a common issue in the medical literature is that these samples tend to be small (N=16 in both of the studies mentioned), so further research into the effects has yet to fully been investigated.

For a more extreme example of virtual training, in 2014, Jann Mardenborough entered a competition playing *Gran Turismo* (a popular driving simulator game) where the winner had a chance to join a professional driving team. Not only did Mr. Mardenborogouh win the competition, but he also qualified for the team, and is making a career of being in professional driving. In a 2014 interview, Mardenborough said, "The game is quite similar to real-life...in *GT6* you can really feel the car move underneath you, and if you put too much yaw or pitch into the car, it will react as it would in real life with a bit of a snap. It was crazy to jump from the virtual world into a sports car for the first time. I didn't feel like there was much difference in terms of the way the car feels and how you deliver your inputs" (Barron, 2013).

These findings and examples give us a theoretical and practical direction of inquiry, as it seems to be evident that gaming, and virtual reality, can be used for training different skills. In Grancharov et al. (2003), the participants were also given a baseline psychomotor abilities test, and the results showed that those who trained in the VR program were 29% faster at the gallbladder surgery and were less likely to commit errors than those who did not receive the VR training. There also are practical reasons to pursue this as well. There is more room for error and repetition in virtual training than traditional

training, materials can cost less (in the long run), and there can be more objective and efficient forms of feedback.

The question of if these sorts of effects could translate to gun use have yet to be fully researched as well. With the effects of aggression known from video games, the question then arises, are we not only exposing players to a great risk factor of aggression but also giving them the training to act out this aggression?

There are also practical questions to be asked here as well. Additionally, as technology continues to become more refined, it will become less expensive. If we can have similar, or even better, training effects from virtual training, this could potentially save time, money, and decrease the risk of training people in using firearms. This could be particularly useful for our military, who have already begun training soldiers using video games (Grossman, 1995).

In 2018, Brad Bushman looked into the question of if games could train people to shoot a gun, and found that participants who played a violent shooting game were more likely to shoot at a mannequin's head if the game reinforced higher rewards for getting headshots, and this effect was true regardless of if participants used a normal video game controller or one shaped like a pistol. The purposes of the present study are to take the paradigms from Bushman (2018) but to repurpose the pistol-shaped gun with virtual reality.

We also hope to take these learning and training effects to a more generalizable level and want to see if we can find a similar effect by looking at another skill, putting a golf ball.

Furthermore, when we ask these questions in light of the aggression research, especially the violent media effect, we can't help but ask, are we enabling people to have the means to act aggressively? To feel competent when they act aggressively? To have the confidence to act aggressively? These questions also become pertinent when one exposed to many risk factors may now be given the confidence to act aggressively through their potential virtual training.

Efficacy, Confidence, and Willingness to Engage in a Task

Classic research into efficacy expectations tells us that when people feel like they can perform a certain task well, they will be more likely to engage in it, and in general, as knowledge and comfort with a task increase, so do the likelihood of engaging in it. In fact, the more confident we are that we will perform well, the more likely it is that we will perform well (Lent, Brown, & Larkin, 1984; Bentz & Hackett, 1983). We also know that merely imagining oneself engaging in a behavior, such as donating blood, can increase one's expectations and behavioral commitments to participating in that behavior (Anderson, 1983; Anderson & Godfry, 1987).

In 1977, Bandura posited his theory of self-efficacy (1997b). Self-efficacy is defined as a person's belief in their ability to perform a specific behavior needed to influence specific outcomes, "whereas confidence is the feeling or consciousness of one's powers or reliance on one's circumstances" (Finch, Weiley, Edward, & Barkin, 2008). Bandura more specifically defines the difference between efficacy expectations (the belief one can perform the intended behavior) from outcome expectations (believing that the behavior will have the expected outcome). So, one can feel confident that they can perform a task or behavior, but not feel as if they can control the outcome of the situation.

Finch, Weiley, Edward, & Barkin (2008) looked at how perceived self-efficacy influenced confidence in violence prevention counseling. What they found was that pediatricians were more confident in discussing violence prevention topics such as limiting media violence and different discipline technique, but when it came to other topics such as gun storage and removal, they were less confident and less likely to discuss them. They also note, "that low perceived self-efficacy and lack of self-confidence are deterrents to delivery of prevention services, such as dental screening, screening for risky health behaviors, domestic violence screening, and safety and family issues (Dela Cruz, Rozier, & Slade, 2004; Ozer, Adams, Gardner, Mailloux, Wibbelsman, & Irwin, 2004)."

Another example stems from Cheng et al. (1999), which found that 93% of pediatricians had a high level of confidence in discussing the potential dangers of second-hand smoke. However, only 56% believed that they could do anything to prevent it. Likewise, Maiuro et al. (2000) identified perceived self-efficacy as a moderator in discussing domestic violence during domestic violence counseling sessions.

We hypothesize that not only do games have a training effect on actual skill (as discussed earlier) but that they will make participants feel more comfortable and confident in the tasks being portrayed on the screen and being enacted by the player, thus making the player more likely to engage in them in a real-world scenario.

Present Research

In this study, participants were evaluated on their skills in shooting an airsoft gun at a paper target, and at putting a golf ball on an office putting green. They were randomly assigned to be trained in one of six conditions (see table 1) over a 2 to 3-week period.

Participants then completed six sessions total over this period. The first session included a baseline assessment of their skills in putting and shooting, as well as introductory surveys and assessments of attitudes. The next four sessions were the "training" sessions, in which they practiced the (one) skill randomly assigned to them for twenty-minute sessions, as well as completed some additional surveys. The final session was a post-training test, where participants came back to the lab and tested again on their shooting and putting skills, as well as retook the various attitudes and efficacy scales they initially completed.

CHAPTER 2. METHODS

Design

The study was a 2 (Skill practiced: golf or gun) by 3 (Practice Mode: VR game, "flat screen" game, or "practical" training) by 2 (Skill measured: shooting or putting) mixed design, with the first two factors being between participants and the third factor being a within-participants factor. The dependent variables were scores on attitudes and efficacy beliefs concerning golf and guns and accuracy on shooting and putting. To better assess (and control) gender effects, participants were blocked by gender and then randomly assigned to one of the six training conditions. Participants took pre and post-tests on accuracy for both shooting and putting (e.g., a person who practiced the VR gun condition still took the putting test). This allows for the scores on the skills participants did not train on, to act as a de-facto control group.

Table 1
List of Six Conditions

		Skill Practiced	
		Shooting	Putting
Practice Mode	VR	VR	VVR
	Flat Screen/Controller	Flat Screen/Controller	Flat Screen/Controller
	Practical	Practical	Practical

Participants

Drop-Outs and Missing Data

One hundred thirty-eight undergraduate participants from a large midwestern university participated in the study and were given course credit for their participation.

However, some participants failed to complete the study or took too long to complete all six sessions. Those who strayed outside of the targeted time frame (21-28 days to completion), did not complete the second testing session, or experienced experimenter error, were removed from data analysis, this totaled to 38 participants. Potential future analyses could include some of these participants using missing data procedures for longitudinal analyses and missing time points (e.g., Twisk & Vente, 2002) to accommodate for these issues in drop-out. Means were calculated to supplant any missing data from the final 100 participants included.

Demographics

For the final analysis, 100 participants were analyzed after using the above exclusion criteria: 60 males (60%) and 40 females (40%). The average participant age was 19.21 years old ($SD = 1.55$), and most identified as being Caucasian (76%). 14 (14%) participants completed the VR shooting condition, 14 (14%) completed the VR golf condition, 15 (15%) completed the practical ("real-life") gun condition, 17 (17%) completed the practical golfing condition, and finally, 20 (20%) participants completed the "controller" golf and shooting video game condition respectively. Additionally, 49 participants reported having used a gun prior to the study (49%; M (of gun use, 1-4 scale, see materials) = .85, $SD = 1.12$) and 66 reported having gone golfing before (66%; $M = 1.13$, $SD = 1.02$). Only 19 participants reported spending no time playing video games weekly (19%; $M = 2.28$, $SD = .87$).

Materials

Skill Testing

For this study, participants were evaluated by performance on shooting a target with an airsoft gun, and how well they perform at putting a golf ball (accuracy of shots, number of shots). Participants were brought into the lab and randomly assigned to a golf or gun training condition. They then would take a baseline measure of performance for both the shooting task and the golf-putting task.

Participants used a battery-powered airsoft gun to shoot 16 "bullets" (airsoft pellets) at a paper target approximately 10-12 feet away from them (see appendices a-b). Research assistants (RAs) recorded how many shots hit the target, and how many missed. The "score" was then calculated by measuring the distance how close each of the shots was to the "bullseye." A hit on the bullseye was scored "zero," and shots outside of that were measured with measuring tape and recorded to the quarter of the inch. The closer a participant's score was to zero, the more "accurate" that participant was in this task. If participants missed the paper target all-together, the score would be marked as a "9."

Participants were also given 16 shots with a putter on an "office" golf putting set that was roughly 9 feet long (see appendix d). After each "stroke" from the set location, RAs measured how far away the ball was from the hole. Participants putted at a marked spot nine away from their target hole for each of their 16 shots. Like the shooting task, this was a "zero-score" measure, where if participants hit the ball in the hole, they received a score of zero, and if they missed the hole, the distance to the hole was measured to the quarter of the inch. Scores closer to zero were considered the most "accurate."

These assessments were given as a pre and post-test measure to see if partaking in the training conditions helped participants improve their scores from test one to test two. As stated before, participants completed both tests, regardless of which training condition they engage in to act as a control measure. These scores were calculated by summing the total distance from the targets.

Games

Four different games were used for the different conditions in this study. The game used for the "traditional game" shooting range was *Battlefield 4*, which features a shooting range area that players can practice shooting stationary targets (see appendix e). For the virtual reality game, participants played *Gun Club VR*, which uses the Vive's motion controllers as the primary form of controls (see appendix f). For both the traditional golf game and the VR golf game (which was also played on the Vive using its touch controllers – see appendix g), players played *The Golf Club* which has both traditional and (see appendix h) virtual reality modes, as well as a mode to practice putting specifically.

For the shooting range VR game, participants stood in the middle of the lab space with the VR headset on, while holding a controller in their hand. Presented to them on the screen would be a shooting range, where they would then practice shooting with a handgun for 20 minutes. The perspective in the headset was in first-person, and the one would use the Vive controller like you would a gun, bringing it to your face to look down the scope, and pulling the trigger on the back of the controller to shoot (much like pulling the trigger of a gun).

For the shooting range controller game, participants would load into a shooting range in *Battlefield 4*. Just like the VR game, the point of view was first person, and on the screen, participants could see their hands holding the gun. Participants would then be instructed to switch to using the equipped handgun and would then walk up to a target and shoot it. After a while the targets would fall down, and participants could move onto a new one. In this particular level design, the fallen targets would pop back up after a certain amount of time, so participants could “cycle” through the targets for their twenty-minute sessions. The shooting controls were that of a normal first-person shooter, where participants could control avatar movement and the game camera with analog sticks on the controller and could aim down sights and shoot the gun using the triggers on the back of a controller (used an Xbox One wired controller for the controller conditions).

In *Golf Club VR*, participants had much of the same controls as they did for the VR shooting game. However, this time the VR controller acted like a golf club. Within the head display, participants saw a first-person perspective of a golf club being held in front of them, and the club would move in response to the participants moving the Vive controller. Participants could hold the controller much like one would hold a real-life golf club (again, RAs were instructed not to “coach” participants) and would swing at the golf ball presented to them in the head-mounted display. For the controller version of the golf game, participants saw a third person-view of the avatar they were controlling. Rather than the standard first-person controls seen in the shooting condition, participants controlled the avatar with the left analog stick on the controller (could have them adjust their orientation to the left or right) and they controlled the golf club with the left analog stick. To swing the club, participants would pull back on the analog stick and then push it

“through” much like the pull-back and follow-through on a golf swing. The harder and faster one did this with the analog stick, the harder you would hit the ball in the game (again, analogous to swinging hard with a golf club in real-life).

Self-Reported Efficacy

The Efficacy of Shooting Behavior was previously developed by Carnegie and Anderson (2008) and used for this study. Items on this scale are rated on a 1 to 7 Likert scale (1 = *strongly disagree*, 7 = *strongly agree*), with high scores showing a positive attitude about guns, high usage of guns, and high confidence and openness to use guns.

The scale is broken up into 17 questions, some sample questions include, "holding, aiming, and accurately firing a real handgun is easy to do "if needed, I would have no problem firing a gun at another person," "I have the ability to hold, aim, and fire a real handgun," and "using a firearm to protect loved ones is acceptable to do if they are in danger." These items have been adapted to measure attitudes towards golfing and putting as well by merely replacing "handgun" with "golf putter" or "golf club." In this study, the reliability of this scale was consistent with previous research ($\alpha = .86$); additionally, the appropriate golf version of this scale also showed strong internal consistency ($\alpha = .92$).

These findings are relatively close to the reliability found in similar measures such as The Attitudes Toward Guns and Violence Questionnaire (Shapiro, Dorman, Burkey, Welker, & Clough, 1997), which was developed to help assess youth attitudes towards guns and their likelihood to own and/or use a gun. As Shapiro, Dorman, Burkey, Welker, & Clough (1997) found, the scale was successful in finding that those who

scored high on the scale had a 1 in 3 chance to own a gun, while those who scored low had a 1 in 125 chance of being a gun owner.

Control Variables and Suspicion

Basic demographic data about participants was gathered. They reported their gender, age, political affiliation, religious beliefs, GPA, and general socio-economic information. Experience shooting guns and playing golf will be gathered using the following questions: "Have you ever fired a real a gun before?", "Have you ever played paintball before?" "Have you ever fired an airsoft, or bb, gun before?", "Have you ever played golf/mini-golf before?" (1 = *yes*, 0 = *no*); "If 'yes' then how many times?" (*About once a week/month/year*; 4-point scale, 1 = once a year, 4 = once a week). If participants answered "no" on these questions, they were then scored at "0" for all exposure calculations.

Experience with video games was also measured. Participants were asked to report, "How often do you play video games (weekly)?" (*Never, Sometimes (0-3 hours), Regularly (5-10 hours), It is my main hobby (10+ hours)* 1 = *Never*, 4 = *It's my main hobby*). Experience with games that feature shooting or golfing was assessed as well. Participants will be asked, "Do you play a lot of games with guns/golf?" (*Rarely, Sometimes, Often*). For these analyses, only "How often do you play video games weekly" was calculated. Participants also completed the Aggression Questionnaire (Buss & Perry, 1992) as well, but results from this scale were not used for this particular analysis.

Additionally, surveys were collected after each training session assessing participants' comfortability and enjoyment of the tasks, but those scales have not been

scored or analyzed as they were not part of the main hypotheses. (Both versions of the scale can be seen in appendices i and j, as well as the scales collected after the training sessions.

During the final session, and before being debriefed, participants were asked a series of questions to assess their suspicion about the study. Participants were first asked what they think of the study, which they can freely type a response to, and then will be asked a series of "yes/no" questions such as: "Were you confused by the tasks or instructions?", "Do you think the lab gave away any information the experiment was about?" and "Do you think there might have been more to this study than you have been told?" If participants selected "yes" to any of these questions, they were prompted with a text box to explain further. (All surveys can be seen in appendices k-m).

Procedure

Before arrival, participants were randomly assigned to one of the six training conditions. When participants arrived, they completed an informed consent document (see appendix 14) and were told the necessary procedures of the study and explained that it took place over a multi-session and multi-week period.

After participants consented to the study and agreed to continue, they completed a baseline survey that gathered their demographic information, past video game exposure, past golf/gun exposure, and the efficacy and aggression scales.

Upon completion of these surveys, participants then engaged in the shooting and putting tests. RAs were instructed not to give any feedback to participants, and if prompted about technique or form ("Am I holding this right?"), to deflect and say

"Whatever you are comfortable with" to help ensure that coaching is not a confounding variable in this study.

After doing these questionnaires and demographics surveys, participants completed their first test of shooting *and* putting performance, which is critical to note, as this is important to our data analytic procedures. Even though participants only participated in one of the training paradigms (i.e., VR shooting practice), they would go ahead and be tested on both shooting and putting tests. This effectively meant that for each participant, we had a de facto "control" to compare them to (themselves on the skill they did not practice).

The RAs scheduled participants for their next appointment and logged it on a Google Calendar page. They also had access to a Google Sheet page where participants were tracked by a randomized ID that told RAs what condition participants were in. RAs filled out this document at the beginning and end of every session so they could keep track of when the participant last came in, when their next upcoming appointment was, and what session of the study they were currently on.

Participants then went through their two to three weeks of training in their randomly assigned training condition. These training sessions had each participant engage in the said training condition for 20-minute periods, then completing a quick survey measuring their attitudes about the task, how well they thought they did, and their attitudes about their assistants. Again, the research assistants with them were not allowed to offer help other than initial instructions on how to play the games, as coaching could become a significant confound in the results if feedback were allowed.

After these four training sessions, participants returned to the lab for a sixth and final session where they performed the same tests on shooting and putting as they did initially and were scored again on the same criteria. They then retook the same questionnaires to assess if their attitudes and confidence toward those specific tasks had changed.

Hypotheses

We hypothesized that all participants would show improvement between the two different skills tested (putting and golfing) but that the most amount of improvement for each participant would be seen for the skills tested that participants also practiced (i.e., participants who practiced shooting would improve more on their shooting score than their putting score; H1). We expected this to further express itself based on which mode of practice (i.e., VR, real-world, controller) the participants were assigned to practice that skill in. We anticipated that those who practiced the skill "in the real world" would show the most amount of improvement, followed by those who practiced the skill in VR, with those who practiced using a controller showing the least amount of improvement. While we anticipated that all three practice modes would show improvement on the second test from the first test, we hypothesized that the amount of improvement would tier in that specific order (H2) based upon an interaction of which skill they practiced (shooting or putting) as well as the mode they practiced (real-life, VR, controller).

We also anticipated that the golf and shooting conditions would see roughly the same amount of improvement (H3) compared to each other. This would indicate that these skills picked up in games are not merely shooting mechanics, but as other research has shown, that video games can improve a variety of motor skills.

Another intriguing effect we anticipated seeing was that, while we controlled for video game experience/exposure, for those who had a lot of game exposure, they would start at a higher point of success, and perhaps only see marginal increases in their performance. This way it would be clear that those with no prior exposure to the skill they practiced would see the most improvements.

We also expected to see the participant's self-efficacy to change after playing these games as well. After playing/practicing for multiple weeks, we predicted that participants would feel more confident and show more willingness to engage in these activities. We also predicted that these results would mirror those found in the performance, where self-reported efficacy for the skill practiced would increase more than for the skill not-practiced (H4), that increased self-efficacy would also have a similar interaction based upon which mode the skill was practiced in (H5), and that there would be similar rates of increases in self-efficacy for both those who practiced shooting and putting overall (H6).

It is important to note one potential confound in the study. We recognize that using two different shooting games for the VR versus traditional controller is a possible problem, but there are currently no shooting range games that feature both a traditional gaming mode and a VR more, Both shooting games offer similar enough experiences that we believe that it is an excellent place to start.

Analysis Plan

Given our design and hypotheses, it is important to revisit a couple of critical points that we have already highlighted as well as outline what our strategy was going into the final analyses, the first being that we decided to treat the skill type (shooting and

putting) as a within-subjects factor. Again, we did this by having each participant perform both the shooting and putting tests at both the beginning and the end of the study, even though they only completed one specific training condition.

This leads us to some challenges as we have a significant question to parse out before we begin to look at the more nuanced improvements as hypothesized above: did participants show improvement in their shooting/putting, as well as increases in reported self-efficacy? We set to demonstrate this first with simple t-tests to look at the difference in means between time one and time two on the shooting/putting tests as well as the golf and gun self-reported efficacy measures.

Once we demonstrate this (or fail to), we can move forward knowing that the differences in the scores being looked at are in the direction we are hypothesizing and discussing, which we intend to do using repeated measures MANOVAs. We also hope to look at some potential control variables such as gender and previous experience shooting and/or putting. Again, due to the design and methodology of this study, doing such things, such as standardizing the scores, as well as calculating residuals, become necessary and important, and more on that methodology will be discussed later.

CHAPTER 3. RESULTS

Sample Size and Power

When initially proposed, the suggested sample size was targeted at 150 participants for the final analysis. However, the end of this study's data collection cycle was right around when COVID-19 forced universities to shut down campuses for the Spring semester of 2020, forcing us to halt our data collection procedures. In the interest of completing the thesis (and its defense) on the proposed timeline, we opted to continue to move ahead with what analyses we could with the data we had collected.

However, since we have come up short on our proposed goals for sample size, this also means that our study and some initially suggested hypotheses could not be thoroughly analyzed. More specifically, with the final N of 100, we are simply too underpowered to look at the potential interaction effects with potential control variables such as gender, prior shooting/putting experience, and video gameplay.

We do offer some controls for how well participants tested and felt on efficacy at the beginning of the study (which will be discussed later in this section), but we are not able to more sensitively account for the potential moderation of some of the above-listed control variables on these reported effects. However, we do look at correlational data regarding these variables, and those results will be reported. While we believe that missing these particular analyses does not hurt the overall importance of these effects, we do want to acknowledge this limitation before we discuss the data analysis procedures and results, as well as to continue to be transparent about our original plans and hypothesized findings. We will discuss more about future plans for more sensitive testing in the discussion section.

Outliers

In data cleaning, one must always be aware of outliers. In our particular analysis, it was reasonably easy to identify, especially in the shooting and putting test scores. Some scores were easily identifiable as being impossible (i.e., above a "9" for shooting, or anything below 0). When possible, these raw scores were fixed to correct scores (i.e., easy typos such as 1075 easily corrected to 1.75), or if not, they were treated as missing variables with the mean substitution.

We created box plots in SPSS to look at potential outliers as well as check the distribution of our dependent variables (see appendices n – p). We found six cases that qualified as "asymmetric outliers" (as indicated by a star in SPSS; Weinberg & Abramowitz, 2008). We looked back at the raw data collected for any coding errors, however upon review, the scores were indeed correct, and we determined it best to simply replace them with the next highest score. Additionally, our data seemed to have normal distributions and did not require further transformations. This gave us confidence that we could conduct and interpret our hypothesis testing.

While some may argue that this amount of Winsorizing may warrant further data transformation, we did not do so here for the sake of simplicity and time. In future analyses, once we have a larger sample, we may find that some of these outliers will not appear as such, or if not, we can more sophisticatedly address their inclusion in the data sample.

Correlations of Variables of Interest

Reported in Table 2 are the correlations of the variables of interest as well as potential control variables about gun and golf performance and efficacy. Additionally, we

created two new variables to evaluate the condition participants were in to reflect a 2x3 analysis. There were reasonably strong correlations with all our reported variables of interests and their respective final testing and efficacy scores. Additionally, you can see that in terms of our dependent variables, we do see strong correlations in the proposed directions between time one and time two. I.e., Gun Efficacy 1 has a strong negative relationship with Gun Score 2, meaning that participants who felt confident and comfortable shooting when they first arrived for the study, tended to have lower (better) final shooting scores, and this effect is mirrored in the golf efficacy and putting scores.

Additionally, we see that gender has a strong correlational effect on shooting and putting, as well as higher efficacy scores, as males scored lower on the performance tests as well as gave higher ratings of self-efficacy. Again, while we were not able to directly test these effects, the correlational data does suggest further investigation.

Table 2

Correlations Between Final Gun and Golf Performance and Efficacy Scores

	Shooting Score 2	Gun Efficacy 2	Putting Score 2	Golf Efficacy 2
Shooting Score 1	.60**	-.53**	.27**	-.07
Gun Efficacy 1	-.44**	.91**	-.22*	.16
Putting Score 1	.22*	-.09	.33**	-.16
Golf Efficacy 1	.34**	.19	-.26**	.76**
Gender	-.35**	.55**	-.24*	.24**
Gun Exposure	-.27**	.43**	-.24*	.12
Golf Exposure	.05	.07	-.02	.36**
Gun Use	-.29**	.62**	-.23*	.15
Golf Use	-.10	.15	-.18	.43**
Video Game Play	-.25*	.18	-.09	.18

Note. $N = 99$, Gender coded as 1 = male, 0 = female

† $p > .05$, * $p < .05$, ** $p < .01$, *** $p < .001$.

Hypothesis Testing

Preliminary Analyses

Next, a paired sample t-test was run to compare the difference between time points on both the shooting and putting tests, as well as differences in efficacy between the first and final sessions and assess the general trend of our data. These results show that there was a statistically significant amount of improvement between test one and test two for both the shooting test ($t_1, M=38.76, SD=22.01$; $t_2 M=29.97, SD=17.83$; $t(99)=4.86, p < .001$) as well as the putting test ($t_1, M=234.06, SD=132.91$; $t_2 M=167.95, SD=92.28$; $t(99)=4.91, p < .001$). Likewise, self-reported efficacy also increased for both shooting ($t_1, M=3.95, SD=.94$; $t_2 M=4.20, SD=.92$; $t(99)=-6.29, p < .001$) and golfing ($t_1, M=4.44, SD=1.21$; $t_2 M=4.79, SD=1.17$; $t(98)=4.21, p < .001$).

Additionally, the Time 2 scores reveal a "tighter" focus around the zero point for both the shooting and putting scores. The efficacy scores also were less variable at Time 2. These are shown in Table 3.

However, these results are over the whole sample. More sensitive analyses were conducted to assess the effects of the experimental manipulations. Note as well, for the shooting and putting tasks this is their total score (i.e., summing their score from all 16 shots/putts) but for the efficacy scales, due to the difference in the number of items (9 for the golf measure and 17 for the gun measure) we took an average score for comparison, however, a higher rating is still indicative of higher perceived self-reported efficacy.

Table 3
Paired Sample t-Tests for Test Performance and Self-Reported Efficacy Change

	<i>Test 1</i>		<i>Test 2</i>		<i>t</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	
Shooting Score	38.76	22.01	29.97	17.83	4.86***
Putting Score	234.06	132.91	167.83	92.28	4.91***
Gun Efficacy	3.95	.94	4.20	.92	-6.29***
Golf Efficacy	4.44	1.21	4.79	1.17	-4.21***

** $p < .01$, *** $p < .001$. $N = 100$ for all means

Main Analyses: Z-Scores and Residuals

For this study and its subsequent hypothesis analysis, we wanted to make sure we were accurately testing the hypotheses we presented as well as controlling for participant's previous skill and exposure. Also, due to the design of having everyone participate in both tests, but in only one practice type/condition, we wanted to make sure we could test the key hypothesis that participants showed the most improvement in the skill that they practiced. The preliminary analyses showed that overall, participants improved performance on the skill tasks from Time 1 to Time 2 (lower shooting and putting scores) and that over their self-reported efficacy at these two skills increased. The main analyses to follow test the experimental design effects. Did participants who practiced a specific skill show the most improvement in that skill? If so, did the three modes of practice differentially improve skills? Was self-efficacy differentially related to which skill was practiced, and did the modes of practice have different effects?

The scoring of the shooting and putting tasks were done in a similar manner (16 shots on a zero-sum scale), but the scores, of course, were drastically different. To put both skill scores on the same scale, we created z-scores for the shooting and putting tests.

These z-scores were computed with both Time 1 and Time 2 scores combined, allowing us to show that the Time 2 scores changed from the Time 1 scores. Additionally, to control for individual participant skill levels, we controlled for Time 1 skill scores by first running two regression analyses in which the Time 1 z-scores predicted the Time 2 z-scores, one for each skill. Then we partialled out the effect of Time 1 skill on Time 2 skill in the main ANOVAs because it is unclear how (or whether) SPSS can partial out one specific covariate (e.g., T1 gun score) from only one dependent variable (e.g., T2 gun score), we saved the residuals from the regression analyses, and ran the main analyses on these residuals. This is essentially the same as a standard ANCOVA, except that the d.f. for the denominator in all F-tests is too large because it doesn't take into account the d.f. associated with computing (and controlling for) the slope. We, therefore, corrected the d.f., mean square error, F-tests, p-levels, and effect sizes in the final reported results and ANOVA tables.

Also, although we collected several potential control variables that showed strong correlations (such as gender and gun/golf exposure and use), we did not include them in the main analyses, for two reasons. First, because of the COVID19 pandemic, we were not able to run as many participants as originally planned, thereby decreasing power to detect very small interaction effects that we originally thought worth examining. Second, by controlling for skill at Time 1, we should greatly reduce the effects of these other control variables. For example, gender effects on shooting a gun or putting a golf ball based on gender differences in prior experience are already "controlled" by our statistical procedure.

This same regression and residual analysis process were used for the reported self-efficacy measures. Because the self-efficacy scores for both the shooting and putting tasks were on the same scale items, we did not convert them to z-scores. The regression models used to create the residuals (before calculating them with the intercept kept in the equation) were all significant for the shooting tests ($\beta = .48$, $a = -32$, $F(1, 98) = 56.35$, $p < .001$), golf tests ($\beta = .23$, $a = -34$, $F(1, 98) = 11.88$, $p = .001$), gun self-efficacy ($\beta = .88$, $a = 71$, $F(1, 98) = 460.67$, $p < .001$) and golf self-efficacy ($\beta = .473$, $a = 1.55$, $F(1, 98) = 130.62$, $p < .001$). You can see all the regression slopes in figure 1.

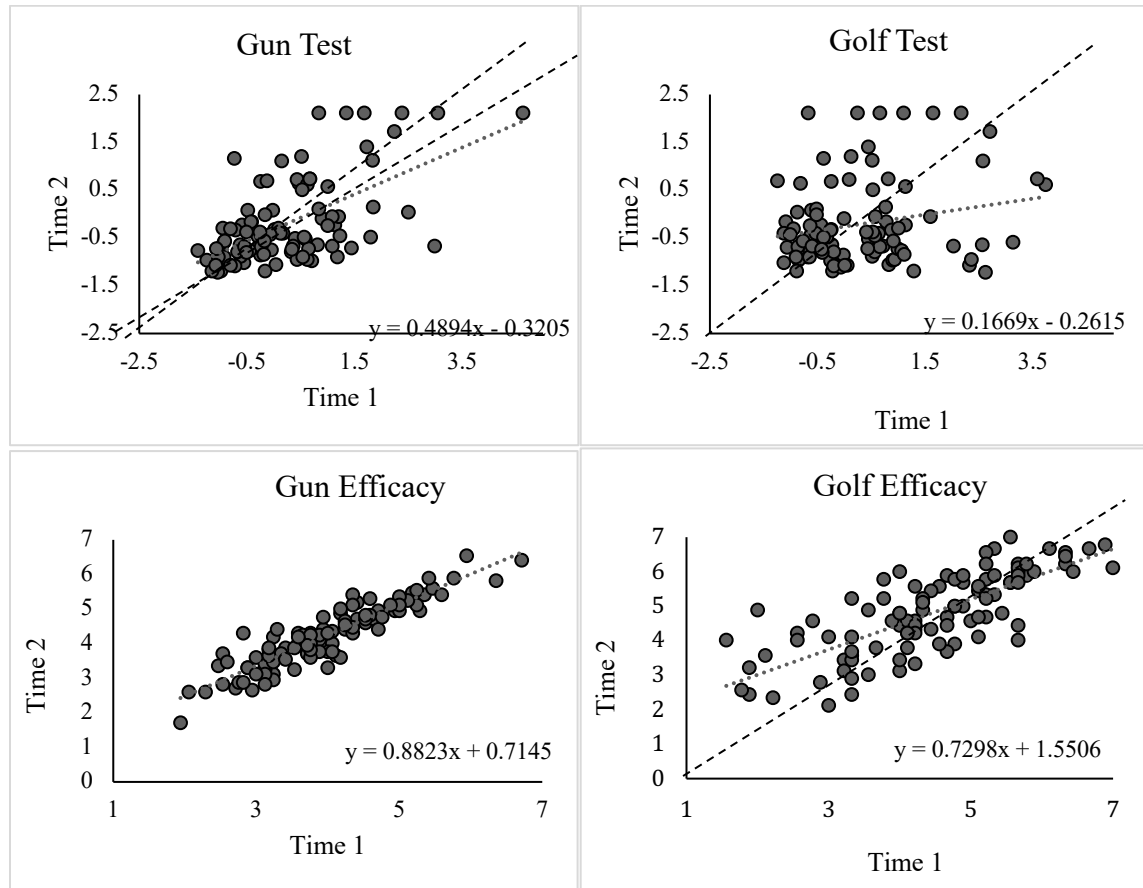


Figure 1
Regression Lines for Skills Tested and Self-Efficacy Change at Time 1 and Time 2

Improvement of Performance

To assess the effect of the training conditions on improvement, we ran a 2 (Practiced Skill; putting or shooting) x 3 (Practice Mode; VR, practical, controller) x 2 (Measured Skill; putting or shooting) repeated measures MANOVA in SPSS. Again, due to how we created these residuals to analyze (by using the regression residuals), and the process of running a repeated measures MANOVA in SPSS, we needed to manually correct the output given to us by the statistical software, as it did not take into account the use of regression residuals, and the denominator degrees of freedom would be off slightly (2, in this case).

Again, due to the nature of the hypothesis and analysis, the interest in the between-subjects results are minimal to the hypothesis testing, because the between-groups effects all average the two skill performance improvement measures. Therefore, there is no theoretical reason for expecting any significant effects in this part of the analysis. For example, there is no reason to expect the Skill Practiced manipulation to affect the average improvement of the average of the two skills (H3).

There were indeed no significant effects of skill practiced (shooting/putting; $F(1, 92) = .60, p > .44, \eta^2 = .02$), the mode used to practice the skills (VR, real-life, controller; $F(2, 92) = .38, p > .38, \eta^2 = .05$), or their interaction ($F(2, 92) = .85, p > .43, \eta^2 = .04$) in the between-groups portion of the analysis.

Table 4***Repeated Measures MANOVA of Gun and Golf Tests: Residual-based Improvement***

<i>Between-Groups Effects</i>						
	<i>df</i>	<i>Type III Sum of Squares</i>	<i>Mean Square</i>	<i>F</i>	<i>Sig.</i>	η^2
Skill Practiced	1	0.54	0.00	0.60	0.44	0.02
Practice Mode	2	1.48	2.41	.99	0.38	0.05
Skill Test x Practice Mode	2	1.03	0.3	0.85	0.43	0.03
Error	92	65.04	0.71			
<i>Within-Groups Effects</i>						
<i>Repeated Variable: Skill Test (Shooting and Putting Test Residuals)</i>						
	<i>df</i>	<i>Type III Sum of Squares</i>	<i>Mean Square</i>	<i>F</i>	<i>Sig.</i>	η^2
Skill Test	1	0.02	0	0.01	0.92	0.00
Skill Test x Skill Practiced	1	2.40	2.41	7.45	0.01	0.08
Skill Test x Practice Mode	2	0.53	0.3	0.93	0.4	0.02
Skill Test x Skill Practiced x Practice Mode	2	0.27	0.16	0.5	0.61	0.01
Error	92	28.90	0.31			

More importantly, in the within-subjects effects, the hypothesized interaction of the skill test x skill practiced was significant, $F(1, 92) = 7.82, p < .01, \eta^2 = .08$; see Figure 2. This shows that for our participants, the skill they practiced showed more improvement (the residual T2 scores) than the skill they did not practice, which supports our initial hypothesis (H1; see table 4). Neither the practice mode by skill test ($F(2, 92) =$

.86, $p < .21$, $\eta^2 = .02$), nor the three-way interaction between skill test, skill practiced, and mode ($F(2, 92) = .45$, $p > .64$, $\eta^2 = .04$; see figure 2) were significant. The latter does not support our hypothesis (H2; see table 3) that the practice mode would affect participant's improvement on the skill that they practiced.

Change of Self-Efficacy

Identical repeated measures 2 x 3 x 2 MANOVAs were run to test the change of gun and golf self-reported efficacy by skill and activity, and similar patterns of results were found. When looking at between-subjects effects, insignificant differences between the skills practiced (shooting/putting; $F(1, 91) = .94$, $p = .34$, $\eta^2 = .02$), the mode used to practice the skills (VR, real-life, controller; $F(2, 91) = .53$, $p = .31$, $\eta^2 = .04$), and the interaction between the skill practiced and the mode to do so ($F(2, 91) = .17$, $p = .68$, $\eta^2 = .01$) were found once again. These results, coupled with the results from the t-tests, support our hypotheses that between the golf and shooting conditions, there was a similar amount of increase in efficacy (H6; see table 5).

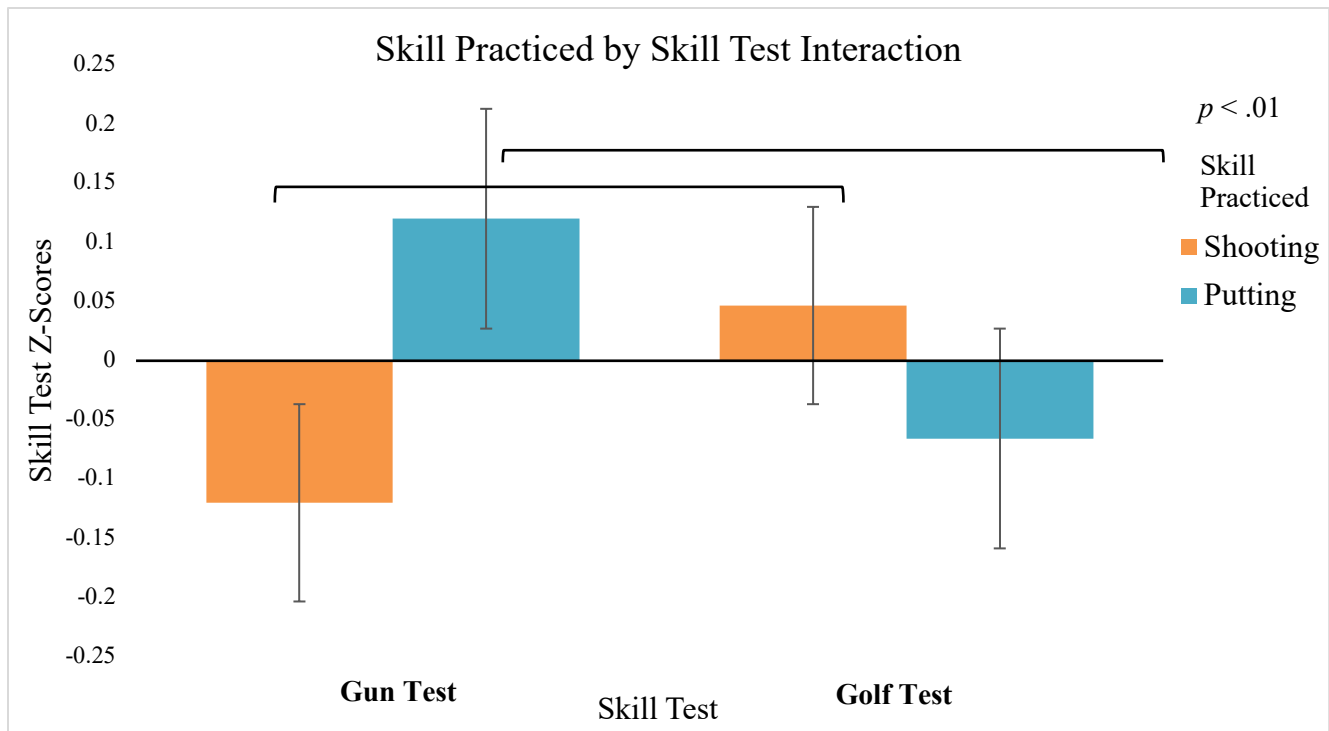


Figure 2
Skill Practice by Skill Test Interaction

Table 5
Repeated Measures MANOVA of Gun and Golf Self-Efficacy

	<i>df</i>	<i>Type III Sum of Squares</i>	<i>Mean Square</i>	<i>Between-Groups Effects</i>		
				<i>F</i>	<i>Sig.</i>	η^2
Skill Practice	1	0.42	0.42	0.94	0.34	0.02
Practice Mode	2	1.06	0.53	1.18	0.31	0.04
Skill Test x Practice Mode	2	0.35	0.17	0.39	0.68	0.01
Error	91	40.73	0.44			

Table 5 continued

<i>Repeated Variable: Efficacy (Shooting and Putting Efficacy Residuals)</i>				<i>Within-Groups Effects</i>		
	<i>df</i>	<i>Type III Sum of Squares</i>	<i>Mean Square</i>	<i>F</i>	<i>Sig.</i>	η^2
Efficacy	1	0.02	0.02	.06	0.81	0.00
Efficacy x Skill Practiced	1	1.65	1.65	5.92	0.02	0.06
Efficacy x Practice Mode	2	0.25	1.00	0.45	0.64	0.01
Efficacy x Skill Practiced x Practice Mode						
Practice Mode	2	0.72	0.36	1.3	0.28	0.03
Error (Efficacy)	91	25.34	0.27			

For the within-subjects effects, as seen with the skill tests, there also was a significant difference with the interaction between increased efficacy dependent and the skill participant's practiced ($F(1, 91) = 5.92, p = .02, \eta^2 = .06$; see figure 3), in direct support of our predicted results (H4). However, there was no significant interaction between practice mode and self-efficacy scores ($F(2, 91) = .45, p = .64, \eta^2 = .01$), or the three-way interaction of self-efficacy type, skill practiced, and mode ($F(2, 91) = 1.30, p = .42, \eta^2 = .28$), which does not support our hypothesized results (H5).

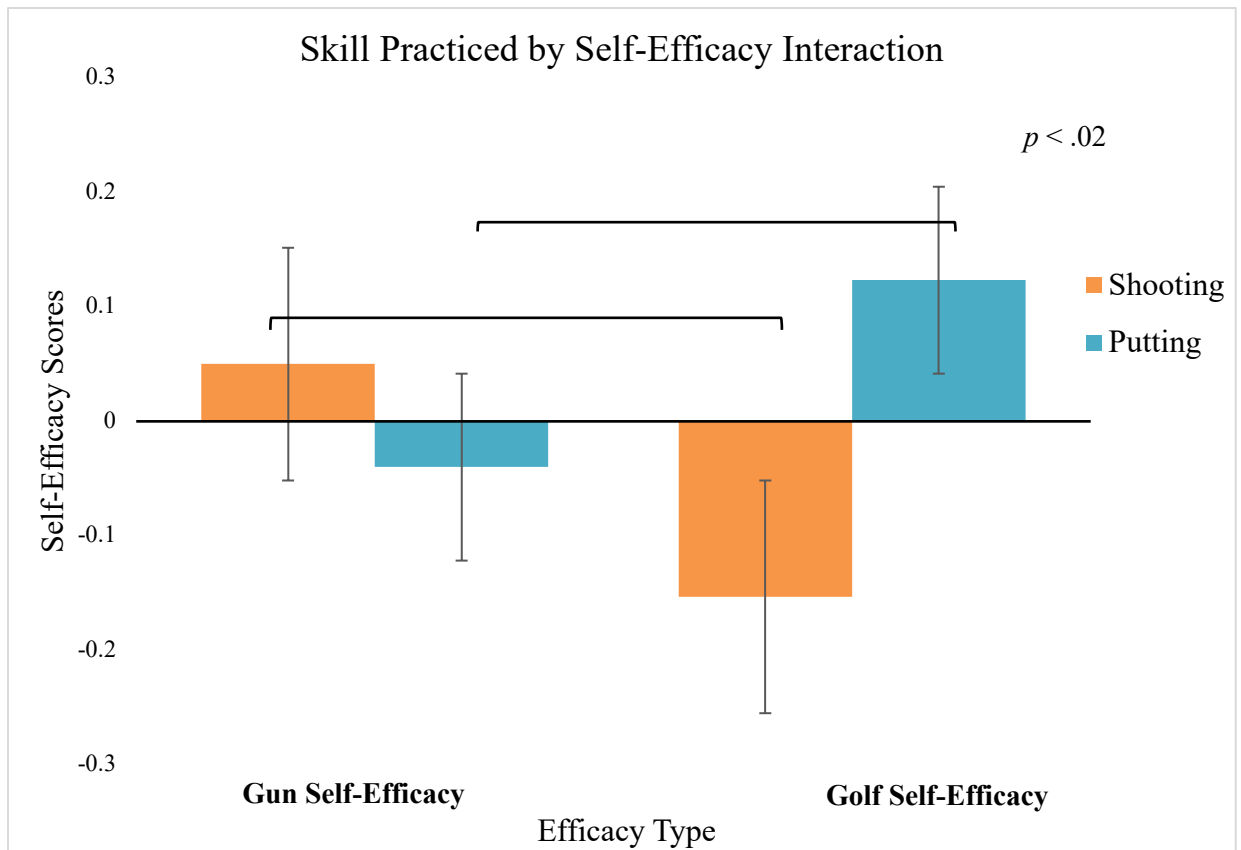


Figure 3
Skill by Test Type Interaction

CHAPTER 4. GENERAL DISCUSSION AND CONCLUSION

Our results clearly show that participants did show improvement between their two test scores, and more importantly, that they had the most improvement on the skill they practiced. Additionally, it seems to be that the amount of improvement in the skills was not affected by which mode participants practiced the skill in. Those who practiced in VR and with a traditional video game controller seemed to improve upon their skill just as much as those who practiced in real-life. Of further interest, it is clear that this same pattern manifests in the higher ratings of self-efficacy, where participants showed higher time two self-efficacy ratings for the skills they practiced, but that there was no difference in the mode of practice.

As noted before, there are a handful of strong considerations we must take with these results. Namely, that we are underpowered if one hopes to look at things such as the three-way interaction of the skill tested, the skill practiced, and the practice mode. The effect sizes found were not quite as large as we had anticipated, however, we should actually expect this particular interaction to be quite small. Because none of these effects are crossover effects in the predicted interaction (i.e., practicing one task should not make you perform worse at the other task – in fact there probably is still a moderate amount of improvement simply from doing it again) this interaction term is rather difficult to achieve appropriate power for. We hope in the future to potentially add to this data set to get closer to a more appropriate sample size.

This is true for other potential moderators as well (such as gender) and their potential interactions as well. While we did control for some individual differences by

using the residuals from the regression process described earlier, we would still want to see how some of these moderating variables would impact our main effects.

We also understand that the differences in games for the shooting VR and controller conditions could also have a potential impact and that if a game in the future is designed and released that allows us to create the same shooting range experience both in VR and on a flat-screen, then these findings will need to be replicated to assess and compare (though the potential null effect of practice mode indicates this could also have no effect).

There are several other limitations we must address as well, notably that the timeframe of the study as a whole, and the practice sessions within it, were relatively short. Additionally, a colleague suggested that having participants have a "warm-up" period before the second testing session may have helped boost improvements. Another iteration (with more time and monetary funding) could use more sensitive testing as well, as opposed to hand measurements on sheets of paper or an office putting green. However, even with these "simple" approaches, we are encouraged to still find the results we have. One could easily try a replication, but having participants come out to a real shooting range and/or putting green as well, to see further the impact of these types of training on the skill in the real world. One could hypothesize that these results could either be more magnified in a non-laboratory setting or diminished.

With that said, the impact of the results at hand should not be understated. Our manipulation clearly showed that by having participants practice putting or shooting, even for short periods for around half a month, they improved on those tasks and gave higher ratings of self-efficacy. This is especially interesting, given that it seemed not to

matter *how* the participants practiced; it only matters that they practiced on the correct skill.

This finding, if replicated in future studies, carries quite a significant amount of value. It would demonstrate that using virtual means of training is almost, if not just, as good as practicing that task in a more material fashion. As noted before, plenty of research has been done on this, and the effects of "immersion" and how realistic the virtual training is will always affect the training as well, but perhaps not as much as initially anticipated.

One may ask why we found comparable improvement between the three modes of practice, and we believe that this harkens back to the idea of observational learning. While the VR and real-life conditions did offer tangible mechanical feedback based upon physical performance, the controller conditions mostly do not. However, what participants do have in the controller conditions is a modeling of correct and "good" mechanics being presented to them in the game. For instance, in the golf controller game, participants could see the golfer swing and note that the harder he swung, the faster and harder the ball would be hit. This also was accompanied by the bio-mechanical simulation of pulling the analog stick back and pushing it through, much like a real-life golf swing. Additionally, learning things like taking into account the wind, the slope of the greens, and how to stand while putting are all skills and strategies that can be very easily simulated or shown in a video game and then transferred to the real-world. This seems to be in-line with other classic performance findings that show that simply thinking about how to perform well at a task can help increase performance at that task.

Similarly, for the gun video games there is behavior being molded as well, one obvious example is how to hold the gun. While the games were in first person, they still presented “hands” holding the gun that the participants could see. If participants note that the avatar is holding the gun differently than they did in the first test, this could encourage them to change their grip to model after the grip presented to them in the game, which could improve their performance. Other behaviors such as reloading the gun are modeled as well in the game, even if just by an animation. After seeing this animation over and over again, participants may feel like they also know what reloading an actual gun looks like, especially because the games present themselves as realistic simulators. Additionally, in the *Gun Club VR*, participants had to reload the guns themselves after their clips ran out, and also had to cock the guns and take off the safeties when they started shooting. In *Battlefield 4* while players don’t necessarily do these things themselves, these animations are often presented.

This increase in reported self-efficacy is what to us is the most interesting finding of this experiment, as that seems to be much more malleable and able to be influenced by video game technology. Under Bandura's models of self-efficacy and observational learning, playing video games (both with controllers or in VR) would theoretically have huge impacts on player's self-perceptions to engage in similar tasks in real life. One might describe this, almost like watching sports on television and becoming an "armchair coach." This colloquial term refers to the idea that when people are highly invested sports fans, they tend to think they understand the operations of the game and of the coaching and management as well as the players/coaches/executives of the teams that they watch. While it's true that a person who watches hundreds of hours of a sport is undoubtedly

learning a lot about the game and has more knowledge than the everyday person or even a casual fan, there is almost no reason to believe that person could/should perform at a level similar to, or have any of the insights of, those participating at professional levels of the sport.

When a person engages in a virtual environment for hundreds of hours as well and sees similar behaviors and actions modeled over and over again, they most likely are to believe that they could actually partake in that behavior/skill in real-life and perform it reasonably well. As soon as this is true, people are much more likely to go out and engage in that task in real-life, as the aversion of failure is no longer as salient.

This seems to be a fairly intuitive finding as well, one that we collectively assume must happen. Due to the COVID-19 pandemic, the US Military has faced some issues finding new recruits. Recent news stories have begun to circulate that they have begun recruiting measures via online gaming communities, mostly through military-shooter games like *Call of Duty*. Initial reporting on this has shown that this is an effective strategy, and they have found success recruiting from these populations of very heavy gamers (Kesling, 2020). Based upon our findings this is rather unsurprising, as those who play these types of games probably have the confidence and willingness to join armed forces.

While we believe that this effect in virtual media is much more likely to manifest in innocent, productive, and positive ways, there are potentially more dangerous and harmful ramifications as well. This study showed that participants clearly showed higher rating self-efficacy after a few hours, which means that they would be more likely to use, or want to use, a gun if they spent that time practicing shooting. Again, we believe that

this effect is mostly harmless, but one can imagine a scenario where other risk factors for acting aggressively and violently may come into play (such as high exposure to violent media). A particular person may feel more capable and confident to use a weapon of some kind because of the modeling and "practice" they experienced in a virtual environment. To be clear, the risk of someone acting out violently comes from a plethora of risk factors, but increased efficacy on the use of violence certainly could play a potential factor.

Even though these results carry a lot of potential impacts both theoretically, practically, and even in industry, further studies need to be conducted. One possible mitigation to the concerns just raised would be that this study, in particular, used games and environments specifically meant to act as realistic simulations. They were not traditional video games in the sense of having a story, fantastical setting, or competitive mechanics. A replication could be done to assess similar effects but by using more "traditional" video game experiences. As well, while the means of testing participants were fairly life-like, they were not the actual activities themselves and not in their traditional environments. Seeing if these results hold with more sensitive and realistic testing is a necessary next step. Additionally, longitudinal follow-ups would be interesting to compose as well, as you could ask participants if they do indeed go out and participate in these tasks in the real world after participating in the study.

On our end with this data, we have a few different directions we hope to take. The first, and arguably most important, is to increase our sample size and power to test for potential moderators and interactions. Once we do so, we can paint a much clearer and more focused picture on the parameters of these effects, which can easily help foster

future studies and replications. Several additional analyses can be done as well, such as longitudinal modeling and looking at the data points we collected from each training session. We can also run models to see what relationships efficacy and performance have with each other, and whether they noticeably predict, moderate, or mediate, each other.

The impacts of this study are not merely limited to the effect we found, but also in the methods we used. We hope that our methodology helps encourage more "medium-length" longitudinal work, as well as helps create new avenues in which we can analyze those results. As a reminder, all of the materials, data, and syntax used will be publicly available in hopes to aid other researchers looking at similar effects or using similar methodology.

As more and more sensitive and robust technological equipment and virtual environments become readily available, we as scientists have an incredible opportunity to figure out how they are shaping our world, cognitive abilities, and behaviors. It cannot be overstated that we are hugely excited about these advancements in technology, as well as avid consumers of it (including video games!). With all of this excitement, however, needs to come a detailed and refined approach to looking at how technology is shaping our culture and our species. We believe that all aspects of the impact technology have on human behavior and cognition should be considered, and as good scientists, we should always be open to where the data takes us.

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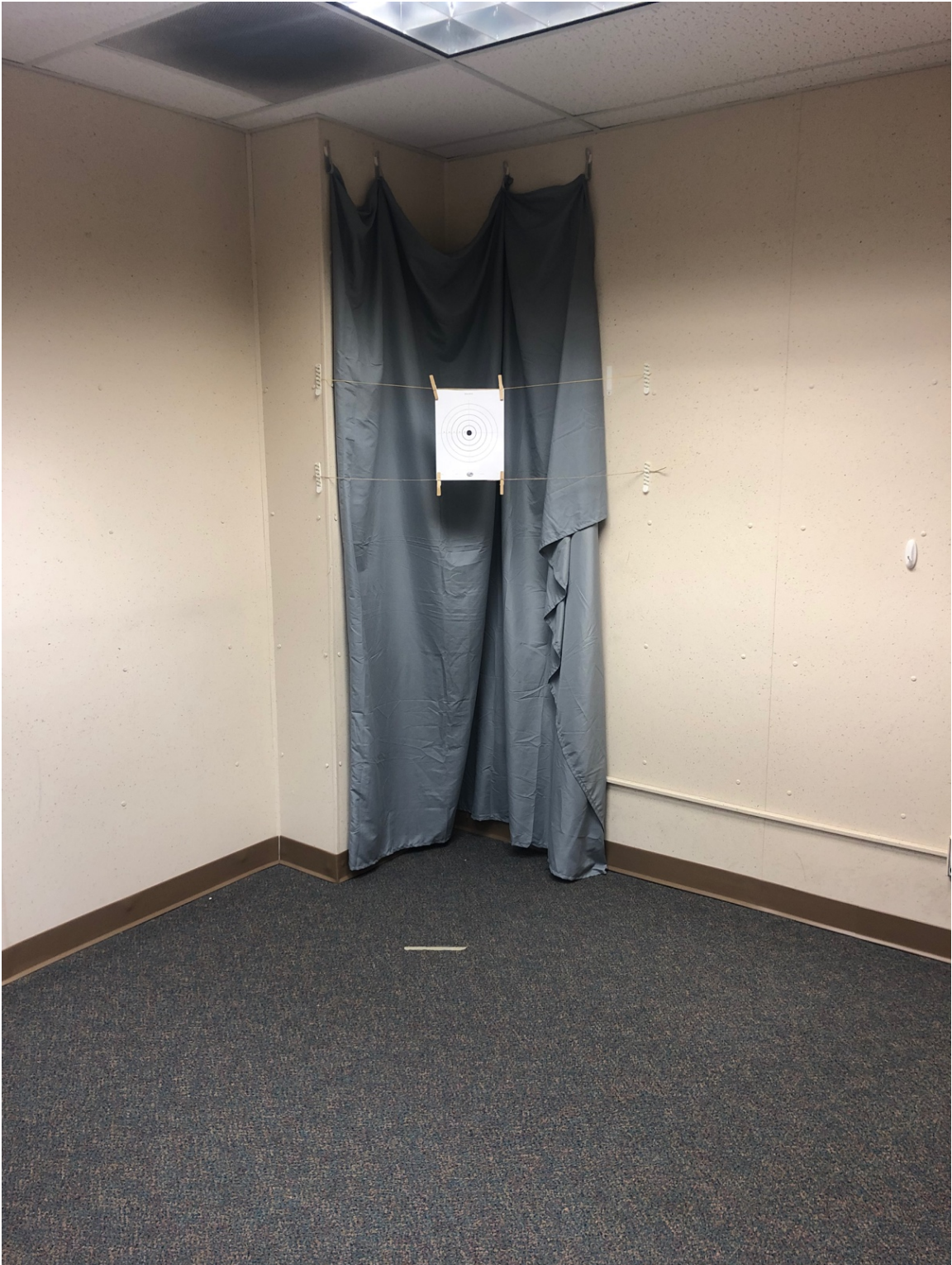
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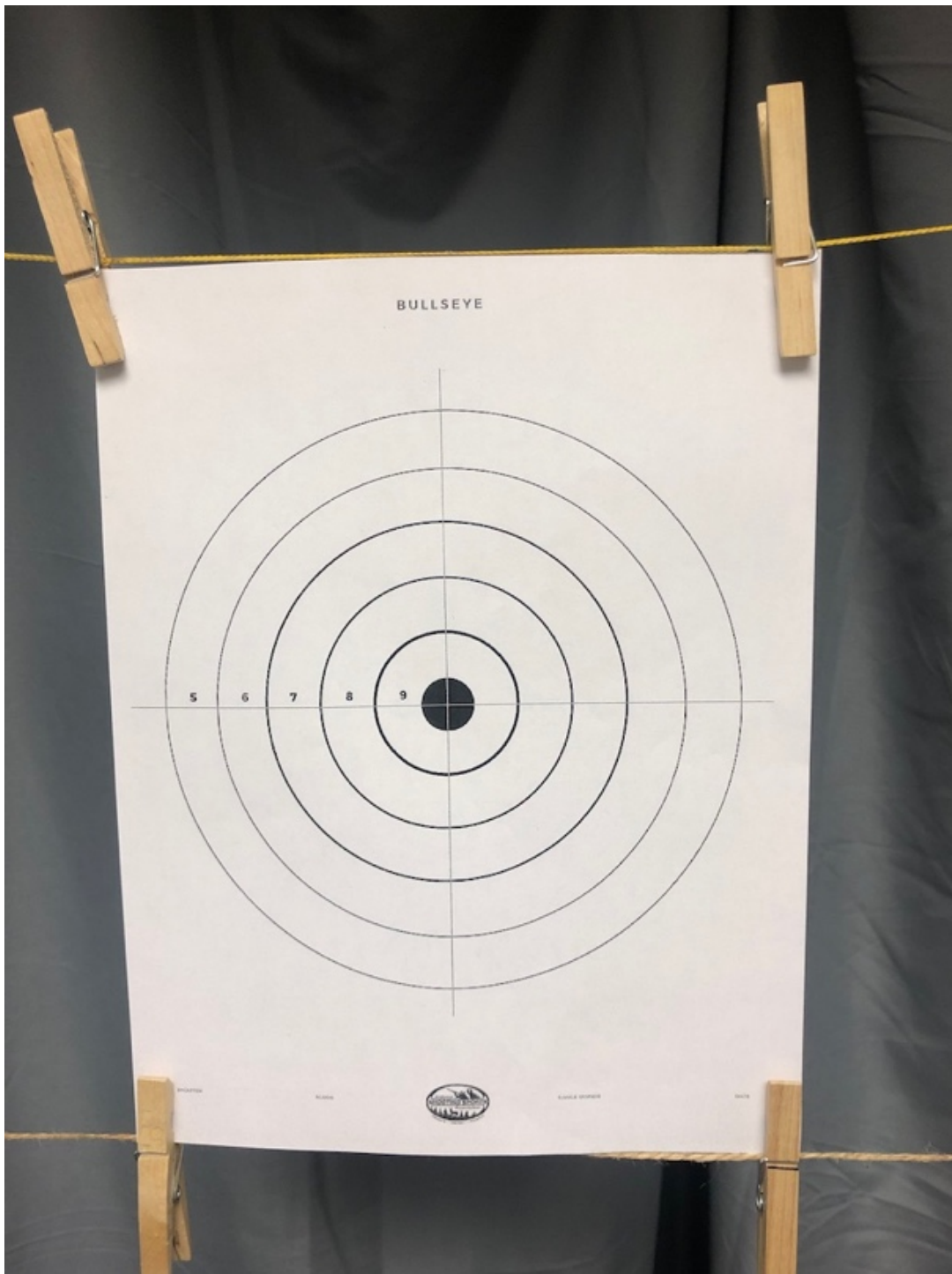
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APPENDIX A. PAPER TARGET DISTANCE

APPENDIX B. AIRSOFT GUN



APPENDIX C. PAPER TARGET

APPENDIX D. PUTTING MATT

*Note the end of the mat is slightly raised (as if a bump on a golf green)



APPENDIX E. SCREENSHOT FROM BATTLEFIELD 4

Participants select handgun and shoot at the stationary targets marked with the orange triangles.



APPENDIX F. SCREENSHOT FROM THE GUN CLUB VR



APPENDIX G. VIVE CONTROLLERS

APPENDIX H. THE EFFICACY OF SHOOTING BEHAVIORS SCALE

Please using the following scale to indicate the extent to which you agree or disagree with each of the subsequent statements. Write the number in the blanks in front of the statements.

-3	-2	-1	0	1	2
3					
Strongly Disagree			Neither agree nor disagree		Strongly Agree

- _____ 1. I could shoot an intruder with a real handgun if I needed to.
- _____ 2. I would feel bad about shooting at any living thing, especially a human being.
- _____ 3. I would try to kill an intruder with a gun if threatened.
- _____ 4. I have the ability to hold, aim, and fire a real handgun.
- _____ 5. I have the skills necessary to accurately shoot and kill another person.
- _____ 6. If needed, I would have no problem firing a gun at another person.
- _____ 7. Holding, aiming, and accurately firing a real handgun is easy to do.
- _____ 8. I would stop shooting at an intruder as soon as he/she tried to run away.
- _____ 9. I would stop shooting at an intruder once I hit him/her.
- _____ 10. I would stop shooting at an intruder if I missed him/her.
- _____ 11. I have the ability to shoot an intruder in the leg, rather than another body part.
- _____ 12. I would be successful at hitting targets at a shooting range.
- _____ 13. Firing a real weapon accurately would be too hard for me to do successfully.
- _____ 14. Thinking about a weapon makes me feel uncomfortable.
- _____ 15. If I had a gun when an intruder came into my home, I would fire "warning shots" to scare him/her away.
- _____ 16. Using a firearm to protect loved ones is acceptable to do if they are in danger.

____ 17. If more people kept guns at home for use against intruders, crime rates would drop a lot.

APPENDIX I. GOLF EFFICACY SCALE

Please using the following scale to indicate the extent to which you agree or disagree with each of the subsequent statements. Write the number in the blanks in front of the statements.

-3	-2	-1	0	1	2
3					
Strongly Disagree			Neither agree nor disagree		Strongly Agree

- _____ 1. I could putt with a real golf club if I needed to.
- _____ 2. I have the ability to hold, aim, and putt a real golf club.
- _____ 3. I have the skills necessary to accurately putt a golf ball
- _____ 4. If needed, I would have no problem putting a golf ball.
- _____ 6. I would enter a putting competition if given the opportunity.
- _____ 7. Holding, aiming, and accurately putting a real golf ball is easy to do.
- _____ 8. I have the ability to put the golf ball close to the hole.
- _____ 9. I would be successful at hitting targets at a putting green.
- _____ 10. Putting a real golf ball accurately would be too hard for me to do successfully.

APPENDIX J. PRE-TRAINING SURVEY

1. What types of extra-curricular activities do you participate in regularly? (*Mark all that apply.*)

- | | | |
|--|--------------------------------|---|
| <input type="checkbox"/> Team sports | <input type="checkbox"/> Music | <input type="checkbox"/> Church or religious activities |
| <input type="checkbox"/> Individual sports | <input type="checkbox"/> Drama | <input type="checkbox"/> Other |
- (Specify: _____)
- ☐ Clubs ☐ Part-time job

2. In the past year, about how many times have you attended church or religious services?

- | | | |
|--|---|--|
| <input type="checkbox"/> Never | <input type="checkbox"/> About once a month | <input type="checkbox"/> More than once a week |
| <input type="checkbox"/> Once or twice | <input type="checkbox"/> 2 or 3 times a month | |
| <input type="checkbox"/> Several times | <input type="checkbox"/> About once a week | |

3. Have you been in a physical fight in the past year? ☐ Yes ☐ No

4. What is your GPA (Grade Point Average)? (*If you are a freshman, please answer for your senior year of high school.*) _____

6. Are you: ☐ Male ☐ Female ☐ Other

7. How would you classify yourself?

- | | | | |
|---|--|--|--------------------------------|
| <input type="checkbox"/> African American | <input type="checkbox"/> Latino/Hispanic | <input type="checkbox"/> Native American | |
| <input type="checkbox"/> Asian/Pacific Islander | <input type="checkbox"/> Multi-Racial | <input type="checkbox"/> White | <input type="checkbox"/> Other |

(Specify: _____)

8. What is the highest level of education your mother (or stepmother) finished?

- | | | |
|---|---------------------------------------|--|
| <input type="checkbox"/> Some high school | <input type="checkbox"/> Some college | <input type="checkbox"/> Graduate or professional school |
| <input type="checkbox"/> High school | <input type="checkbox"/> College | <input type="checkbox"/> Don't know |

9. What is the highest level of education your father (or stepfather) finished?

- | | | |
|---|---------------------------------------|--|
| <input type="checkbox"/> Some high school | <input type="checkbox"/> Some college | <input type="checkbox"/> Graduate or professional school |
| <input type="checkbox"/> High school | <input type="checkbox"/> College | <input type="checkbox"/> Don't know |

10. What is your political affiliation?

- ☐ Republican ☐ Independent ☐ Don't Wish to Respond
☐ Democrat ☐ Other

11. Is English your native language? ☐ Yes ☐ No

Recall the home in which you lived the most years during elementary school. Then answer the following questions:

12. How many toilettes were in this home? _____

13. How many bedrooms were in this home? _____

14. Did your family rent this home? _____ (yes/no)

15. Have you ever fired a real gun before?

☐ Yes ☐ If yes, how often did you shoot?

week

☐ No

month

year

less

☐ About once a

☐ About once a

☐ A few times a

☐ Once a year or

16. Have you ever played Paint Ball before?

☐ Yes ☐ If yes, how often did you shoot?

week

☐ No

month

year

less

☐ About once a

☐ About once a

☐ A few times a

☐ Once a year or

17. Have you ever played airsoft, or bb gun, before?

☐ Yes ☐ If yes, how often did you shoot?

week

☐ No

month

year

less

☐ About once a

☐ About once a

☐ A few times a

☐ Once a year or

18. Have you played real golf before?

- ☐ Yes ☐ If yes, how often did you shoot? ☐ About once a
 week
☐ No ☐ About once a
 month
☐ A few times a
 year
☐ Once a year or
 less
19. Have you played mini-golf before?
- ☐ Yes ☐ If yes, how often did you shoot? ☐ About once a
 week
☐ No ☐ About once a
 month
☐ A few times a
 year
☐ Once a year or
 less

Please answer the following questions about your video game play

On a typical school day in the last calendar year (Monday through Friday), for how many hours do you **play video games** during each of the following times? (*Please write numbers in the spaces below.*)

6 am - Noon	Noon - 6 pm	6 pm - Midnight	Midnight - 6 am
_____ hours/day	_____ hours/day	_____ hours/day	_____
hours/day			

On a typical weekend day in the last calendar year (Saturday or Sunday), for how many hours do you **play video games** during each of the following times? (*Please write numbers in the spaces below.*)

6 am - Noon	Noon - 6 pm	6 pm - Midnight	Midnight - 6 am
_____ hours/day	_____ hours/day	_____ hours/day	_____ hours/day

APPENDIX K. AGGRESSIVENESS SCALE

The following questions ask about you perceive the world and the way you interact with other people. Please read each of the following items carefully. You can choose from 1 to 6 to indicate the degree to which you agree with the statement (1 = Totally disagree, 6 = Totally agree).

1. I have resentment towards people who have hurt me.
2. When things are not as I want, I get angry
3. My problems stress me
4. If someone attacks (physically/ verbally) me, I attack them back.
5. I never forget the hurt people have done to me.
6. I am aggressive under provocation.
7. My intimate partner makes me feel misunderstood.
8. I get desperate by my intimate partner's personality.
9. There are people I hate.
10. I get easily desperate.
11. When I am sad, everything bothers me.
12. I always remember people who have harmed me.
13. There are people who make me harm for pleasure.
14. I am a violent person when people deserve to.
15. There are people who are envious of me.
16. When someone behaves better as usual is because wants something from me
17. There are people who speak ill of me.
18. If someone shouts at me, I shout at them back.
19. When I argue with someone, I insult them.

- 20. I have hurt my intimate partner's feelings.
- 21. I have insulted people who have attacked (physically/ verbally) me.
- 22. When someone makes me angry, I tell them things to make them feel bad.
- 23. There are people who attack me (physically/ verbally) for no reason.
- 24. If someone hits me, I hit them back.
- 25. I always defend myself when somebody attacks (physically/ verbally) me.

APPENDIX L. POST- TRAINING SESSION SURVEYS

1. Please rate the game you played on the following dimensions using the scale below

1	2	3	4	5	6
	7	Not at all			
Extremely					

- _____ 1. How violent was this game?
- _____ 2. How bloody was this game?
- _____ 3. How fun was this game?
- _____ 4. How frustrating was this game?
- _____ 5. How exciting was this game to play?
- _____ 6. How fast paced was this game?
- _____ 7. How realistic looking were the characters in this game (if none, leave blank)?
- _____ 8. How realistic were the events that took place in this game?
- _____ 9. How realistic looking was the scenary in this game?
- _____ 10. Were there a lot of pauses in this game?
- _____ 11. How easy was it to use the video game controller?
- _____ 12. How frustrating was it to use the video game controller?
- _____ 13. How fun was it to use the video game controller?

(For all participants)

1. Since you were last in the lab, have you fired a real gun, a BB gBB, pellet gun, or paint ball gun?

- | | |
|---|--|
| <input type="checkbox"/> Yes <input type="checkbox"/> If yes, which one(s) did you fire (check all that apply)? | <input type="checkbox"/> Real gun
<input type="checkbox"/> BB gun
<input type="checkbox"/> Pellet gun
<input type="checkbox"/> Paint ball gun |
| <input type="checkbox"/> No | |

2. Since you were last in the lab, have you played golf?

- | | |
|---|---|
| <input type="checkbox"/> Yes <input type="checkbox"/> If yes, how many times? | <input type="checkbox"/> 1-2
<input type="checkbox"/> 3-4
<input type="checkbox"/> 5-6
<input type="checkbox"/> 7+ |
| <input type="checkbox"/> No | |

3. Since you were last in the lab, have you played video games?

- | | |
|---|------------------------------------|
| <input type="checkbox"/> Yes <input type="checkbox"/> If yes, how long? | <input type="checkbox"/> 1-5 hours |
|---|------------------------------------|

☐ No

☐ 5-10 hours

☐ 10-15 hours

☐ 15+ hours

For each of the following statements, please indicate how true it is for you, using the following scale (R means item is reversed scored):

How did you feel about the activity you just participated in?

1 2 3 4 5 6 7

not at all true-> somewhat true-> very true

Interest/Enjoyment

I enjoyed doing this activity very much

This activity was fun to do.

I thought this was a boring activity. (R)

This activity did not hold my attention at all.(R)

I would describe this activity as very interesting.

I thought this activity was quite enjoyable.

While I was doing this activity, I was thinking about how much I enjoyed it.

Perceived Competence

I think I am pretty good at this activity.

I think I did pretty well at this activity, compared to other students.

After working at this activity for a while, I felt pretty competent.

I am satisfied with my performance at this task.

I was pretty skilled at this activity.

This was an activity that I couldn't do very well. (R)

Effort/Importance

I put a lot of effort into this.

I didn't try very hard to do well at this activity. (R)

I tried very hard on this activity.

It was important to me to do well at this task.

I didn't put much energy into this. (R)

Pressure/Tension

I did not feel nervous at all while doing this. (R)

I felt very tense while doing this activity.

I was very relaxed in doing these. (R)

I was anxious while working on this task.

I felt pressured while doing these.

Perceived Choice

I believe I had some choice about doing this activity.

I felt like it was not my own choice to do this task. (R)

I didn't really have a choice about doing this task. (R)

I felt like I had to do this. (R)

I did this activity because I had no choice. (R)

I did this activity because I wanted to.

I did this activity because I had to. (R)

Value/Usefulness

I believe this activity could be of some value to me.

I think that doing this activity is useful for _____

I think this is important to do because it can _____

I would be willing to do this again because it has some value to me.

I think doing this activity could help me to _____

I believe doing this activity could be beneficial to me.

I think this is an important activity.

Relatedness

I felt really distant to this person. (R)

I really doubt that this person and I would ever be friends. (R)

I felt like I could really trust this person.

I'd like a chance to interact with this person more often.

I'd really prefer not to interact with this person in the future. (R)

I don't feel like I could really trust this person. (R)

It is likely that this person and I could become friends if we interacted a lot.

I feel close to this person.

APPENDIX M. INFORMED CONSENT FORM

Title of the Study: Does Practice Make Perfect

Investigators: Andreas Miles-Novelo. B.S., Craig A. Anderson, Ph.D. and Johnie Allen, M.S.MS. **Eligibility Requirements:** Participants must be 18 years old or older to participate. Those with a history of strong motion sickness or seizures are encouraged not to participate. Participants also must be comfortable with standing for 20-30-minute increments.

Introduction

This study examines how video games and virtual reality can make us better at certain sports skills. We are interested in learning more about how video games (both normal and in VR) VRn help people learn and become better these skills, in this case shooting a BB at a paper target and putting a golf ball. You are being invited to participate in this study because you are a student in Com. Studies 101, Psychology 101, 230, or 280.

Procedure

This study examines how video games and virtual reality can make us better at certain sports skills. We are interested in learning more about how video games (both normal and in VR) VRn help people learn and become better at certain tasks, in this case shooting an airsoft gun at a paper target and putting a golf ball. To complete this study, we will ask you to do the following things:

- Complete some questionnaires containing a number of questions about your beliefs, life experiences, and typical behaviors. If you are uncomfortable answering any of these questions, you may skip them; however, complete and honest responses are very valuable to our research, and your responses will remain confidential.
- Complete baseline measures of both target practice (using the airsoft gun) and putting (on a miniature golf green).
- Return to the lab on a semi-regular basis (2 times for 3 weeks, or 3 times for 2 weeks) to "practice" golf and/or shooting tasks
- Take a final measurement of the target practice and putting tasks.

CAUTION: The VR headset can cause some mild nausea and can potentially trigger seizures for those with a prior history of having them. If you are susceptible to motion sickness or seizures, we ask that you don't participate in this study.

Risks

You will be asked to complete several questionnaires, and some of the questions may be sensitive in nature. If you feel uncomfortable with the questionnaires, you can stop immediately with no penalty and you will receive credit for your time. Also, you may

skip any questions or tasks if you do not feel comfortable. The VR headset can cause some mild nausea and can potentially trigger seizures for those with a prior history of having them. If you are susceptible to motion sickness or seizures, we ask that you don't participate in this study. Participants should also be comfortable standing for 20-30 minute increments. We are using a plastic airsoft gun in lab. Participants and experimenters will be required to wear goggles when handling the airsoft gun, but any misuse can cause welts and/or bruising if you are hit (or hit someone else) at close range.

Benefits

You will receive first-hand knowledge of how psychological research is conducted, which will complement information from your psychology or communications class. It is hoped that the information gained in this study will benefit society by improving our understanding of people behavior and interactions.

Costs and Compensation

There will not be any costs to you for participating in this study, except for your time spent in answering. This study will occur over 6 session, each around 30 in length. You will receive 7 SONA credits for completing the full run of the study - 1 credit per session and an additional credit for completing the full study. **You will sign up for the first session via SONA and then we will manually schedule your remaining sessions.** If for any reason you must cancel or reschedule a session, contact Andreas Miles-Novelo at andreasm@iastate.edu. Please keep in mind that alternative ways to receive course credit are available within each of these classes: Com. Studies 101, Psychology 101, 230, and 280) please consult your syllabus.

Participant Rights

Your participation in this study is completely voluntary and you may refuse to participate or leave the study at any time. If you decide to leave the study, it will not result in any penalty or loss of benefits to which you are otherwise entitled.

Research Injury

Please tell the researchers if you believe you have any injuries caused by your participation in the study. The researchers may be able to assist you with locating emergency treatment, if appropriate, but you or your insurance company will be responsible for the cost. Eligible Iowa State University students may obtain treatment from the Thielen Student Health Center. By agreeing to participate in the study, you do not give up your right to seek payment if you are harmed as a result of being in this study. However, claims for payment sought from the University will only be paid to the extent permitted by Iowa law, including the Iowa Tort Claims Act (Iowa Code Chapter 669).

Confidentiality

Records identifying participants will be kept confidential to the extent permitted by applicable laws and regulations and will not be made publicly available. However, federal government regulatory agencies, auditing departments of Iowa State University, and the Institutional Review Board (a committee that reviews and approves human subject research studies) may inspect and/or copy study records for quality assurance and

data analysis. These records may contain private information. ISU IRB: 18-408-00
 Approved Date: 01/29/2019 Expiration Date: N/A To ensure confidentiality to the extent permitted by law, identifying information will not be collected. The only identifying information that will be collected are participants' emails, and these will only be used during your time participating in the study (to link data across session), after which your data will be de-identified so as no one will know your identity. Initially, only the research team will have access to collected data, which will be stored in password-protected electronic databases or on password-protected computers. We are working with an additional team on this project not from ISU and they too will only see the de-identified data. If the results are published, de-identified data may be shared with other researchers in the future for additional research or verification of our findings, or scientific open-access sites, but your identity will remain confidential because no identifiable information will be collected.

Questions or Problems

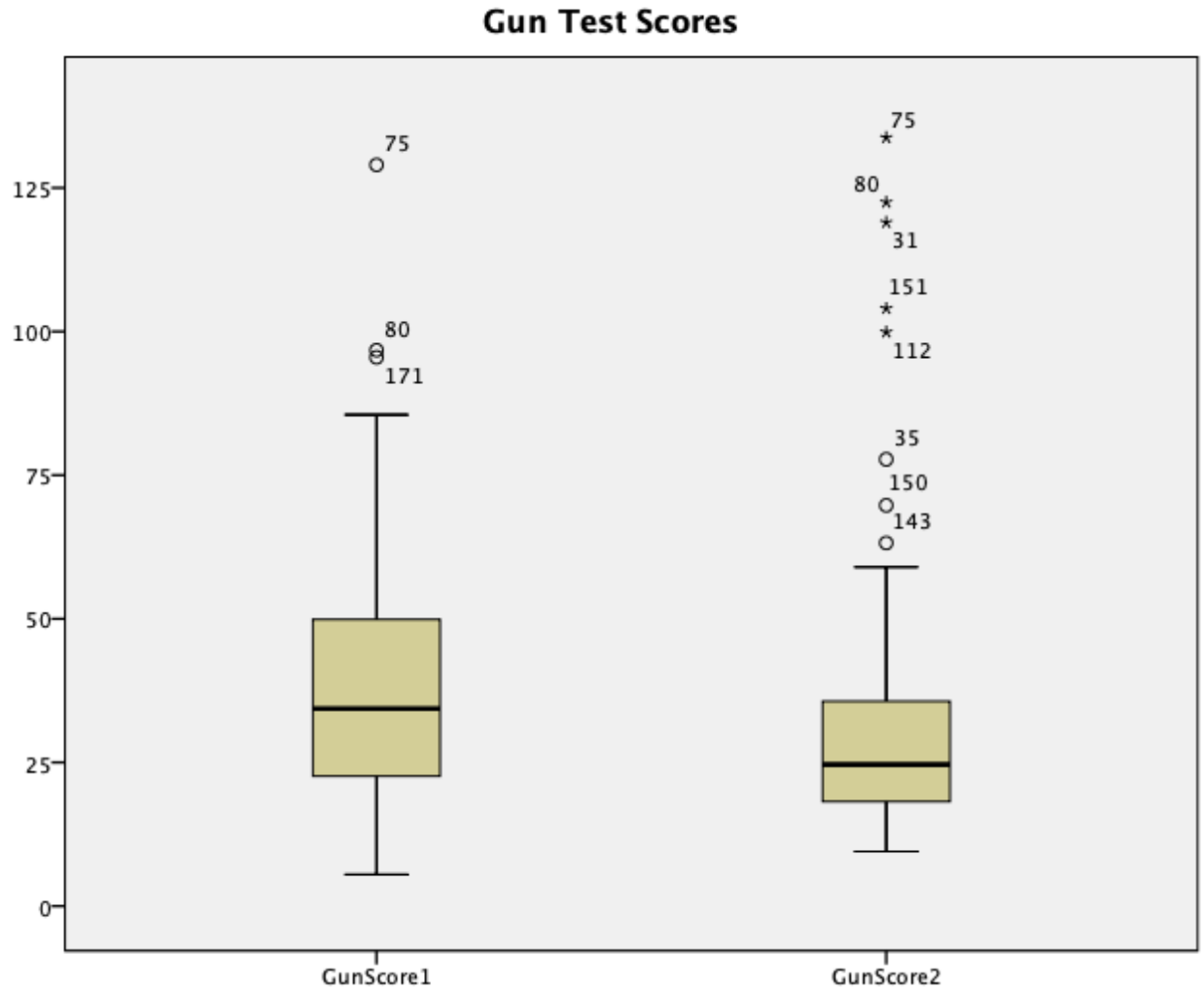
You are encouraged to ask questions at any time during this study. For further information about the study, contact Andreas Miles- Novelo at andreasm@iastate.edu or Dr. Craig A. Anderson at caa@iastate.edu. If you have any questions about the rights of research participants or research-related injury, please contact the IRB administrator at 515-294-4566, 515-294-4215, or irb@iastate.edu.

You may or may not choose to participate in this study. If you choose to participate, please read the following statement and acknowledge your voluntary consent by clicking "I agree."

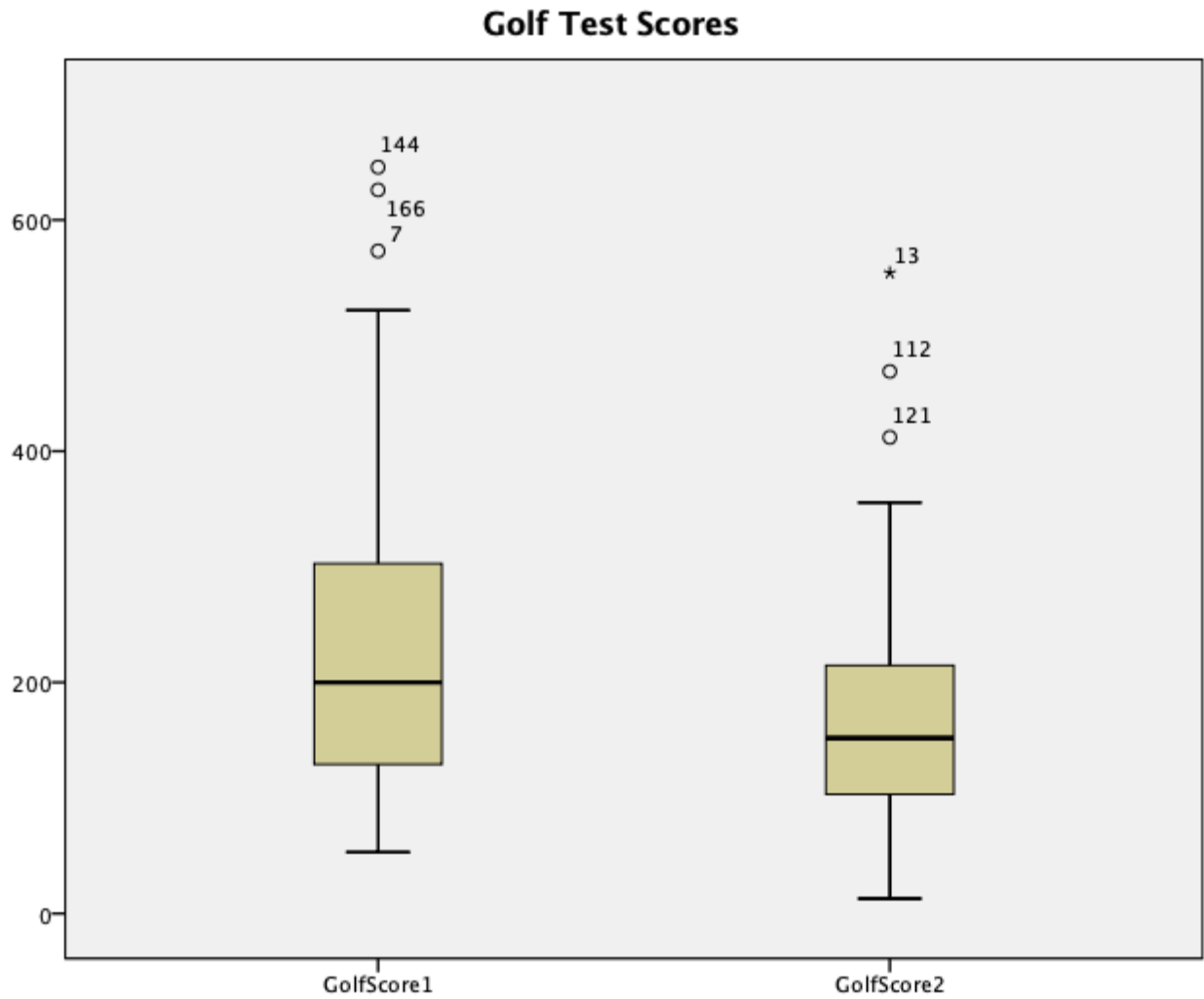
I hereby consent to my participation in this study. I have been informed and understand the purposes and procedures of this study that can be divulged to be in advance. I understand that my participation is completely voluntary and that I am free to withdraw consent and discontinue participation at any time without losing credit. I agree to participate in this study as described above.

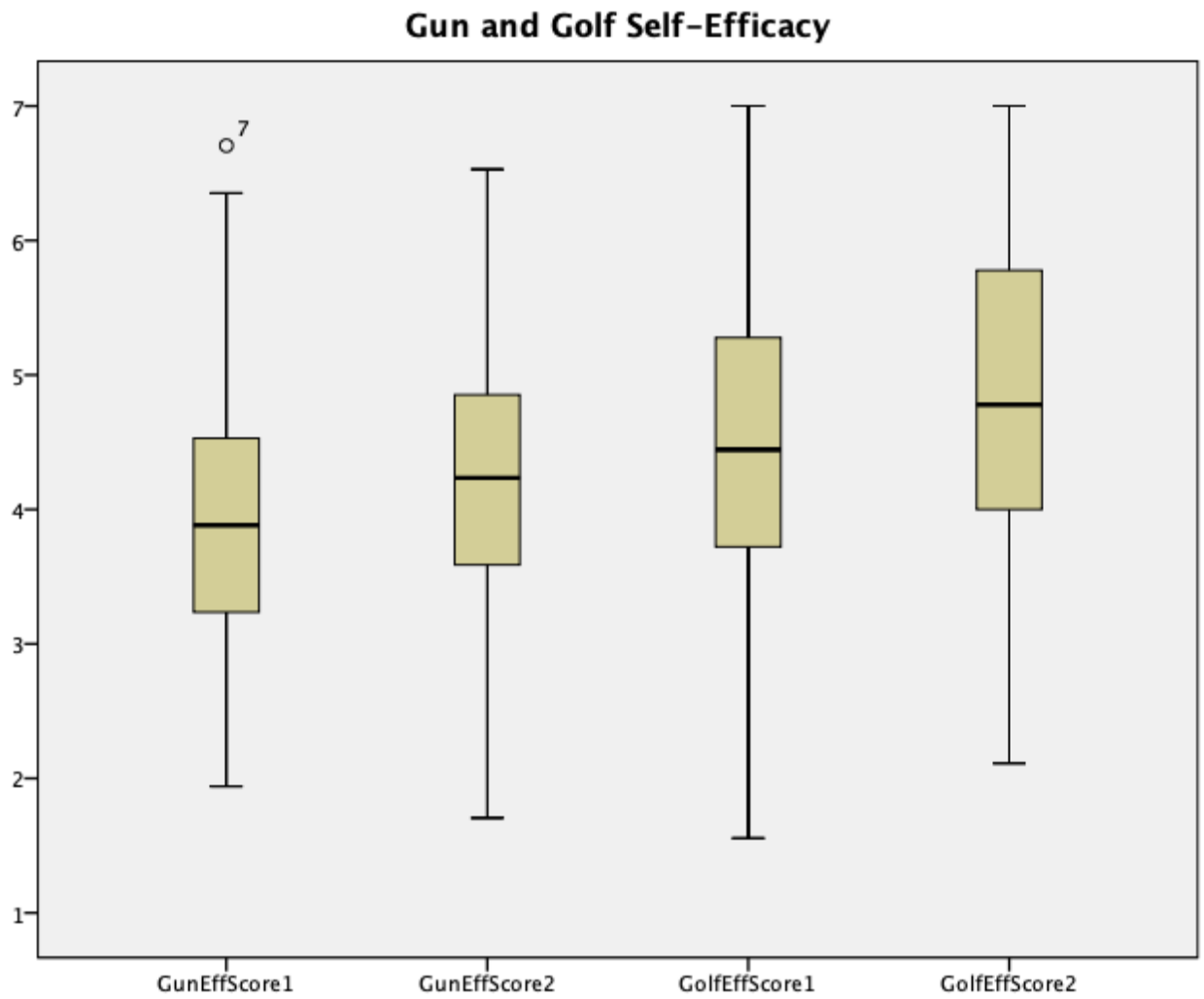
☐ I agree

Date _____

APPENDIX N. GUN TEST SCORES BOXPLOTS

Numbers in graph are case numbers for participants

APPENDIX O. GOLF TEST SCORES BOXPLOTS

APPENDIX P. GUN AND GOLF EFFICACY SCORES BOXPLOTS

APPENDIX Q. IRB APPROVAL

Note: The name of the study changed to “Does Practice Make Perfect?” after some initial issues in recruitment.

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Institutional Review Board
Office for Responsible Research
Vice President for Research
2420 Lincoln Way, Suite 202
Ames, Iowa 50014
515 294-4566

Date: 11/12/2019

To: Andreas Miles-Novelo Craig Anderson, PhD

From: Office for Responsible Research

Title: The Effects of Video Game and Nongame Practice on Sports Skills

IRB ID: 18-408

Submission Type: Modification **Review Type:** Expedited

Approval Date: 11/12/2019 **Approval Expiration Date:** N/A

The project referenced above has received approval from the Institutional Review Board (IRB) at Iowa State University according to the dates shown above. Please refer to the IRB ID number shown above in all correspondence regarding this study.

To ensure compliance with federal regulations (45 CFR 46 & 21 CFR 56), please be sure to:

- **Use only the approved study materials** in your research, including the **recruitment materials and informed consent documents that have the IRB approval stamp**.
- **Retain signed informed consent documents** for 3 years after the close of the study, when documented consent is required.
- **Obtain IRB approval prior to implementing any changes** to the study or study materials.
- **Promptly inform the IRB of any addition of or change in federal funding for this study.** Approval of the protocol referenced above applies only to funding sources that are specifically identified in the corresponding IRB application.
- **Inform the IRB if the Principal Investigator and/or Supervising Investigator end their role or involvement with the project** with sufficient time to allow an alternate PI/Supervising Investigator to assume oversight responsibility. Projects must have an eligible PI to remain open.
- **Immediately inform the IRB of (1) all serious and/or unexpected adverse experiences** involving risks to subjects or others; and (2) **any other unanticipated problems involving risks** to subjects or others.
- IRB approval means that you have met the requirements of federal regulations and ISU policies governing human subjects research. **Approval from other entities may also be needed.** For example, access to data from private records (e.g., student, medical, or employment records, etc.) that are protected by FERPA, HIPAA, or other confidentiality policies requires permission from the holders of

those records. Similarly, for research conducted in institutions other than ISU (e.g., schools, other colleges or universities, medical facilities, companies, etc.), investigators must obtain permission from the institution(s) as required by their policies. **IRB approval in no way implies or guarantees that permission from these other entities will be granted.**

- Your research study may be subject to [post-approval monitoring](#) by Iowa State University's Office for Responsible Research. In some cases, it may also be subject to formal audit or inspection by federal agencies and study sponsors.
- Upon completion of the project, transfer of IRB oversight to another IRB, or departure of the PI and/or Supervising Investigator, please initiate a Project Closure to officially close the project. For information on instances when a study may be closed, please refer to the [IRB Study Closure Policy](#).

If your study requires continuing review, indicated by a specific Approval Expiration Date above, you should:

- **Stop all human subjects research activity if IRB approval lapses**, unless continuation is necessary to prevent harm to research participants. Human subjects research activity can resume once IRB approval is re-established.
- **Submit an application for Continuing Review** at least three to four weeks prior to the **Approval Expiration Date** as noted above to provide sufficient time for the IRB to review and approve continuation of the study. We will send a courtesy reminder as this date approaches.

Please don't hesitate to contact us if you have questions or concerns at 515-294-4566 or IRB@iastate.edu.