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Investigating The Effects Of Simulation On Transfer In A High Risk Confrontational Setting

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INVESTIGATING THE EFFECTS OF SIMULATION ON TRANSFER IN A HIGH RISK CONFRONTATIONAL SETTING

by

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ABSTRACT

Individuals, who work in high risk confrontational (HRC) settings in which a conflict exists, experience high-stress levels in their jobs and are known to have a high level of decreased performance and decreased survival. Individuals being trained to handle such conflicts should be trained effectively to accomplish the ultimate objective, staying alive. The problem is the lack of research and program evaluations examining effectiveness of training simulations in the transfer of skills under HRC settings. The purpose of my study was to test if the skill of target acquisition could be effectively transferred to a real environment (RE) after exposure within a virtual environment (VE). Ackerman's (1988) Theory of Ability Determinants of Skill Acquisition supports the progression participants advance through in the transfer of learning. A randomized posttest only comparison group design was used.

The population involved 24 novice paintball players. Participants were randomly assigned to a simulation treatment or a non-simulation comparison application. Two days after receiving the intervention, participants engaged in live practice sessions (game 1 and game 2) in a RE where target acquisition skills were measured. Evidence suggests significant differences were found between novice players in the type of intervention received and the number of targets acquired in a RE, whereas, no significant change in scores was found between practice sessions, and no interaction was found between intervention received and practice. Recommendations for replicating studies include: (a) focusing on the manipulation of specific variables within the training context, (b) using different live environments, (c) examining factors that influence teaming and strategy formation, and (d) combining experts and novice players for a closer representation of a population in an HRC setting.

This dissertation is dedicated to my family and closest friends who have supported me throughout this accomplishment.

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LIST OF ABBREVIATIONS/ACRONYMS

Acronym	Term
2D	Two-Dimension
3D	Three-Dimension
ANOVA	Analysis of the Variance
DDM	Dynamic Decision Making
DMV	Department of Motor Vehicles
DOD	Department of Defense
DV	Dependent Variable
EID	Ecological Interface Design
FLECT	Federal Law Enforcement Training Center
FOV	Field of View
HMD	Head-Mounted Display
HRC	High-Risk Confrontational
ID	Instructional Design
IV	Independent Variable
MR	Mixed Reality
RE	Real Environment
RV	Reality-Virtuality

VE	Virtual Environment
VR	Virtual Reality
WMD	Weapons of Mass Destruction

CHAPTER ONE: INTRODUCTION

Military and law enforcement personnel are exposed to high risk confrontational (HRC) settings in which dynamic and stressful conditions often exist. The literature about training individuals to correctly handle these dynamic environments is limited. Documented examples of training methods being used for HRC settings involve the Federal Law Enforcement Training Center (FLECT) that conducted a two year research project in which a stressful scenario was played out in a simulated realistic environment. This environment was designed to optimize officer responses under specific stressful conditions (Atkins & Norris, 2004). Other examples include the military in the use of simulated exercises, regional training exercises, and models and simulations for understanding and dealing with Weapons of Mass Destruction (WMD) and other highly stressful events (Department of Defense, 1998).

For my study, an HRC setting is defined as any job or task requiring an individual to place oneself in a life-threatening confrontation with an element or person. As previously mentioned, there is a scarcity of research focused on HRC settings and specifically on the transfer of learning of a skill based task using simulation. This scarcity may be due to the costly nature of running HRC events and the difficulty in creating all possible dynamic situations. In addition, research conducted under stressful situations is broadly categorized to examine physiological responses, team dynamics, and decision making and not focused so much on skill acquisition. However, within the literature, simulations seem to be a common approach for those organizations, communities, and industries responsible for training difficult and complex tasks. Examples include the medical industry for managing surgical complications or aviation community in learning how to handle aircraft system malfunctions.

Simulations typically combine simulators with actual operational equipment, prototypes of future systems, and realistic representations of environments. Simulations provide a means to replicate job situations/scenarios so that individuals can increase their knowledge and skills through practice in a safe environment.

Although simulations have been praised for their training effectiveness (Paul, Fleig, & Jannin, 2005), some studies report little to no benefits of using simulation to facilitate learning. Lack of empirical support is particularly apparent in simulations developed to supplement the training of individuals who work in HRC settings. For example, the Department of Defense (DOD) study, *Department of Defense Plan for Integrating National Guard and Reserve Component Support for Response to Attacks Using Weapons of Mass Destruction*, (1998), report that a gap exists between battlefield skills training for first responders and the unique response skills training required for civilian first responders. Both replicate HRC settings found in WMD terrorist attacks.

Another troubling discovery, noted by Atkins and Norris (2004) in the FLECT study, indicates that law enforcement officers, when experiencing high-stress levels, also exhibited decreased performance that compromised survival. Individuals being trained to handle life-threatening conflicts should, at a minimum, master the ultimate objective, staying alive. The findings by Atkins and Norris recognized that training programs currently in place need to be revised or enhanced to improve the survival rate of those in HRC settings. It is these types of gaps in simulated training systems that were the impetus for my study.

The problem addressed by my study contributes to the body of research by examining the effectiveness of the use of training simulations in the transfer of skills in HRC settings. Two primary reasons for the current lack in empirical findings are: (a) the cost associated with adequately duplicating all of the dynamic situations that are found in HRC settings, and subjectively, (b) the narrow focus of most simulations to a specific objective supporting a finite set of conceivable options with a finite set of reactions (Cloud & Rainer, 1998). In addition, as noted by Cloud and Rainey, even though providing dynamic interactions within a simulation creates a more typical real-world setting, these interactions are still limited by the model constructed of system behavior. A definitive answer about the effectiveness of HRC simulations is tied to the needed creation for more robust simulation models.

Purpose

The purpose of my study is to test if the skill of target acquisition can be transferred to a real environment (RE) after exposure within a virtual environment (VE). The proposed VE intervention being used is a desktop computer-based paintball game referred to as the "simulation treatment." To determine if the VE had an actual effect on transfer, a second intervention is being implemented to enhance one's knowledge of target acquisition, a paper-based text with graphics on shooting fundamentals referred to as the "non-simulation comparison application."

Research Question and Hypothesis

My study presents one question: can a VE be effectively used to train individuals to perform better in the RE? Through pre-exposure in a VE, one may quickly realize that paintball is a dynamic situation. Being able to find an opponent, aim, and then shoot is only one aspect to increasing one's score in target acquisition. Another factor in increased target acquisition performance is managing the dynamics of the game. Dynamics are defined as settings in which outcomes may not be the same even though the same actions were taken. To effectively manage under HRC conditions an individual must be able to quickly assess a dynamic situation (as an expert would exhibit), make a determination of corrective action, and have superior performance in carrying out that action.

The focus for my study is to investigate if there is increased performance in target acquisition for novices who are exposed to a simulation treatment prior to performing in a RE as opposed to novices who are exposed to a non-simulated comparison application. To help answer the research question, the following hypothesis will be tested:

Ho1: There is no significant difference in target acquisition scores for individuals who received the simulation treatment and those who received the non-simulation comparison application while performing in an HRC real environment.

Ho2: There is no significant change in target acquisition scores from game 1 to game 2 based on practice for individuals performing in an HRC real environment.

Ho3: There is no interaction between type of intervention received and practice in an HRC real environment.

Operational Definitions

An *Interaction Effect* is measured by looking at the relationship or effect any independent variable (IV) may have on the dependent variable (DV). For my study, the IV is the type of intervention received, the simulation or non-simulation comparison application, and the DV is the target acquisition scores acquired in the RE.

A *Non-Simulated* environment can contain static information, such as printed text, to provide knowledge to a learner. For my study, the non-simulated training media is an eight page copy of Chapter 6, “Shooting Fundamentals”, from the Basics of Pistol Shooting by the National Rifle Association (1991). Shooting fundamentals are the baseline guidance for proper pistol application to acquire a target.

A *Real Environment* consists of using actual objects and being physically present in the environment. The RE for my study is an outdoor paintball playing field. Participant’s performance is being measured as to the number of opponents hit during live game play and the amount of time on the playing field.

Target Acquisition is calculated as the number of actual hits on opposing participants based upon the amount of time the participant lasts within the live game. The formula is Time on Field (converted to seconds) / Number of Opponents Hit = Target Acquisition Score. The lower the participant’s score the higher a participant ranks in target acquisition. For example, if a participant hits two opponents in 46 seconds prior to being hit, they will have a ranking of 23. If another participant hits 4 opponents but survives for 154 seconds prior to being hit, they will have a ranking of 39. This formula is designed to help rank participants for analysis purposes only and is not suggesting that the lower ranking participant actually performed better or was more efficient. There are too many variables to take into account to make this determination, such as hiding for a longer period of time or using a spray technique opposed to strategic shooting.

To account for a closer approximation of actual hit time, the game is observable and monitored by a paintball field referee. The referee ensures participants who have been hit leave the field immediately; leaving fewer participants on the field over time. Each participant is paired with their score of targets acquired (a verbal report by the participant of the number of targets acquired when leaving the field) with the time recorded on video footage from the 2 live practice sessions (Game 1 and Game 2).

A *Virtual Environment* can consist of a partially or totally based computer-generated sensory and inputs. For my study, the VE uses a desktop computer to play a simulated game of paintball that contains computer-simulated objects. Interaction with the environment occurs through common computer peripherals to include a monitor, keyboard, and mouse.

Overview of Research Design

To test the hypothesis, a posttest-only randomized comparison group research design is used. The research design is based on random assignment that eliminates any potential bias that could result from grouping participants. The simulation treatment participants (Group A) are assigned to practice with a desktop computer-based paintball game prior to participating in the RE, the live game of paintball. The non-simulation comparison application participants (Group B) receive the paper-based text with graphics on shooting fundamentals prior to participating in the RE. Once at the paintball facility, all participants are then randomly assigned to Team 1 or Team 2 and are given the opportunity to play two live practice sessions of paintball (games 1 and 2) with a one hour break in-between.

Population and Sample Size

Participants are drawn from the population of candidates in a major research center located in the southeast region of Florida. A total of 32 voluntary participants, over the age of 18, are required for my study. Participants consist of a stratified sample of individuals that are novices at playing live games of paintball, airsoft guns, or laser tag. All participants are treated in accordance with the American Psychological Association's Ethics in Research with Human Participants (1992).

Intervention and Instruments

Two intervention levels are used in my study. The first intervention is used to determine if prior exposure to the VE has a positive effect on target acquisition, the simulated desktop computer-based paintball game. The simulation device consists of five desktop computers with access to the PC game. The simulation helps to emulate a group game of paintball for practice purposes. The second intervention, the non-simulated paper-based text with graphics on shooting fundamentals for target acquisition, is used for comparison and interaction effects.

Instruments consist of a Classification Matrix (Appendix D, page 83), provided as an initial requirement to participate, a Reaction Questionnaire Training Methods (Appendix G, page 90) form, administered after the intervention is received, and a Reaction Questionnaire Live Play (Appendix H, page 92) form, administered after the second live game play in the RE.

Variables and Data Analysis

The DV consists of a score based on time on the field and number of opponents hit during practice sessions within the RE. The IVs are the simulation treatment and the non-simulation comparison application. Fifty percent of the participants (Group A) are trained with the simulation prior to actual live play in the RE. The other fifty percent (Group B) are trained using the non-simulated material. Once at the paintball facility, all participants are again randomly assigned to two teams to participate in the live practice sessions.

Data analysis consists of conducting a one-way repeated-measures Analysis of the Variance (ANOVA) with one between-subjects factor. Target acquisition is classified as interval parametric data in which differences between the two groups (Team 1 and Team 2) are measured. In addition, a covariate is used to determine if there is an interaction between the interventions, and practice scores.

Overview of Theoretical Foundation

Ackerman's (1988) Theory of Ability Determinants of Skill Acquisition is adopted as the theoretical foundation for my study. The focus is to determine if a VE can aid in the transfer of a skill to a RE, namely to an HRC setting. Ackerman's (1992) study, in which his own theory of Ability Determinants of Skill Acquisition is used, investigated transfer of learning for skill acquisition of air-traffic controllers using a simulated desktop computer-based radar screen. The task of learning from a desktop computer was appropriate for his study because the air-traffic controller task met the needs defined by Ackerman as being complex in nature, having inconsistent information processing, yet contained substantial overlap to the real-world. My study is similar to this in two respects. First, a desktop computer-based simulation is used as the VE. Second, the task of target acquisition is complex and dynamic where initiating cues and consequences of actions vary extensively, and finally, the task can be replicated with sufficient fidelity to overlap with real-world experience.

Ackerman (1992) explains that there are three phases in the transfer of learning for skill acquisition: (a) cognitive, (b) associative, and (c) autonomous. Collectively these three levels define a cognitive process that distinguishes a novice from an expert. The phases of the process build upon one another to the point that skill-based behavior eventually becomes automated in response to complex environmental stimuli, as can be found in HRC settings. Figure 1 provides a graphic representation of this theoretical framework including the relationship of the 3 phase cognitive process to the IV and the DV measures of my study.

As shown in Figure 1, the initial cognitive phase, typical of novice behavior, is focused on formulating concepts and developing procedural skill, such as attention to semantics for verbal information related to the text-based description or spatial orientation for maneuvering within the simulated game. During the associative phase basic skill and knowledge become engrained. There is less deliberate cognitive focus and more of an emphasis on increasing speed and accuracy through practice. With continued practice, the novice moves toward mastery, or the autonomous phase exemplified by expert behavior. In this phase actions are automatic and the focus is on refining psychomotor responses.

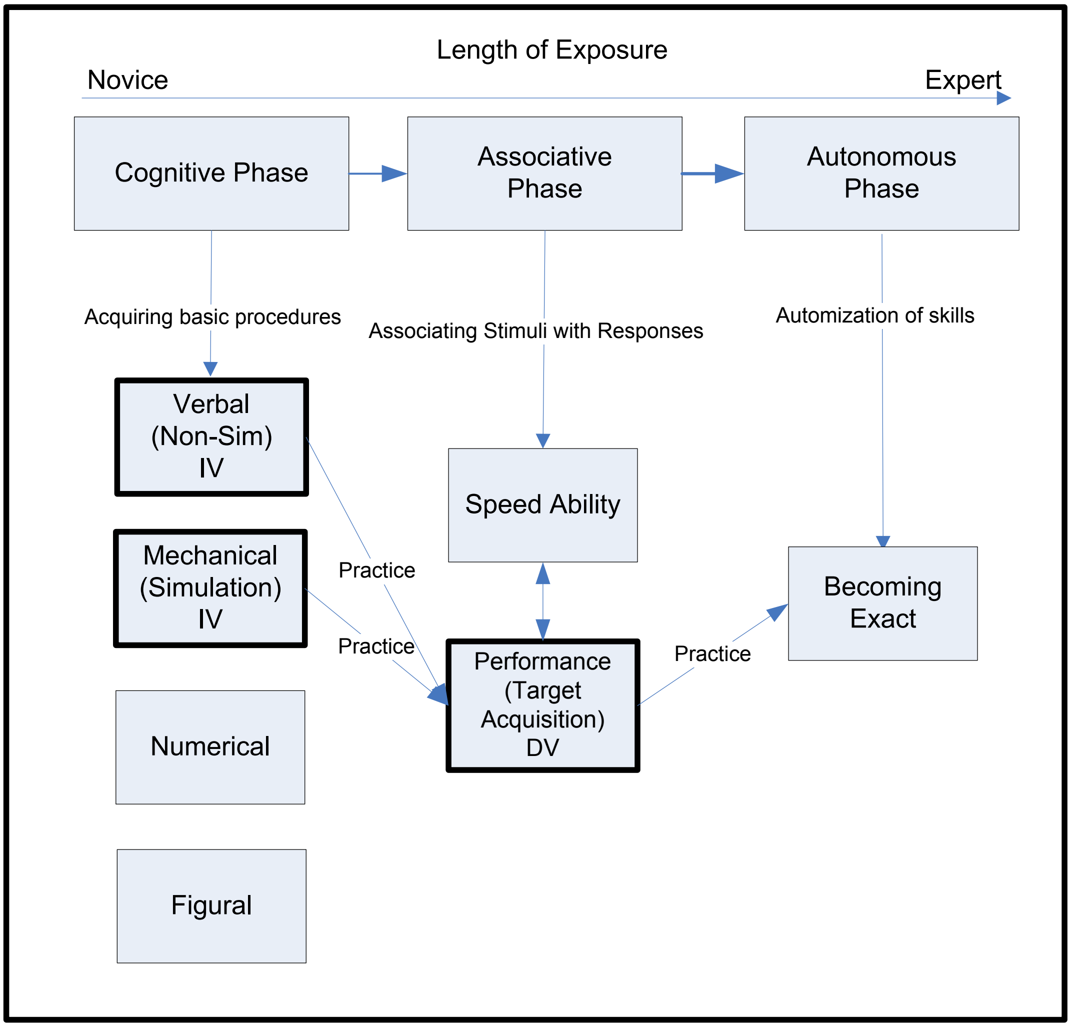


Figure 1. Theoretical framework and study measures.

Based upon Figure 1, the skill of target acquisition for my study begins at the cognitive phase where the task of finding, aiming, and shooting are introduced with written information (Verbal – Non-Sim) or in a computer-based format (Mechanical – Simulation). Because participants are novice players, there will be a high cognitive demand once in the RE. With practice, a transition to the associative phase of increased speed and performance begins where the participant actually begins to hit their intended "target" (Performance – Target Acquisition).

It is anticipated that some participants will not experience the associative phase due to the limited amount of exposure to the RE. Therefore, if there is no improvement in a participant's score from the first measure to the second measure, then the participant is considered to still be in the cognitive phase.

Another explanation for participants remaining in the cognitive phase is based on what Ackerman (1992) suggests; tasks that have inconsistencies require greater attentional resources and do not become easier over time. Therefore, these tasks remain in the cognitive phase and do not transition over to the associative phase because they remain attention dependent. The moving target (the opponent) introduces a source of inconsistency in my study. The opponent can make various decisions to hide, not hide, fire back, or rush an opposing participant, which adds to the complexity of the target acquisition task.

That is not to say that participants cannot increase their skill when dealing with moving targets. Virtual environments are being used to increase skill and ability in target acquisition through training transfer (Jacobellis, 2007). Jacobolleis believes that a realistic way to improve tactical capabilities is to continually train with nonlethal simulated munitions, such as paintball and airsoft guns, in force-on-force training scenarios.

Overview of Empirical Evidence

Four areas of research provide the empirical foundation for my study. These areas include: (a) the real environment of live paintball, (b) the virtual environment for training, (c) the key concepts and elements of the transfer of learning, and, (d) target acquisition research and measurement. The four areas are relevant to my study in the following ways. First, the RE is represented by a live paintball setting. Second, although research on the use of live paintball as a method for teaching is limited, there is evidence to show that live paintball can play a major role in creating a sense of realism (Correll et al., 2007; Gordon, 2005; Jacobellis, 2007; Schnirring, 2006; Smith, 2003).

The VE in my study is represented in a desktop computer-based paintball game. Studies that focus on a comparison of a VE to a RE training method have been limited. But studies that compare a desktop computer to other simulated environments (e.g., a head mounted display (HMD) or fully-immersive CAVE environment with 10 foot walls and an HMD) have shown that the use of desktop computers as virtual environments lead to effective transfer (Loftin, Scerbo, McKenzie, & Catanzaro, 2004; Moreno & Mayer, 2004).

Transfer of learning is represented in my study in three dimensions including: (a) positive and negative transfer, (b) simple to complex transfer, and (c) the occurrence of near and far transfer of why transfer may or may not occur. These dimensions are further explained in chapter two and describe relationships to my study. In addition, the three phase cognitive process discussed earlier, although relevant to my study, is not demonstrated due to the lack of exposure and practice time in the VE and the RE. These cognitive elements that aid in the transfer of learning are also in alignment with Akerman's (1992) study, to include; (a) cognition, (b) situativity, and (c) automaticity. More details are also provided in chapter two.

Target acquisition is represented in my study by the number of paintball hits achieved in the RE and the amount of time in live play prior to being hit. One of the few articles found on the use of ammunition and delivery of fire was presented by Fresenko (2002). In this article, Fresenko (2002) supplied the definition of target acquisition as the relationship between ammunition consumption and the degree of damage. For purposes of my study, the degree of damage is measured by the number of opponents hit. In lieu of ammunition consumption, a standard mathematical formula, endorsed by a NRA Certified Pistol Instructor, (Dwyer, 2008), provides a ranked scoring method (i.e., Time on Field (converted to seconds) / Number of Opponents Hit = Target Acquisition Score).

Significance

Practitioners, instructional technologist, and research communities can benefit from this study. Practitioners will be particularly interested in methods that facilitate the transfer of learning through effective VE instruction. Practitioners who are classroom focused and currently apply paper-based, non-simulated instruction on a daily basis, will have more concrete evidence of the value of VE versus more traditional methods of instruction. For example, the VE replication of a science process (Smurall & Curry, 2006), has been shown to enhance the transfer of skills and knowledge from a classroom to a RE. Similarly, practitioners have also expressed an interest in the application of games to aid in the transfer of learning of skills and knowledge but find that at present games lack the capabilities to do so (Fortugno & Zimmerman, 2005). My study provides impetus for continued research and support for gaming technology in academic environments.

Instructional technologist need to consider the HRC target audience specific to the application setting in order to implement good design and development to training in this arena. As noted by (Smurall & Curry, 2006), good instructional sequencing will help to advance students from mere knowledge to practical application. Proper instructional design methods for simulated training devices appear to be a key to learning success and have been noted by Kirkley and Kirley (2005); Kritzenberger, Winkler, and Herczeg (2002); Leberman, McDonald and Doyle (2006); and Schwabe and Goth (2005), all of whom indicate that training is affected by proper use of instructional methods. Examples of using non-traditional classroom environments that would require advanced instructional models are shown by Kritzenberger, Winkler, & Herczeg (2002) who studied the intuitive understanding of elementary school children ages 8 to 9 using a mixed-reality environment of physical (dance) and digital media (computer). Another example is Kirkley and Kirkley (2005) who stressed the importance of instructional methodologies for training development using mixed-reality and virtual environments while also pointing out the lack of definition of these methods.

The research community will want to test and verify these findings, which may address discrepancies and pose new issues. In addition, researchers that worked closely with spatial knowledge (Colle & Reid, 2000; Foreman, Stanton, Wilson, & Duffy, 2003) to researchers looking at transfer of skill and knowledge from a classroom to a real environment (Smurall & Curry, 2006) or for additional simulator effectiveness (Taylor & Lintern, 1993) can use similar methods applied in my study to refute or provide additional support of the findings. From the advanced work originating from these three communities, individuals who perform work in HRC settings will eventually benefit by the expected increase in job safety.

As research and instructional approaches advance, improvements in the design or capabilities to aid in the transfer of learning will directly affect the handling and representation of life-threatening situations found in HRC settings. These improvements may not necessarily be aesthetic in nature, such as having higher quality images, nor may they necessarily require having fancier models, such as replications. They may, however, promote the selection of the proper training alternative for HRC skills and knowledge that lead to improved critical thinking vital to the operational environment.

Chapter Summary

This chapter presented the premise to my study, which, is based upon the lack of proper training methodologies to support those working in high risk confrontational settings. Empirical research in the HRC arena are few, yet each reports the need for devices that can provide effective training that will improve performance and increase survival rate. The findings of my study should encourage instructional technologists and researchers to explore development of simulated devices that leverage the theory of transfer to aid in higher learning. Once this integration is more thoroughly understood, practitioners can then implement these strategies into the highly complex world of HRC settings. Chapter two continues with the theoretical foundation introduced in the preceding pages and provides a review of literature relevant to simulation devices, transfer of learning concepts, and the definition of target acquisition related to my study.

CHAPTER TWO: LITERATURE REVIEW

Simulations are used to recreate actual job performance situations when practice in the actual environment is not practical due to increased risk of personnel injury or equipment damage (e.g., medical and aviation fields). They allow a trainee to continuously practice and improve upon their psychomotor and analytical skills in an environment that is safe. Although the benefits of using simulations are intuitive, they are limited by the model design and the fidelity to the actual environment. HRC situations are particularly problematic because of the complex nature of these types of situations (e.g., WMD scenario) and the ability to depict the myriad of possible permutations of cues, alternatives, and consequences of actions that contribute realism. In addition, research is lacking about the effectiveness of simulations in promoting transfer of learning in HRC settings.

To better explain how simulation impacts skill acquisition in the HRC context, requires a fundamental understanding of: (a) the theoretical framework of Ability Determinants of Skill Acquisition upon which human motor skill is developed, (b) the capabilities of various simulation devices for skill development, and (c) the mechanics of the transfer of learning that promotes skill acquisition. In addition to exploring these core areas, this chapter also provides details about the measurement of target acquisition.

Ability Determinants of Skill Acquisition

The theoretical framework for my study is based on the human motor skill research known as the Theory of Ability Determinants of Skill Acquisition developed by Ackerman

(1988). Because previous theories helped to build Ackerman's foundation, these theories are highlighted for their significance. As early as the 1900's, Thorndike studied similarities between facts and skills for transfer attainment and also researched the theory of Between-Subjects Variability, measuring if subjects converge or diverge in performance over time with training. Although there were no conclusive findings from Thorndike's research, Ackerman (1986, 1987, 1988) found that interindividual variability of performance did decrease with practice if the task was within the abilities of the individual. Additionally, novel tasks, combined with complex tasks, required greater attention, which led to an increase in errors and a decrease in speed with which the task was accomplished. For participants in my study, the shooting of a marker (a paintball gun) is a novel task causing a higher cognitive demand and slower performance than for those already familiar with shooting firearms. However, during my study, as participants are able to practice finding opponents and aiming, and shooting a marker, these abilities should improve.

Ability determinants of performance, also known as Simplex theory, was further studied by Humphreys (as cited in Ackerman, 1988). Simplex theory suggests that as one gains practice, ability determinants of performance are changing but not in a linear fashion. Another theory, Ability-Performance Correlations (Fleishman, 1972; Fleishman & Quaintance, 1984), ties in a cognitive assessment, such as identifying broad intellectual abilities during initial learning of a simple, consistent task. Ackerman (1986) determined that there is an alignment between ability, performance, and information-processing, especially for those tasks that are inconsistent (such as the game of paintball).

Ackerman's (1988) Theory of Ability Determinants of Skill Acquisition is a combination of his previous research and the theories previously described that account for both skill and cognitive abilities. For skill acquisition, Ackerman (1992) defines three characteristics that are essential to the study of complex tasks, such as a cognitive effort-intensive training activity: (a) the task must represent a complex skill, (b) there must be continual inconsistent information, and (c) there needs to be a strong overlap of task representation in the real world. For the purposes of my study, the complex skills are finding, aiming, and accurately shooting a target (collectively defined as target acquisition). The reference to continual inconsistent information compares with the location and the movement of a target (e.g. the opponent). The equivalent task overlap with the real environment is inherent in the typical HRC settings faced by the military, law enforcement, and homeland security, who use weapons as necessary in their daily routines. However, even daily routines can become complex and inconsistent depending upon the encounter.

Cognitive abilities defined in Ackerman's (1992) study, and in the overview in chapter one, consist of three phases: (a) cognitive phase, (b) associative phase, and (c) autonomous phase. As previously described, these phases form a continuum moving the individual from a novice performer to an expert. Initially, the learner focuses attention on instruction in the basic skills and knowledge required for finding, aiming, and shooting at targets. Once the fundamentals are understood and strategies have been formalized in the cognitive phase, the learner can then practice their skill acquisition in the associative phase. As the learner becomes more proficient at a task, actions are more automatic or habitual and require little conscious attention, as experienced when in the autonomous phase.

For the purpose of my study, the cognitive and associative phases are monitored. An assumption is made that if the associative phase is achieved (target acquisition) then one can conclude that the cognitive phase was achieved; conversely, if the associative phase is not achieved, one also should be able to conclude that the cognitive phase was not achieved. However, the lack of a basic understanding of instruction and goals should not necessarily be attributed to the lack of abilities of the individual but should be further investigated to determine why this first step in information processing did not take place. For example, the lack of individual improvement could be linked to an instructional design flaw, and not the individual's capabilities. The autonomous phase, which is characteristics of expert behavior, is not addressed in conjunction with my study due to the limited time frame for practice, but warrants further investigation. Prior to examining the influence of cognitive abilities on the transfer of learning, an understanding of the capabilities of simulations is presented.

Simulations

Simulations have been used to facilitate learning as far back as the 17th century. For example, in the 1600s sand tables were used to simulate "war games." Today, simulations range from tabletop game boards to complex hybrid systems. The most comprehensive definition and diagram of the various simulation systems comes from Milgram and Kishino (1994) who use the term "mixed reality" (MR) to represent the combinations of real and virtual worlds. According to Milgram and Kishino, these worlds create a virtual continuum composed of real environments on one extreme to virtual environments on the other extreme, as shown in Figure 2. In addition, MR is a fairly new term, representing a new approach to training within a simulated environment (van Schaik, Turnbull, van Wersch, & Drummond, 2004; Wang, 2006).

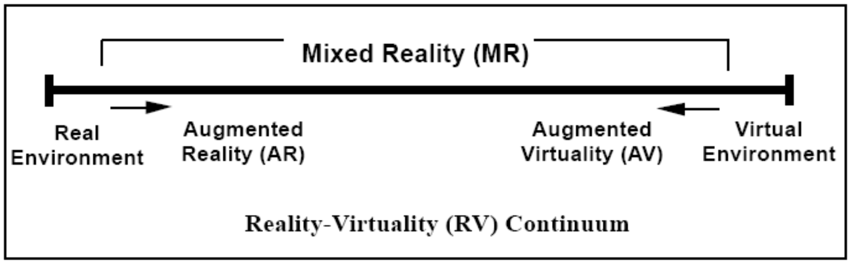


Figure 2. Reality-Virtuality Continuum showing the mixed reality with extremes.[1]

Although the central area of the Reality-Virtuality (RV) Continuum contains augmented reality and augmented virtuality, for the purposes of my study, these more finite distinctions along the continuum are not considered; instead the focus is on the real environment (RE) and the virtual environment (VE). Characteristics of real and virtual environments specific to my study are listed in Table 1. Although a RE can contain two-dimensional (2D) images (such as photographs, x-rays, video), it is not listed as a characteristic since it does not apply to my study. As in VE, three-dimensional (3D) images are common in training applications and studies that use head-mounted displays (Moreno & Mayer, 2004; Savage, 2007; Witmer, Bailey, Knerr, & Parsons, 1996); 3D images are not listed as characteristic in my study since HMD's are not used.

[1] From "Augmented Reality: A Class of Displays on the Reality-Virtuality Continuum," by P. Milgram, H. Takemura, A. Utsumi, and F. Kishino, 1994, *Telemanipulator and Telepresence Technologies, 2351*, pp. 282-292. Reprinted with permission of the author.

Table 1

Simulation Types and Common Characteristics Specific to Proposed Study

Simulation Type	Characteristics
Real Environment	Real objects
	Actual existence or physical presence
Virtual Environment	Virtual objects (2D) rendered
	All components are simulated or synthetic
	Displayed on a computer monitor

Real Environment

A real environment is one in which training is conducted using real objects, such as buildings, cars, and weapons, while the participants are physically located in that environment. There is no use of digital images or devices in a RE.

The review of literature revealed only two articles that focused on paintball as a training method used in a RE, neither of which are research based. The first article describes Army training locations that use the game of paintball as an effective way to enhance the skills of personnel prior to deployment to the streets of Iraq (Gordon, 2006). Results, although descriptive in nature, indicate that the strategic response ability of soldiers is greatly enhanced and may contribute to reducing casualties once soldiers are on the streets of Iraq. One reason for this skill enhancement is that the paintball game closely approximates the physical and mental demands of street combat. Even the paint splatter is reminiscent of a wound; once hit, each soldier becomes acutely aware of where they were hit, and, in turn, can imagine the effects of a real bullet.

Although being hit in training translates into ego bruising, in real life circumstances it translates into the difference between life or death.

The second article that focused on paintball is about a Marine company that uses the game to mimic a combat zone to increase good battlefield habits, which in turn, increases their survivability (Agency Group 09, 1998). Prior to training, the Agency Group 09 replaced the standard “marker” with a realistic M16A2 service rifle. This too, greatly enhanced the realism of the training, and achievement of positive results. The realism that is created in these Army training environments is what makes the RE training settings successful. The symbolism that the game of paintball provides is devastation, complexity, and a confusing environment associated with combat situations.

Additional literature searches have shown that terminology is frequently used rather loosely in describing a RE. For example, simulation terms, such as augmented reality and augmented virtuality are sometimes referred to as “being like” a real environment. These tentative references make it difficult to narrow down studies that focused purely only on RE’s as their backdrop for training. However, two research articles on RE’s stood out and are highlighted below that have implications to my study.

Munzer, Zimmer, Schwalm, Baus, and Aslan (2006) conducted a study in which 64 participants, a mix of male and female, performed a wayfinding experiment at the zoo of Saarbrücken (Germany). The participants used wayfinding devices (handheld PDA and tablet computers) in four conditions: (a) visual plus context, (b) auditory plus context, (c) auditory, and (d) a map. A one-way between subjects ANOVA was performed at a 95% confidence interval level. Findings indicated that participants who used a map for wayfinding performed better (nearly perfect) based on being actively involved with the map, as opposed to passively receiving information, as in the other three conditions. Although my study does not use a device for acquiring information during live play, it does support the use of a desktop simulation as a learning tool prior to RE exposure.

Atkins and Norris (2004) conducted a longitudinal study of 100 participants (83 males and 17 females), ranging from 21 to 51 years of age, over a study period of 2 years. They used a repeated measures research design with an objective to develop a Survival Score Index by studying 97 skills sets in various stressful situations. Stress levels were tiered over six conditions. The study was implemented right before participants completed the Federal Law Enforcement Training Center (FLETC) program. Findings indicated that the live training scenarios were validated as being realistic and duplicated the highly stressful situations of law enforcement. Findings also indicated that decision-making ability (perceptual narrowing), communication skills, and cognitive processes diminished during high stress. In addition, motor skills, although capable of being performed, were performed out of sequence or the wrong action was taken, resulting from a high cognitive demand, which created cognitive overload.

The Atkins and Norris (2004) study is in direct alignment with my study for three reasons: (a) a high stress level is created through the live game play, (b) the use of motor skills, shooting a “marker,” is part of the activity, and (c) cognitive overload exists due to the novice experience level of the participants, as well as the overload of sensory and physiological input created by high adrenaline levels.

Virtual Environment

Augmented reality and virtual reality (VR) engage users in an immersive environment by using 3D images rendered high-end computer systems along with peripheral equipment, such as HMD's, body suits, and haptic devices (such as gloves or pens). However, as noted by Chen, Toh, and Fauzy (2004), with technological advances in desktop personal computers, VR simulations can now run on lower-end systems. Another advantage of using VR on desktops is its lower cost, noted by Péruch, Gaunet, Thinus-Blanc, and Loomis (as cited in Jansen-Osmann & Berendt, 2002). Ausburn and Ausburn (2004) argues that PC systems are only appropriate for a semi-immersive environment, which is the type of environment being explored for my study, a VE in which there are no peripherals other than the computer keyboard and mouse.

Several studies note the problem of transfer of learning from simulated conditions to the real world, although not all studies used desktop computers as their simulation device (Correll et al., 2007; Foreman et al., 2003; Witmer et al., 1996). Specifically, Foreman et al. looked at spatial knowledge of a real school environment acquired from virtual (desktop computer display) or physical models by able-bodied children and children with physical disabilities. Findings indicated that VE-trained participants can carry out practical spatial tasks more effectively than novice participants in performance. However, opposite of the hypothesis proposed for my study, Witmer et al. showed that participants' performance of wayfinding in the RE consisted of fewer mistakes than that of participants who received VE training, even with increased rehearsal time. Overall, the Witmer et al. study indicated that VE's are effective for learning complex navigation tasks.

Another interesting study by Correll et al. (2007) examined police officers and community members and undergraduate students in a shoot/don't shoot decision making interactive video game that served as a VE. Three studies were conducted: The first study included local participants (124 officers and 135 Department of Motor Vehicle (DMV) civilians) and national participants, restricted to 113 officers. A mixed model ANOVA was performed. Results for the shoot/don't shoot segment indicated that officers from the local and national groups did not differ in their bias of the 'shoot' response ($F_{1,\ 126} = 10.05$, $p < 0.002$; $F_{1,\ 361} = 1.22$, $p = 0.27$). However, pairwise analysis of community members indicated that the community were less forgiving in determination of shoot/don't shoot, and preferred 'shoot' more often ($Fs_{1,361} > 4.12$, $ps < 0.05$).

For the second and third Correll et al. (2007) studies, similar findings were found as in study one. Study two decreased the window of opportunity in making a decision to shoot/don't shoot. The restricted time window, increased errors (16% of the 100 trials) in their decision to shoot/don't shoot and showed timeouts (17% of 100 trials) for delayed decisions (Correll et al.). Study three provided the opportunity for practice over a two day period, but used 48 undergraduates as the participants. Study three results indicated that during game play, there was a reduction in the bias to shoot, but was quickly lost when they resumed game play on Day 2. Correll et al. indicate that extended training is needed to change behavioral response.

In correlation for future research with my study design, it would be interesting to pair novice players with experienced players to determine if the amount of paintballs expelled during live game play is greater for novice players (representing the community) than for experts (representing officers). Another possibility for future research would be to provide novice players with training in a VE over time and then see if target acquisition scores increased in the RE with this training. An increase in scores would support that training in a VE is an effective method to improved judgments and for gaining more cognitive control when in the RE.

Transfer of Learning

Transfer of learning is the process of applying what has been learned (carried over) to a new or similar situation, problem, or setting. It is this transfer, or carry-over, from an instructional situation to the real world setting that is the goal of training. In essence the transfer process occurs when an individual builds requisite associations, or mental schema, that enhances storage and retrieval from memory. In effect this mental framework helps individuals learn related subject matter more rapidly (Bransford, Brown, & Cocking, 2000; Hume & Shepard, 2001; Leberman et al., 2006; McKeachie, 2001). Transfer of learning is a key ingredient in a training environment intended to facilitate individual acquisition and refinement of skills and knowledge. As noted by Leberman, McDonald, and Doyle (2006), "transfer is the link between learning and the performance. . ." (p. 31). Although transfer has been studied for decades, it is still a process that is not completely understood (McKeachie, 2001; Salomon & Perkins, 1989).

For the purposes of my study, there are key elements to transfer that are highlighted that may help to explain 'why' transfer would or would not take place. This discussion begins with an exploration of the three dimensions of transfer; (a) positive and negative transfer, (b) simple to complex transfer, and (c) near and far transfer.

Positive and Negative Transfer

Positive transfer occurs when stimuli and responses are similar (Leberman et al., 2006; McKeachie, 2001; Royer, 1986). Ansburg and Shields (2003) examined the transfer of principles between different reasoning tasks. In their experiment they studied the transfer abilities of 84 subjects (students in an introduction psychology course) trying to solve six permission problems under four training conditions (combination of problem comparison with and without feedback). Those who received training on the problem comparison solved 15% more of the target problems (solutions) than those who did not receive the training, indicating positive transfer. Another study, (Bebko, Demark, Im-Bolter, & MacKewn, 2005) investigated positive transfer effects of learning one motor skill (experienced cascade jugglers) to related task (bounce juggling). The results of this experiment indicated that juggling skills improved $F_{(5,35)} = 20.26$, $p < 0.0001$ with practice. Not surprisingly, the results revealed that experienced jugglers started and maintained skill lead over the novice players.

Reinforced skills can produce a measure of success in the transference between learning and performance. In my study, using a simulation, participants can practice shooting a virtual weapon (through use of the keyboard) within the VE, and then fire their “marker” in the RE. In both cases, the stimulus, the opponent, is the same but the response (keyboard versus marker) is different. If the participant is able to hit the target (opponent), then the connection between their skills (finding, aiming, and shooting), which was also practiced in the VE, can be positively qualified. When these reinforced skills that are gained in training are applied to the “live” situation, a positive transfer is then fully realized.

While positive transfer facilitates learning or performance in another situation, negative transfer means that a learned response actually hinders appropriate performance. For example, people who learn a second language typically apply patterns of speech production characteristic of their native tongue, thus giving them a foreign accent, Ormrod (as cited in Schmidt, Young, Cormier, & Hagman, 1987). However, if stimuli and responses are significantly different, neither positive nor negative transfer occurs, causing a transfer gap. The effects of lack of transfer was made evident in a study conducted by Ansburg and Shields (2003) in which the feedback provided to permission problems did not promote transfer to arbitrary problems. The results indicated that the subjects were unable to make connections between the different conditions in which the stimuli (the problems) were different and the responses (the feedback) were different.

In the case of my study, the potential of negative transfer occurs when the stimulus of seeing a moving opponent is constant but the response differs when reacting to that opponent in a different environment. The learned response of dealing with an opponent in a VE may interfere with the appropriate response of dealing with an opponent in a RE. For example, with a simulation, the participant's response is to shoot at moving opponents. Increasing the difficulty of the exercise, where the participant is engaged in a live arena, the stimuli is still an opponent but now other elements come into play, such as fear. The participants' ability to successfully shoot at moving opponents in a VE is one result. The participants' "inability" to successfully shoot at moving opponents that are in a RE, and that shoot back, is a second result, albeit different. This lack of connection between the two conditions resulting from the same stimuli can potentially result in negative transfer.

Simple to Complex Transfer

Leberman et al. (2006) define simple transfer as occurring when previous knowledge can be used in a new situation with little to no effort. This is in alignment with Salomon and Perkin's (1989) "low road transfer" concept when tasks are performed effortlessly. The effortless transfer to related situations may be termed automatization, as noted by Salomon and Perkin's (1989) as the "automatic triggering of well learned behavior in a new context" (p. 113).

Leberman et. al, (2006) define complex transfer as using the previously acquired knowledge in a new situation while seeking extended applications in which that knowledge can be used. This process of complex transfer is defined by Salomon and Perkin's (1989) as "high road transfer" which requires greater cognitive processing and may be detected in situations in which individuals are learning rules and principles.

For my study, simple transfer is illustrated when a participant's fundamental knowledge of finding, aiming, and shooting a real weapon is easily duplicated in different real environments, such as playing live paintball in an outdoor arena and then playing live paintball in an indoor arena. The new context of the different live arenas will not erode the participant's ability to find and opponent, aim, and shoot a real weapon. Conversely, a complex transfer may be illustrated when participants, who can find, aim, and shoot in a VE using a keyboard at stationary computer generated opponents can transfer their acquired knowledge to the RE in which a "marker" is used against live moving opponents. Further cognitive extension would include the participants' ability to adhere to game rules, such as not placing fallen paintballs into the hopper, which can cause the marker to fail to shoot. As participants seek extended applications of their ability to find, aim, and shoot, a “complex” integration of knowledge is formed.

Near and Far Transfer

Near transfer is posited to take place when previous knowledge is being applied to situations that are similar to what is being newly experienced and takes minimal cognitive effort (Leberman et al., 2006; McKeachie, 2001; Royer, 1986). For my study, near procedural transfer, is indicated by any participant that is already proficient in shooting a hand gun (previous skills and knowledge), then is required to shoot a “marker”. Near transfer can also occur when participants are playing in an outdoor RE using “markers” and then transfer to another outdoor field using the same equipment.

Far transfer is essentially the process of applying existing knowledge to a novel learning situation which takes a high cognitive effort (Leberman et al., 2006; McKeachie, 2001). This concept is suggested to occur when knowledge gained from previous experiences is put into a dissimilar situation, and the individual is expected to successfully apply this acquired knowledge.

In my study, far transfer, which requires a high cognitive effort, is posited to occur if a participant, who is given the non-simulated comparison application, is able to take their newly acquired knowledge and transfer that information to the proper use of finding, aiming, and shooting a “marker” at opponents in a RE.

Now that the three dimensions of transfer have been explored, the cognitive elements that aid in transfer will be examined: cognition, situativity, and automaticity. The ability to capitalize on these elements is what distinguishes a novice from an expert. Although my study was not designed to explore the differences between a novice and an expert paintball player, the distinction between an expert and a novice in acquiring the cognitive elements is defined.

Experts versus Novices

Bransford et al. (2000), report in great detail the characteristics that distinguish experts from novices. There is strong evidence to suggest that experts interpret information differently, as well as organize, represent, and create mental models of a situation differently than that of novices (Hinds, Patterson, & Pfeffer, 2001; Novick, 1988; Schoenfeld, 1987). Experts tend to create schemata from similarities that are perceived, whereas, novices are too concerned with seeing the smaller pieces, such as facts (Schoenfeld, 1987). However, as noted by Bransford et al., experts become expert through the use of cognitive thinking, starting with basic learning, moving on to the association of stimuli with responses, and finally, practicing to the point that performing a task becomes automated. Experts generally demonstrate reduced stimuli interference and reduced errors (Correll et al., 2007); just like experts, novices, can become expert through the same process. But, we cannot forget, underlying this process is the science of transfer. If transfer is not taking place, one cannot move from one cognitive element to the next, which is also supported in Ackerman's (1988) theory and in Ackerman's (1992) description of cognitive phases. According to Ackerman, transfer occurs in skill acquisition in the three phases, from (a) cognitive, to (b) associative, and finally to (c) autonomous. These phases are parallel to the elements described below: (a) cognition, (b) situativity (also considered the associative phase), and (c) automaticity. The following paragraphs describe the mental process involved of how these cognitive elements are linked with transfer of learning.

Cognition

From a cognitive perspective, and related to Ackerman's (1992) definition of the cognitive phase, as individuals are learning they create mental models and structures (schema) to make connections with various pieces of information. Schema originated from elements of semantic memory which contains the "knowledge of concepts, rules, principles, generalizations, skills, and metacognitive skills" (p. 7) that are based on the extraction of experience (Andre & Phye, 1986). Schema is often triggered by stimulation in our environment, which, when drawn upon can result in three types of cognitive mechanics: assimilation, accommodation, or equilibration. Lunzer (1986) provided explanations of the mechanics in the following manner: (a) assimilation takes existing schema and creates new schema that is extended to the existing situation; (b) accommodation adapts existing schema to fit a novel situation through trial-and-error or systemic inquiry or through logical inferences and creates a new schema; (c) equilibration is the balancing act of separating two conflicting schemas, known as cognitive dissonance, that have been triggered by the same stimulation and creating yet another schema. Exposure to stimulation, both new and existing, evokes these cognitive mechanics that lead to higher order thinking.

In a situated learning condition, the focus is then on the development of higher order thinking (Leberman et al., 2006) in which real world conditions are presented and aligned with existing prior knowledge. Under this type of optimized learning environment, schema building, as noted by Clark, 2003, allow one to interpret their environment and to make sense of what is being experienced based upon their prior knowledge. Eventually, schema or sequences are stored in long-term memory and, through practice, become over-learned and turn into automated processes (Phye, 1986). As adult learners, Clark (2003) and Huitt (2003) indicate there are three primary stages to process information: encoding, storage, and retrieval; as a learner receives new information, it is the integration with prior knowledge that results in encoding, and the creation of a new schema into long-term memory. When information is needed from recall, it is retrieved from long-term memory and aids in higher order thinking.

Engaging in higher order thinking forms connections between an environment and experience, and is known as critical thinking (Desse, 2001), problem solving, (Price & Driscoll, 1997) and reasoning (McKeachie, 2001). It has also been noted that higher levels of cognitive processes require higher demands on cognitive skills, and therefore, a novice may be ill-equipped, lacking these skills (Kuhn, Black, Keselman, & Kaplan, 2000). In my study, because practice in the RE is limited in time to mere minutes, and because participants are novices, they are not afforded the opportunity to practice at length, and therefore, will not be able to form connections regarding the game of paintball. Due to the nature of live practice sessions, novices should experience a higher demand on cognitive skills including increased sensory activities, such as the production of adrenaline. Senses are heightened when faced with “being hit” by real paintballs (unlike that of playing a virtual version where “being hit” is simulated). In addition, the human element makes the game dynamic, thus, making learning more challenging, as elaborated upon in situativity below.

Situativity

Situativity, which is related to Ackerman's (1992) definition of the associative phase, is part of the higher level cognitive perspective when one participates in regular patterns of activities, which is characterized as communities of practice (Greeno, 1998). However, as described by Greeno, constructing understanding is not always accomplished in a stable environment that provides regular patterns, but, can also be accomplished in a dynamic environment as well. Greeno's reasoning is similar to a term called dynamic decision making (DDM), as noted by Gonzalez (2004). Gonzalez adds that "…dynamic decision making dictates that multiple and interrelated decisions be made in a continuously changing environment. Such decision-making is difficult and often taxes individuals' cognitive resources." (p. 142). Dynamic decision making is related to my study since the interaction among the participants in the live practice sessions cannot be predicted. In addition, since my study is using novice players, there is no existing schema to draw from to aid in a successful outcome. However, over time, if enough practice could be afforded, it would be expected that a participant's repetitive actions may become predictable. Finally, the higher order thinking involved with situativity eventually encompasses automaticity, characteristics of an expert (Leberman et al., 2006).

Automoticity

Automoticity, which is related to Ackerman's (1992) definition of the autonomous phase, is an unconscious process that experts tend to use based on a highly organized structure of chunked information, stored as schemas, that was developed over years of experience, (Bransford et al., 2000; Salomon & Perkins, 1989). Automaticity involves less routine cognitive processing (Ferguson, 2000) and is individual to each person. Automaticity is created either through (a) intentional goal-directed processes that require an act, or (b) preconscious processing that only requires the environment as a trigger (Bargh & Chartrand, 1999). However, tasks that are not consistent in nature and that have many possibilities with various responses are not as easy to learn (Halff, Hollan, & Hutchins, 1986; Tubau, Hommel, & LÃpez-Moliner, 2007).

To increase the likelihood of automaticity, repeatable actions and higher-order thinking need to be infused into the learning situation. However, when dealing with unpredictable tasks found in HRC settings, this makes it difficult to acquire an automatic response. The more we learn about transfer of learning, simulated environments, and real world problems and outcomes, the more adept the training industry will become at designing training systems that get to the heart of what is now missing; effective learning situations for dynamic environments in which there are infinite combinations of problems and solutions.

Target Acquisition

Research related to target acquisition was limited. Studies dealing with firearms (which may or may not include real ammunition) would be a logical inclusion as empirical evidence to my study. In addition, studies in which participants engage a "human" target would be of greater interest. Disappointingly, the investigation into target acquisition research in this area has provided no such findings. As a result, background studies using RE's and VE's were adopted to provide context for target acquisition discussion. For my study, target acquisition is defined as the striking of a RE opponent with a paintball while using a "marker," which is representative of a firearm. The participant's measure of target acquisition, the score, is based on time on the field and the number of opponents hit.

Chapter Summary

The purpose of this literature review was to establish the theoretical foundation and to outline the key characteristics of the real and virtual environments that are pertinent to my study. Additional review of the literature presented key concepts on the transfer of learning and the cognitive elements that make this connection. There is strong empirical evidence that over time repeated practice under similar conditions does play a role in effective transfer of skills and knowledge. However, an HRC setting, due to its complex nature and the challenges of replicating a suitable simulated environment, experiences far less success in transfer of training and overall effectiveness. Chapter three outlines the research methods used to examine the effectiveness of using a simulated device in the transfer of a skill from a VE to a RE.

CHAPTER THREE: RESEARCH METHODS

My study was based on the measurement of participants skill in target acquisition initially introduced through an intervention and then expressed in a real environment. A prominent concern regarding the current virtual training tools of this time period is that the virtual training simulations do not result in the requisite levels of effective transfer for those performing tasks in HRC settings. It is hoped, that based on the findings of my study, that the training and development community, as well as researchers in the training and simulation field will formally investigate the outcomes and expand upon them. The value in developing advanced virtual training systems is that individuals in extreme life or death situations can be effectively supported with the type of practice opportunities that will ensure survival. As presented in chapter two, improvements in performance reflected as a greater degree of control over decisions and actions taken, can be accomplished if there is a realistic environment in which to practice and gain expertise, as noted by Ackerman's (1988) theory. Although my study included a realistic environment, the measure of practice afforded the participants was limited and therefore was not expected to improve a participants ability to that of an expert or from the basics of the cognitive phase to the associative phase. However, a foundation was laid with this study for additional research that will hopefully provide momentum toward resolution of the challenges faced by those operating in an HRC environment.

Research Design

The research design proposed for my study included a posttest-only randomized comparison group. Figure 3 shows that participants were randomly assigned into two intervention groups: Group A and Group B. Group A, the simulation treatment group, received a simulated desktop computer-based paintball game as the VE two days prior to live game play in the RE and is denoted by an "X_1". Group B, the non-simulation comparison group, received paper-based text with graphics two days prior to live game play in the RE and is denoted by an "X_2". On the day of live game play, the participants were randomly assigned to two new groups (Team 1 and Team 2) regardless of the prior intervention received. Both teams were observed in two live practice sessions noted by Game 1 and Game 2.

	X	Game 1	Game 2
Group A	X_1	O_1	O_2
Group B	X_2	O_1	O_2

Figure 3. Randomized posttest only comparison group design.

Population

The target population for my study was individuals over the age of 18 who worked in a university-based research park area. The total population for this area was approximately 9,500 employees of over 106 businesses. Unfortunately, the population demographics did not indicate how many of the population were under the age of 18. Because of the military presence in the research park area, participants may have had a background involving weapons use and a higher propensity for having played paintball. Recruitment of participants began with an email (Appendix B, page 76) to local workers in the research park area that I am familiar. Those local workers acted as recruits in forwarding additional email addresses to me of others who were interested in participating.

Sample

A stratified sample was used to represent a distinct category of novice paintball players with no experience in playing live paintball, airsoft, or laser tag. Although a total of 32 potential participants from the population noted an interest in participating in my study, only 24 participants could be included in the sample. All participants volunteered and were randomly assigned to two groups, (Group A as the simulation treatment group and Group B as the non-simulation comparison group) for the first-half of my study. Of the participants (N = 24), fifty percent of the participants (n = 12) were exposed to the simulation treatment and fifty percent (n = 12) were exposed to the non-simulation comparison application. One of the participants was not able to continue the second-half of the study leaving the participant count at N = 23. At the start of the second-half of the study, the participants were randomly assigned to two teams to practice in the RE.

Power

Based on the literature review of those who engaged in paintball as a form of training, sample size ranged as low as 35 participants to as high as 135. For my study, I conducted an a-priori power test to determine sample size (Faul, Erdfelder, Lang, & Buchner, 2007). To correctly reject a false null hypothesis (a Type II Error), a large effect size for Case II research ($\Delta_1 = .80$), $\alpha = .05$ (one-tail), and a power of .70 ($\beta = .30$) were selected for a required sample size of 32.

To help control for power, it was verbally recommended to the participants that no communication between the two groups take place between the time of the intervention and the live practice sessions. Because the desktop computer-based game was accessible for purchase online or in stores, it was best the two groups refrained from conversation prior to live game play. There was also a limited amount of time (2 days) between receipt of the intervention and live game play, which would have helped to retain any skills or knowledge acquired.

Research Devices and Intervention

Classification Matrix

For stratification, and to eliminate differences between groups, participants were asked to complete a classification matrix (Appendix D, page 83) prior to the start of my study. Participants self-rated if they had (a) high computer skills or low computer skills, (b) high physical ability or low physical ability, (c) low shooting ability or high shooting ability. Age demographics were also provided by the participants as ranging from 18 – 30 and 31 and older.

Break Period

A break period was essential to determining if the treatment or comparison applications were carried over into the RE. Therefore, between the two observations of the live practice sessions, a one hour break period was provided. Although the break period was originally scheduled for two hours, it became apparent on game day that some participants were bored, while others continued to participate in live game play. In addition, the outside environment was cold and the amount of paintballs provided was running low. The break period consisted of the participant's choice to (a) play additional live paintball games with any player who was at the facility, which would include a range of players from novice to expert, (b) take a break from playing, or (c) drop out of participation. Luckily, no one dropped out of the study during the break period. Once the break period concluded, the second observation (game 2) was conducted to determine if there were any long-term effects of the simulated treatment or non-simulated comparison application.

As with my study, it was seen that participants who did not continue game play during the break period, did not advance in target acquisition score and therefore stayed in the cognitive phase. However, other participants who did continue game play during the break period appeared to migrate to the associative phase based on seeing an increase in their practice scores.

Reaction Questionnaires

In general, reaction questionnaires provided the opportunity for the participants to rate their own ability on target acquisition, to indicate the treatment they received, their opinion about the benefit of the type of treatment received to live practice sessions in the RE, and to rate the mental challenge of the treatment received as well as the mental challenge during practice.

Reaction questionnaires were collected after the intervention was administered and again after the final game was played in the RE. The compilation of results is shown in Table 2. A total of 24 participants completed the Reaction Questionnaire Training Methods (Appendix G, page 90) form, administered after the intervention was received, and 23 participants completed the Reaction Questionnaire Live Play (Appendix H, page 92) form, after the end of game 2. Five main questions were asked with minor differences between the training method (intervention) collection instrument and the live play (practice) collection instrument. Both questionnaires elicited self-reported responses from the participant on four main questions. An additional question (question 3), which is not part of the compilation of scores in Table 2, asked each participant to indicate which training method they received. There was no discrepancy in this question in total responses out of the 23 participants who concluded the study.

Table 2

Findings of Reaction Questionnaires

	Training Method		Live Play	
Topic	Frequency	Percentage	Frequency	Percentage
Past Shooting				
No	6	25.0	6	25.0
Yes	17	70.8	17	70.8
Accuracy				
Very accurate	3	12.5	3	12.5
Accurate	10	41.7	8	33.3
Neutral	3	12.5	6	25.0
Inaccurate	1	4.2	4	16.7
Very inaccurate	1	4.2	1	4.2
Helpful				
No	7	29.2	17	17.8
Yes	16	66.7	6	25.0
Mentally Challenging				
No	17	70.8	10	41.7
Yes	7	29.2	13	54.2

Question 1 inquired if the participant had ever practiced shooting a target in the past. This question is an identical question for both questionnaires. Those who responded affirmatively to having past shooting experience numbered almost three times (71%) as many as those who did not (25%) for both questionnaires. Question 2 was a follow-on to question 1 regarding accuracy. For both reaction questionnaires (administered after the Training Method and Live Play activities), responses were predominantly “accurate” (42% and 33%) respectively. The second highest selected response for accuracy of the Training Method was divided between “very accurate” (13%) and “neutral” (13%). For Live Play the second highest response to accuracy was “neutral” (25%). Although the question of accuracy was tied to “past performance,” the question may have been misread by the participants as to their performance with the intervention and in the RE, accounting for the differences in rating.

Although question 4 is identical on both questionnaires, a different verb tense was used. The question asks about the helpfulness of the intervention received. On the Training Method questionnaire, participants were asked to predict helpfulness and after the Live Play they were asked to assess helpfulness. After the intervention, 66% indicated that the training method would be of help in the RE. However, after the Live Play activity, only 25% indicated that the intervention was of help in the RE.

An additional follow-up question focused on the mental challenge of the intervention and on the RE. Not surprisingly, only 30% indicated that the intervention received was mentally challenging, while 54% indicated that the RE was mentally challenging.

Comments made by participants regarding the usefulness of the type of intervention received indicated that the simulation treatment would provide strategy and techniques to apply while in the RE. Those who received the non-simulation comparison application indicated that the fundamentals were of value, specifically knowing how to aim and shoot with a sight.

Additional comments regarding the usefulness of the type of intervention following live practice sessions indicated that both types of interventions were insufficient. Those who received the simulation treatment indicated that the simulation was nothing like that RE and that there was more to think about in the RE than what was experienced in the simulation. For the non-simulation comparison application, the lack of a sight on the “marker” made it difficult to apply finding, aiming, and shooting techniques described in the material.

Research Devices

The devices used to determine the effectiveness of the transfer of learning for target acquisition were: (a) the desktop computer simulated paintball game (simulation treatment), the (b) paper-based text with graphics material (non-simulated comparison application), and (c) the outdoor paintball facility. The first device consisted of five desktop computers that housed a popular paintball game. This game helped to emulate a group paintball game and served as the simulated treatment for Group A. Each participant in Group A was seated in front of a Dell Dimension 280, Pentium 4 at 3.20Ghz, 1GB RAM, 80GB HD; Windows XP SP2, 17 inch USB Dell Monitor. The desktop computer consisted of (a) a monitor, (b) a keyboard for navigation, (c) a mouse, also used for navigation, (d) headphones, (e) a PC simulated paintball game, and (f) a copy of the default game keyboard and mouse controls. Each participant was asked to play a 10-minute game of paintball, take a 5-minute break, and then play a second 10-minute game of paintball. Once achieved, the participants completed the Reaction Questionnaire Training Methods form. The first-half of participation was completed.

Each participant's desktop computer-based game was pre-set to be somewhat equivalent to the type of field to be played on in the live arena, shown in Table 3. However, there were some unique characteristics of the simulation that were not a part of the RE that involved special computer generated aspects of the game not associated with a live environment. These included a flying segment before starting the game, the radar to view where opponents were located, and the back-to-life option following a hit.

Table 3

Game Characteristics and Settings

Game Characteristic	Game Setting
Game Level	Normal
Type of game	Arcade
Type of playing field	Stadium Large
Maximum number of players	Five (included the participant)
Radar	On
Frag	Unlimited (number of hits allowed)
Number of Rounds	1

Although some features of the simulation were not realistic, the basic actions within the game of finding, aiming, and shooting closely resembled the real game and to using a real “marker”. The non-simulated comparison application consisted of an eight page, paper-based text with graphics in using a pistol ("Shooting Fundamentals," 1991). Each participant was asked to read the paper-based material, take a 5-minute break, and then read the paper-based material a second time. Upon completion, the participants filled out the Reaction Questionnaire Training Methods form.

The third device for my study was a RE encompassing an outdoor arena for the live practice sessions located at a paintball facility, Figure 4. Prior to equipment being provided, each participant donned a hand-painted white T-shirt with an individually assigned alphabetical letter for identification while on the field and within the video recordings. Equipment for each player consisted of a semi-automatic, Spider Extra and Tippman 98 paintball guns, also known as a "marker". These semi-automatic guns release a paintball upon the pull of the trigger and results in a splatter zone of 50 to 75 yards effectively. Paintballs consisted of a gelatin casing, covering a crayon wax filling with water-based food coloring for coloration. Protective head gear included a JT XFire goggles elite mask system. Prior to live play, all participants were provided game gear to include: (a) helmet, marked with colored tape for Team A or unmarked for Team B, (b) a “marker,” and (3) two-hundred (200) (+/- 3) paintballs per practice session.

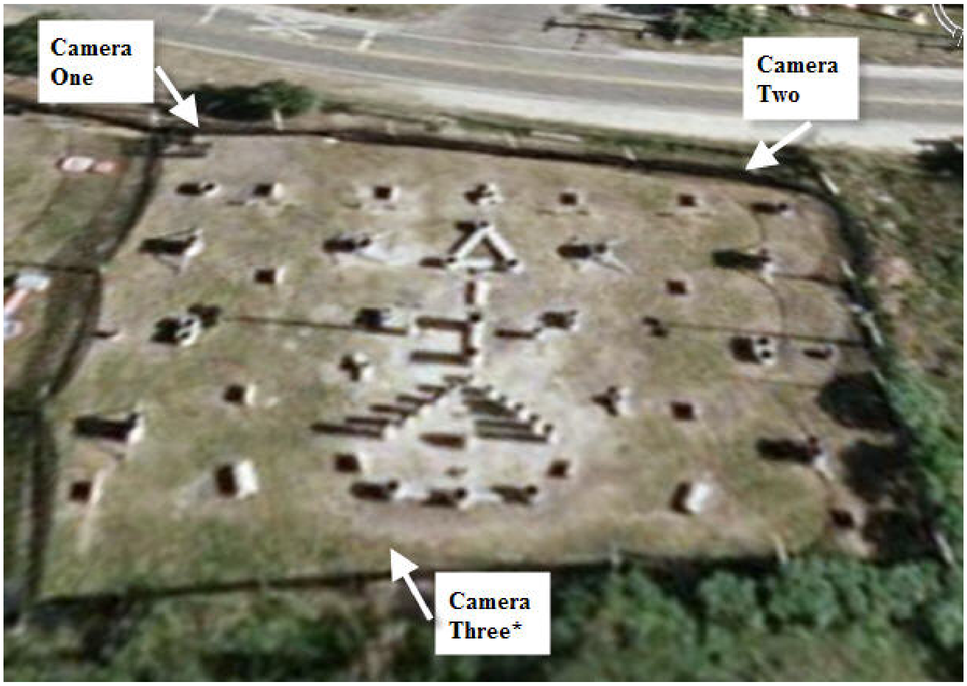


Figure 4. Field E with camera locations[2].

Prior to game start, three cameras were strategically located in proximity to the playing field without obstruction to the participants, illustrated in Figure 4. Camera one was a Sony HDV Z1, camera two was a Sony HDV FX1, and camera three was a Sony Mini-DV. The video footage was later compiled into three video scenes synched together for simultaneous viewing using Final Cut Pro on a MacBook Pro. The video footage was then viewed to determine time of being hit.

As viewed in the videos, the participants performed a series of events in which they sought cover, scanned for opposing participants, and attempted to eliminate the opposing participant from the game by striking them with a paintball. Once hit, participants exited the field verbally indicating to the researcher and scorer the number of opponents they feel they hit during the live

[2] *Note Camera lens direction is noted by the arrows. Cameras 1 and 2 were stationary and behind the mesh barrier, whereas, camera 3 was in front of the barrier and mobile, but shot from approximately the same area shown.

practice sessions. This data was hand-recorded next to the participant's assigned letter on a data collection form for later calculation. After the first live practice session (game 1), the participants took a one hour break in which they either sat out and watched other players compete or participated in additional live games. During the second live practice session (game 2), participants again sought cover, scanned for opposing participants, and attempted to eliminate the opposing participants from the game. Upon exit from the field, the participants again told the researcher and scorer the number of opponents they hit and this data was recorded as before. The participants then completed the Reaction Questionnaire for Live Play as the conclusion to the study.

Dependent and Independent Variables

The DV consisted of the measure of target acquisition equating to the Time on Field (in seconds) / Number of Opponents Hit = Target Acquisition Score. The IVs included the simulation treatment and non-simulation comparison application.

Data Analysis

A one-way repeated-measures ANOVA with one between-subjects factor was used to provide the statistical analysis of data on target acquisition. The scores for target acquisition were acquired from live game play in the RE. Group A and Group B were randomly assigned to teams during equipment check-in at the paintball facility. Two sets of target acquisition scores were acquired per participant based on two live practice sessions (game 1 and game 2). Hypothesis 1 examined if there was a difference in target acquisition scores based on the type of intervention received. Hypothesis 2 looked at the change in live practice scores between game 1 and game 2. Hypothesis 3 then checked for an interaction between the interventions and live practice scores.

Procedures

The procedures for implementation of my study starting with recruitment:

- Initial recruitment of participants was conducted through email. The recruitment email (Appendix B, page 76) included, as attachments, a consent form (Appendix C, page 78) and classification matrix (Appendix D, page 83) for participants to complete.
- Participants were asked to read and either email or fax a signed consent form. A signed consent form allowed the person to continue with the study.
- Participants were also asked to complete a classification matrix to determine their capability levels. This data was used in the statistical findings to rate strengths of the participants compared with target acquisition findings.
- Once all classification matrices were received, the number of participants was randomly assigned to an intervention, either the simulation treatment or the non-simulation comparison application. As participants arrived at a local university, under the permission of the College of Education, for the first-half of the study, they were assigned an alphabetical letter in the order in which they arrived. This alphabetical letter was later used to provide the participants T-shirts for identification purposes during the live practice sessions.

- Group A, randomly assigned as the simulation treatment, met two days prior to live game play, to engage in a 10-minute simulated desktop computer-based paintball game. The simulation game was repeated after a 5-minute break period. After the second computer-based game was completed, participants filled out a Reaction Questionnaire for Training Methods.
- Group B, randomly assigned as the non-simulation comparison application, met two days prior to live game play, to engage in a 10-minute non-simulated paper-based text with graphics reading assignment. The reading assignment was repeated after a 5-minute break period. After the second reading assignment was completed, participants filled out a Reaction Questionnaire for Training Methods.
- Participants were verbally told not to participate in any paintball activities between the receipt of the intervention and live game play.
- The next day, participants received an email notification (Appendix F, page 88) that provided the time, date, and directions to the paintball facility.
- All participants met at the paintball facility for the live engagement two days after receipt of the intervention. Several hours prior to live game play, video equipment was stationed in three locations for later viewing and verification of the time hit.
- Once all participants arrived at the facilities, they were provided their assigned T-shirt to wear for identification purposes while on the field and for identification in viewing video recordings.

- As participants were lined up to receive their paintball gear, they were randomly assigned to Team 1 or Team 2 by calling out a “1” or a “2” consecutively while in line.
- Proper gear was then acquired by each participant and basic instructions on “how to play” were provided by one of the referees at paintball facility to ensure game safety.
- All participants were provided 200 (+/- 3) paintballs to insert into their hopper prior to engaging in the live practice sessions. Additional paintballs were also provided during the break period for additional live game play for those who wanted to continue game play during the break period.
- During each live practice session, participants kept mental track of the number of direct hits made on opposing participants. Video recordings of the two live practice sessions took place for later analysis. This analysis produced the time the participant was hit and the time the participant exited the field. Verification to number of hits made by a participant to an opponent was undetermined due to the lack of video lighting, the fuzzy appearance based on the mesh screen barriers used as protection for the video equipment, and the speed in which the paintballs traveled once fired.
- When a participant was directly hit by an opposing team member, they were instructed to leave the field. The referee was an additional assurance that the participant would in fact exit the game. Upon exit, the participant would verbally provide the number of opponents they felt they hit to the researcher or scorer. This number was hand-recorded on a data collection sheet next to the participant’s assigned alphabetical letter.

- After game 2 concluded participants completed a Reaction Questionnaire for Live Play.
- Additional information about what the participant engaged in during the break period was noted on the data collection sheet. If the participant engaged in additional live play during this time, the number of games played was noted. This information was used for additional statistical analysis.

Limitations

The posttest-only randomized comparison group design used for my study was limited in its analysis because baseline data, usually gathered from a pretest, prior to intervention, was not available. Instead the raw scores of each participant were analyzed. Another limitation involved relying upon the memory and recall from participants for the number of opponents hit while engaged in such a dynamic, unfamiliar environment. The inability to observe all participants during live game play and the lack of adequate video capture of paintball contact forced reliance on a single unreliable data point (participant's verbal recall). An additional limitation was the lack of data on a participant's efficiency (amount of paintballs used to acquire a target). This efficiency rating would have helped to better quantify a participant's target acquisition skill. Overall, the generalizability of my study was heavily weighted toward the male gender and the majority showed a strong propensity for shooting capabilities based upon the classification matrix.

Validity

There are four factors, as outlined by Campbell and Stanley (1963), that could affect the internal validity of my study: first, there is a one hour break period that occurs between the first and second measure. How the participants spent their time during this break period was not controlled and varied from participant to participant. A participant could have either played additional live games of paintball to improve upon their finding, aiming, and shooting skills or not played during this period. Second, maturation of participants could have occurred if they become overly tired or mentally fatigued between game sets and decided to sit out during game 2. Third, experimental mortality could have taken effect if a participant had decided to end their participating in the study. Findings indicated that 20 participants practiced between game 1 and game 2, while only 3 of the participants sat out and observed or read a book. Fortunately, all 23 participants continued with the study after game 1 and participated in game 2. No participant was lost to fatigue nor experimental mortality.

Reliability

To ensure reliability of my study a scorer was used to capture verbally reported scores after each live practice session. In addition, a video subject matter expert was recruited and used for the review of the recordings of each live practice session. The first set of measures, the verbal recall, was collected by the researcher and scorer after each participant exited the field. The participant provided a verbal count of the number of opponents the participant felt they hit during the live practice sessions. The verbal count was hand-recorded on a data collection sheet for game 1 and then for game 2. The second set of measures, the verification of time hit and time off the field, was determined by the video subject matter expert and researcher through the review of the three synched video recordings.

To determine interrater reliability, a consensus of the data collected for the verbal count on the number of opponents hit by each participant was taken. If the participant indicated they were not sure if they hit anyone, they were given a score of zero. For those scores collected, the means (*M* = 0.95, *SD* = 1.22) are identical for the researcher and scorer. The sum of the scores is reliable (interval of 1.0 with 95% confidence). The researcher was not able to record all possible scores for game 2 due to distractions from participants in collecting unused paintballs and turning in paintball gear. When data was not available from the researcher, scorer data was used. One anomaly in the recall of the total number of opponents hit was noticed in the self-reported totals; from game 1 it was claimed that 28 opponents were hit and from game 2, a total of 30 opponents were hit. Both of these values totaled more than the number of participants on the field at one time (N = 23). These inflated numbers may be due to the cognitive overload aspect of the participant or it could be due to participant's refusal to leave the field when hit.

Determination of interrater reliability for time hit and time exiting the field was not as easily achieved as the verbal count. The final values used in calculating target acquisition scores were based on the recorded video time when the participant was hit and the time the participant exited the field during each of the two live practice sessions. Because the actual paintballs were difficult to view in the videos, the method of "time hit" determination was based on the participant raising their hand and/or verbally calling out, "I'm hit!" The videos were stationed at three different views which were synched together for simultaneous viewing. Once the video raters determined there was a "hit," time was recorded. This participant would then be followed through the synched views until they exited the paintball field where participant identification could be made. However, as one of the video raters, it was difficult to follow each participant from one view to the next. Because the video subject matter expert was more adept at following each participant within these views, we then collaboratively viewed the synched videos several more times for accuracy on "time hit" and for participant identification. These numbers were then used in the calculation of target acquisition scores.

Chapter Summary

Chapter three provided a discussion of the statistical analysis used, the processes applied in data collection, and the limitations, validity, and reliability of the study. Overall, throughout this two-phased approached, participation was consistent for those who started (N = 24) versus those who completed the study (N = 23). The procedures section outlined the research processes, while limitations described flaws in the process that were quickly noticed as the research took place. The validity of the study remained high with no mortality during live practice sessions. Interrater reliability, however, was problematic due to video quality and difficulty in viewing and finding the alphabetical letter on each participant. Chapter four presents the statistical results of the findings and builds on the discussion of research methods provided in chapter three.

CHAPTER FOUR: RESULTS

A one-way repeated-measures ANOVA with one between-subjects factor and one covariate was performed to test the research hypotheses and to answer one research question; can a virtual environment be effectively used to train individuals to perform better in a real environment? This chapter presents the research results starting with demographics regarding the classification matrix, followed by the findings of the three hypotheses, and chapter summary.

Participant Demographics

Demographics for all 24 participants who started the study include gender and age, followed by descriptive data taken from the classification matrix. The classification matrix focused on a self-rating by participants regarding their own computer skills, physical ability, and shooting ability levels, as outlined in Table 4.

Table 4

Gender, Age, Computer Skills, Physical Ability, and Shooting Ability Composite

		Group	
		A (Sim)	B (Non-Sim)
Gender	Male	12 (100%)	7 (58.3%)
	Female	0	5 (41.7%)
Age	18-30	8 (66.7%)	3 (25.0%)
	31 +	4 (33.3%)	9 (75.0%)
Computer Skills	High	10 (83.3%)	9 (75.0%)
	Low	2 (16.7%)	3 (25.0%)
Physical Ability	High	12 (100%)	8 (66.7%)
	Low	0	4 (33.3%)
Shooting Ability	High	9 (75.0%)	5 (41.7%)
	Low	3 (25.0%)	7 (58.3%)

Based upon the findings in Table 4, the majority of participants were males, n = 19, and comprised 100% of the simulation treatment group and over half, 58% of the non-simulated comparison group. All females (n = 5) were in the non-simulated comparison group and comprised 42% of that group. The simulation treatment group and non-simulation comparison group included a fairly even distribution in computer skill at the high level of 83% and 75% respectively. However, the comparison group indicated lower computer skills than the treatment group at 17% and 25% respectively. The treatment group ranked themselves “high” at 100%

with regard to physical ability. The comparison group was not as cohesive, ranking themselves as 67% “high” physical ability and 33% “low”. Finally, the majority of the treatment group once again ranked themselves as having a high shooting ability at 75%, while the majority of the comparison group reported themselves as having low shooting ability at 58%. Although the groups were randomly assigned, the demographics and descriptions show that the treatment group contained the more fit and experienced members.

A Pearson Correlation was run to determine if there was a relationship between the classification matrix demographics and practice scores, which represents the ability of an individual to perform better in the live arena. Overall, the results of the correlation analysis data presented in Table 5 suggests that there was no relationship between gender, age, shooting ability or physical ability variables and practice scores. Mean scores for game 2 were higher (M = 73.86, SD = 74.32) than mean scores for game 1 (M = 43.29, SD = 49.23). However, there is a statistical significant negative correlation (-0.449, p = 0.036) between the gender variable and game 2 scores.

Table 5

Pearson’s Correlation Matrix and Descriptives

	Mean	SD	Gender	Age	Shooting Ability	Physical Ability
Game 1 $_{(20)}$	43.29	49.23	-0.376	-0.162	-0.084	-0.376
Game 2 $_{(22)}$	73.86	74.31	-0.449*	-0.185	-0.417	-0.226

Note. Numbers in parenthesis = sample size.

From the total participants of 19 males and 5 females, 4 of the males and 1 female were excluded from the analysis due to missing data. The excluded participants were descriptively similar to those included in the final dataset with an 80% male and 20% female mix. However, with regard to age, 100% of those excluded from the dataset were in the younger age bracket; all males were in the simulation group, and the 1 female in the non-simulation group. Due to the variability in the demographics, the statistical results that follow must be interpreted with caution.

Primary Hypothesis Results

A one-way repeated measures ANOVA with one between-subjects factor was conducted to investigate the omnibus question that there was no difference among intervention received. An alpha of .05 was used. The within-subjects variables were two live practice sessions, game 1 and game 2. The between-subjects factors, the intervention levels, were the treatment (the simulation) and the comparison application (the non-simulation). Results of game 1 and game 2 represent the set of target acquisition scores based on live practice sessions in the RE. However, target acquisition data could not be collected on one participant who was not able to show for the second-half of the study, nor for three of the participants from game 1, and one of the participants from game 2, leaving a complete sample size of 19.

Hypothesis 1

Null Hypothesis 1: There is no significant difference in target acquisition scores for individuals who received the simulating treatment and those who received the non-simulation comparison application while performing in an HRC real environment.

The findings and descriptive statistics of the between-subjects effects are illustrated in Table 6. The between-subjects effects suggests that there was a statistical significant difference in target acquisition scores, ($F_{1,17} = 4.68$, $p = 0.045$) based on type of intervention received. The simulation treatment (*M* =127.42, *SD* = 109.26) had a higher mean score than the non-simulation comparison application (*M* = 80.25, *SD* = 66.69). Approximately 22% of the variance in score can be accounted for by intervention.

Table 6

Findings and Descriptive Statistics Based on Intervention Received

					Simulation		Non-Simulation	
	DF	*F*	Sign	Partial Eta Sq	*M*	*SD*	*M*	SD
Intervention	1,17	4.679	0.045	0.216	127.42	109.26	80.25	66.69

Hypothesis 2

Null Hypothesis 2: There is no significant change in target acquisition scores from game 1 to game 2 based on practice while performing in an HRC real environment.

As illustrated in Table 7, the study results suggests there is no statistically significant change in target acquisition scores ($F_{1,17}$ = 1.77, p = 0.20). Although game 2 scores (M = 70, SD = 69.55) were higher in mean than game 1 scores (M = 45.57, SD = 49.48), only 9% of the variance in score can be accounted for by practice.

Table 7

Findings and Descriptive Statistics by Practice

					Game 1		Game 2	
	DF	*F*	Sign	Partial Eta Sq	*M*	*SD*	*M*	SD
Practice	1,17	1.769	0.201	0.094	45.57	49.48	70.00	69.55

Hypothesis 3

Null Hypothesis 3: There is no interaction between type of intervention received and practice in an HRC environment.

As illustrated in Table 8, study results suggests there is no significant interaction between intervention and practice ($F_{1,17}$ = .19, p = 0.67). Only one percent of the variance in score can be accounted for by intervention.

Table 8

Interaction Findings Based on Practice and Intervention

	DF	*F*	Sign	Partial Eta Sq
Practice * Intervention	1,17	0.190	0.67	0.011

Chapter Summary

Although no statistical significance was found in mean scores from game 1 to game 2, nor was there an interaction based upon practice, evidence suggests there was a statistical significance found in the type of intervention received. This statistical significance is of considerable importance since the focus of my study was to determine if there was a difference in the transfer of a skill to the real environment based upon type of intervention received. What is of continued interest is determining which training intervention and which key variables would aid in the greatest transfer to a real situation. Additional research is definitely warranted.

CHAPTER FIVE: DISCUSSION AND CONCLUSION

My study investigated training effectiveness based on exposure in a virtual environment (VE) measured by the transfer of a skill (target acquisition), in a real environment (RE). Simulations are often used to help create virtual environments to aid in training effectiveness (Paul et al., 2005). However, there is still a lack of empirical studies that focus on paintball or HRC settings as conditions for learning. My study was intended to create an HRC setting that would cause participants to have a high cognitive load based on the dynamic and stressful conditions offered by live game play. This type of environment was duplicated in a research study by Atkins and Norris, (2004) for law enforcement agents. Two levels of the intervention, the simulation treatment and the non-simulation comparison application, were used to make the determination if the treatment depicting a VE had a greater transfer of the skill target acquisition in the RE than the comparison application.

To examine the research question investigated in my study a posttest-only randomized comparison group research design was used. Participants were randomly assigned to a treatment or comparison application. The treatment method was a simulated computerized paintball game in which participants were able to practice for two, 10-minute games. The comparison application was a non-simulated paper-based text with graphics material on the topic of shooting fundamentals, in which participants read through the material twice, for approximately 10 minute each.

Three hypotheses were tested using repeated-measures ANOVA. The results suggest that the type of intervention received had a significant difference in target acquisition scores. Chapter four statistically detailed the results of the three null hypotheses. In chapter five, the hypotheses are related back to the research question and explained based on Ackerman's (1988) existing Theory of Ability Determinants, the transfer of learning concepts, and research findings of supportive literature. This chapter finishes with an overview of implications of the findings and concluding remarks regarding limitations and opportunities for replicating studies.

Interpreting Hypotheses

Hypothesis 1

Overall, findings of my study suggest that there is a significant difference in the performance of novice players in the number of targets acquired in a RE based on the type of training intervention received. One explanation for this significant result could be the reduction in cognitive overload due to prior practice in a simulated environment. As noted by Atkins and Norris (2004), stress plays a role in the creation of cognitive overload, however experience also plays a role in the improvement of scores. For example, one result from the Atkins and Norris study, that measured performance of shot placement (which included weapons clearing, number of shots saved, shots placed on the subject, and shot placement on the suspect) indicated a 70% accuracy for only 3.4% of the trainees and only 19.4% of all rounds fired hit the suspect that was only 3 feet away. However, those with experience recorded a 37.31% pass rate compared to no experience at 9.68% pass rate. This finding suggests that cognitive overload played a part as a limiting factor in their scores, but with experience results improved.

The intervention levels in my study used different cognitive applications for acquiring the basic procedures for target acquisition. The treatment (the simulation) falls under the “mechanical” cognitive process, whereas, the comparative application falls under the “verbal” based cognitive process. Those who received the treatment may have performed better because the mechanical application was experiential and therefore easier to assimilate than the verbal application of text alone. To help determine which intervention had a greater effect, selected cases with an “If” condition of “1” for treatment and then “2” for comparison were conducted. The statistical significance for the treatment group ($p < 0.002$) and comparison group ($p < 0.003$) are equal. In addition, the literature does support the use of a learning tool, such as a map experiment conducted by Munzer, Zimmer, Schwalm, Baus, and Aslan (2006) for wayfinding in which the map-based condition was significantly better than the auditory, walking guided condition ($F_{1,60} = 19.54$, $MSE = 0.0135$, $p < 0.001$). As in the study by Foreman, et al., (2003), a virtual desktop computer display to aid in improved performance resulted in a significant main effect of group, the magnitude of which was large ($F_{1,10} = 10.83$, $MSE = 1002.21$, $p < 0.01$). This was an indication that those trained in Foreman, et al., study using the VE, made fewer errors than those trained with a physical model. In my study, either intervention could be seen as a learning tool but should favor the VE.

Since evidence suggests there is a link between the intervention (learning) and performance (target score increases) it is assumed that some form of transfer took place. For those participants who did not score a “hit” it is likewise assumed that negative transfer could have been experienced (Leberman et al., 2006) in response to finding, aiming, and shooting. One reason for this potential lack of transfer could be because the use of a “marker” versus either computer key strokes or a text description is not equivalent activities and could have inhibited performance. On the other hand, for those participants who received the treatment and were successful in scoring “hits” a type of complex transfer (Leberman et al., 2006) could have been experienced. This complex transfer involved the ability to translate their skills from using a keyboard to aim and fire in a VE to using a “marker” to aim and shoot in a RE. In addition, near and far transfer (Leberman et al., 2006; McKeachie, 2001; Royer, 1986) could have been achieved for those participants who were able to acquire a “hit” in the RE. Near transfer could have been experienced by participants who were already proficient at shooting a hand gun (previous knowledge and skill) and then were able to shoot a “marker” correctly in the RE. Far transfer could have been experienced by participants who received the comparison application and yet were able to find, aim, and shoot a “marker” correctly in the RE.

An additional reason for significance may be due to the error in self-report of actual targets. The lack of verification of the self-reported number of “hits” through viewing the video recordings was limited and not conclusive. Thus, the inflated verbal responses provided by the participants were used. As noted through Ackerman’s (1988) theory, a high cognitive demand would have occluded the participant from remembering a count when the basics of finding, aiming, and shooting were still the main focus. Overall, the number of opponents hit, as noted by self-report for game 1, totaled 28, and for game 2, totaled 30. These numbers were greater than the number of participants on the field (N = 23) at the start of each practice session.

To help further explain the difference found in null hypothesis 1, a repeated-measures ANOVA with age as a covariate was considered but the subset (n = 15) became too small to be able to report. In addition, in both game 1 and game 2, twice as many younger participants from

18 to 30 years of age (n = 8) were found in the simulation treatment group. Whereas, three times as many older participants from 31+ in age (n = 9) were found in the non-simulated comparison group compared to the younger participants (n = 3). As noted earlier, what may confound the findings is the unequal balance in age between the two groups and the fact that all female participants (n = 5) were part of the non-simulation comparison group. However, the missing data values indicated that all missing participants were part of the younger group and 4 of the 5 were part of the simulation group. Essentially, the inclusion of these participants may have created a lower significance when group means were compared.

As noted in chapter four, gender emerged as a significant factor in practice 2 scores. During the break period, 3 of the 5 female participants did not continue game play in the RE. However, it cannot be determined if continued play during the break period might have had an impact on practice 2 scores.

Hypothesis 2

Findings fail to reject hypothesis 2 that focused on a change in target acquisition scores based on practice (game 1 and game 2). Although the mean scores from game 1 to game 2 did increase, indicating an improvement, findings suggests there were no significant difference at 0.05 level between the means. Lack of significance may be found in four potential areas: (a) the small sample size (n = 19), (b) the limitation in time with the interventions (two, 10-minute segments), (c) the limitations in time with the practice sessions (game 1 lasted approximately 2 ½ minutes, while game 2 lasted approximately 5 minutes), and (d) in the length of the break period (one hour). If the participants would have had enough practice time either with the interventions, in the number of live practice sessions played (recorded games), or in the number of games played during the break period (more opportunity to play against experienced players), target acquisition scores may have improved, over time, from game to game. Two studies, one by Ackerman (1992) and the other by Bebko et al., (2005), showed that practice had a positive effect on learning. As with Atkins 1992 study, over 19 practice trials were provided. Results confirmed the significant effect of practice ($Fs_{19,1900} = 205.68$, $ps < 0.01$). Practice significance was also shown by Bebko et al., (2005) in the within-factor ($F_{5,35} = 20.26$, $p < 0.0001$) and the between factor ($F_{1,7} = 6.58$, $p < 0.037$) for juggling skills based over 26 practice sessions. Based on the findings of these two studies, significance would be anticipated to increase target acquisition scores in my study if practice was properly afforded.

Finally, because findings suggests there was no significance in target acquisition scores, it could be assumed that participants did not accomplish two things: (a) a higher level of cognitive processing, and (b) the associative phase in Ackerman's (1988) theory. Higher level processing requires connections to be made between the environments and experience (Desse, 2001; McKeachie, 2001; Price & Driscoll, 1997) but, which novice players may be ill-equipped to achieve (Kuhn et al., 2000). In addition, higher level processing is accomplished through communities of practice (Greeno, 1998), in which participants develop predictable patterns of behavior on the paintball field. To accomplish the associative phase, the basic procedures in finding, aiming, and shooting had to be learned. These basic skills were probably not formed at a significant level due to limited exposure to the interventions or experience in live game play.

Hypothesis 3

Findings suggest that there was no statistically significant interaction between intervention received and practice. Statistically the target acquisition scores did improve, although not significantly, from the game 1 to game 2, which may suggest a natural tendency of improved behavior with exposure to an activity. Due to the parallel movement in scores, it appears that practice did not have a greater or lesser effect on one type of intervention over the other. If my study had included a mix of novice players with experienced players there may still not have been an interaction effect, as based on the juggling study conducted by Bebko et al., (2005) in which no interaction was found, ($F_{5,35} = 1.72$, $p > 0.205$). In the Bebko et al., (2005) study, the experienced jugglers remained ahead of the novice jugglers throughout the study.

Conclusions

The finding of a significant difference in target acquisition scores and the type of intervention received has implications for the type of training applied to those learning skills for high risk confrontational settings. Communities of practice mentioned in chapter one include practitioners, instructional technologists, and researchers. For the practitioner, the advantages of using a desktop simulation, rather than text-based non-simulated material, should be considered for tasks that are physically demanding, dynamic in nature, and involve complexity and risk.

As an instructional technologist, since it appears that various dimensions of transfer did take place, the selection of an appropriate use of a desktop computer simulation should be considered as a type of medium to use for HRC training applications. Determination of the proper training methodologies to apply to specific HRC settings would be of great value to decrease the learning gap and increase safety while advancing students from basic knowledge to practical application.

The research community should continue to explore and quantify desktop simulations as a training medium and explore the variables that would provide the greatest effectiveness of transfer. For example, if earlier research suggests that simulation can provide a better method for learning how to strategize in an HRC setting and, simple textual material provides a better method of introduction to learning fundamentals in preparing for an HRC encounter, then a multi-media approach should be researched to define the specific dimensions of transfer.

There are a number of limitations in my study including statistical concerns and uncontrolled extraneous variables that impact the utility of the results. To overcome some of the limitations encountered, several considerations should be made for replicating studies. Statistically, the number of subjects is of concern; the complete sample size ended up being 19 whereas a robust study would have consisted of a minimum of 32 participants. A pretest should be considered to help overcome the low sample size and the power estimate. In addition, post-hoc tests were not run because of my original independent variable design. Adding a control group as a third level, will provide additional findings and allow post-hoc analysis, if required. The amount of time spent playing the desktop computer-based paintball game was limited to two, 10 minute sessions. This duration could be increased in order to have a greater exposure to the VE leading to the potential of increased transfer in the RE.

The classification matrix had dichotomous choices which may not be “standardizable” across participants. That is, each participant might have different “definitions” of the two options given for the items of the classification matrix. Creating a scale would eliminate individual participant interpretation.

To enhance the non-simulated comparison application, a plastic pistol should be provided to participants reading about shooting fundamentals. This may provide non-gun owners a better sense of finding, aiming, and shooting even though the "markers" did not have sights for aiming.

Certain aspects of the video recording process contributed to the degradation of the quality of the visuals. First, mesh protection of two of the cameras created a fuzzy appearance when viewing the videos. Protecting the cameras with Plexiglas opposed to mesh would enhance the video quality. Second, the visuals were affected by the outdoor lighting which could have been corrected by placement of the cameras inside the protective mesh area or by using a smaller, well lit indoor field. Overall, the mesh and lighting aspects made the alphabetic T-shirt identification of each participant difficult, although achievable. Finally, a fourth camera would have provided extra coverage needed for such a large playing field and potential data regarding participants not viewable from the other three cameras.

Aside from the visual quality, being able to track a paintball in flight was not possible. The speed of the paintballs exiting the "marker" prevented video capture. It was therefore difficult to determine if the participant applied a strategy, like selective shooting, or if a random spray technique was employed. Rather than using a "marker," a comparable laser tag apparatus may be less cumbersome and may assist in more accurate record keeping.

As noted earlier, being able to manipulate specific variables within the training context would provide the opportunity to examine aspects of one medium to determine which variables have a greater impact on performance. In addition, adding in factors that influence teaming and strategy formation could aid in the transfer of learning.

Finally, having a mix of experienced players within the teams would provide a more representative sample of typical HRC situations. For example, the introduction of novice players (which represent the community) mixed with experts (which, for example, represent experienced police officers) may show an increase in skill for novice players based on tangible examples of the successful behavior, as well as provide the potential benefits of teaming and strategizing.

The results of my study suggest a movement towards the attainment of higher critical thinking described in Ackerman's (1988) theory. Some participant's seemed to advance from the cognitive phase to the associate phase for several of the reasons described earlier, while others seemed to remain in the cognitive phase. However, if participants are provided the opportunity to gain enough practice time, either through additional exposure to type of intervention or through additional live practice sessions, participants would then be able to advance from the basics learned in the cognitive phase to the connection of patterns found in the associative phase.

APPENDIX A. COPYRIGHT PERMISSION

From: Paul Milgram [mailto:milgram@mie.utoronto.ca]
Sent: Sunday, September 16, 2007 10:53 PM
To: Carolyn Prickett
Cc: Paul Milgram
Subject: Re: RV Continuum Permission

Hi Carolyn,

I shall be greatly honoured to have you use that figure in your dissertation. Thanks for asking

I wish you the best of luck in the defence of your thesis.

Best regards,
Paul Milgram

Hello Dr. Milgram:

I am a student at the University of Central Florida and pursuing my doctorate degree in Instructional Technologies. My dissertation is in regards to simulation and transfer of learning. I would like permission to use your Reality-Virtuality Continuum figure, as found in your 1994 Augmented Reality: A class of displays on the reality-virtuality continuum, article. Please advise if permission to use in my dissertation is authorized.

Thank you so much for the great work you have produced in this area.

Carolyn Kinsell *(formally Prickett)*

--
****

Prof. Paul Milgram
Dept. Mechanical & Industrial Engineering, University of Toronto
milgram@mie.utoronto.ca
Tel/Fax: 416-978-3662
http://etclab.mie.utoronto.ca

APPENDIX B: RECRUITMENT EMAIL

Hello,

I would like to request your participation in my dissertation study that is measuring the transfer of a skill (finding, aiming, and shooting) in a live paintball setting. Due to the cost of using the paintball facilities, there is a minimal fee of $20.00 to cover protective gear and paintball gun rental. This fee is to be paid at the time of live participation to the facility itself.

I have attached two files required for this study: (a) a consent form, (b) and a classification matrix. Please complete and sign each form and fax to me at 407-381-0017 or provide me with hard copies as soon as possible. Once I have received all forms from each participant, I will then randomly assign each participant to a group. Those who are selected for Group A will be asked to participate in a computer based simulated paintball game networked at University of Central Florida. Those assigned to Group B will be asked to participate in a non-simulated, text based write up of target acquisition. Those assigned to both Group A and Group B will then participate in live play at the Orlando Paintball facilities. Directions to UCF and to Orlando Paintball will be sent upon notification of your assigned group.

Note, in the consent form, it indicates that the UCF meeting will be held on a Saturday, it has actually been changed to a Sunday. The dates of participation are:
UCF 13 January 2008 (selected times to be determined)
Orlando Paintball 15 Jan 08 (start at 6:00pm)

If you know of any other novice players of the game of paintball, laser tag, or airsoft that would be interested in participating in this study please provide me with an email address. I will then send the potential participant the proper information and forms.

Thank you for your time. I will be back in touch once all forms have been received and group assignments made.

If you have any questions, please email or call me at xxx-xxx-xxxx (cell).
cjkinsell@gmail.com

APPENDIX C: CONSENT FORM

Consent form given by student interviewers to INVESTIGATING THE EFFECTS OF SIMULATION ON TRANSFER OF LEARNING IN A HIGH RISK CONFRONTATIONAL SETTING as part of Dissertation coursework.

December 7, 2007

Dear Participant:

I am a graduate student at the University of Central Florida and I am conducting a study this spring, under the leadership of Dr. Atusi Hirumi and Dr. Lea Witta of the Department of Educational Research, Technology, and Leadership of the UCF College of Education. You are being invited to participate in this study based upon the criteria of being a novice player in the live game of paintball, airsoft, or laser tag. To participate, you will be randomly selected to be part of one of two groups. Half the group will be exposed to a PC game of paintball and then live play; the other half will only be exposed text based material and then to live play. The purpose of this study is to test if the exposure to the PC game or exposure to the text based information transfers the skill of target acquisition to a real environment (a live paintball game).

Due to the costs involved in playing live paintball, there will be a minimum fee of $20.00 to participate. You will be provided paintballs (at not cost) to play two live games. In addition, you must be 18 years of age to participate. The required time to participate will be approximately 45 minutes on a Saturday and then for several hours on a Tuesday evening. Location for the PC game and text based information is at a designated room on UCF campus (see directions below). You will have the opportunity to practice for two sessions for 15 minutes each. After the meeting at UCF, you will be asked to appear at Orlando Paintball, herein referred to as the 'facility', (see directions below) on a following Tuesday evening starting at 6:00pm. After waivers for this study and forms from the facility have been signed, paintball safety gear and marker acquired, you will be provided a set maximum number of paintballs (200) for live play per game.

There will be two live competitions. After the first game has ended, there will be a 2 hour break period. During the break period, you are free to continue playing the game of paintball or resting. After the 2 hour break period has ended, you will be asked to play a second round of paintball starting at 8:00pm. After the concluding live paintball session, you will be asked to complete a reaction questionnaire (take no more than 5 minutes). Upon completion of the data gathering sessions (live paintball plays) you are free to continue playing paintball until the Orlando Paintball facilities closes. Any remaining paintballs from the study will be provided to those players who wish to stay and play.

Overview Schedule

Activity
Meet at UCF Participate in a paintball training method (PC game or text based material) Complete a Reaction Questionnaire
Meet at Orlando Paintball Facilities Tuesday Evening (date TBD) Meet 6:00pm Sign Waivers Acquire Safety Gear Acquire Marker Acquire Paintballs One round of live play starting about 6:30pm – 6:45pm Break Starting at roughly 6:50pm – 8:50pm Second round of live play starting about 8:50pm to 9:05pm Complete a Reaction Questionnaire (5 minutes)
Study ends. You may continue live play

Please be aware that you are not required to participate in this study and you may discontinue your participation at any time without penalty or consequences. Your identity will be kept confidential. Your responses will be analyzed and reported in the aggregate to protect your privacy. All data, including video tapes, will be stored in a locked cabinet. Any data collected will be used exclusively for this studies development and dissemination of results. After data analysis of the video tapes, these tapes will be destroyed (erased) and your identity kept confidential.

There is no compensation or other direct benefits to you as a participant in this study. If you have any questions about this research project, please contact my faculty supervisor, Mr. Atusi Hirumi, at 407.823.1760 or Dr. Lea Witta at 407.823.3220.

There are two types of minimal risks in playing a live game of paintball. First, protective head gear is being worn by each participant, as required by Orlando Paintball. However, there is still an anticipated minimal risk that bruising to unprotected areas (e.g., arms, legs) by a paintball's direct hit could occur. Second, participants may be running and therefore run into another participant of a stationary object on the playing field. To minimize risk during research, Orlando Paintball employees will instruct players on the rules of shooting an opponent at a safe distance and in setting their "markers" to a specific power.

As a participant in this study, if you were to become injured during the research, a claim with UCF Environmental Health & Safety, Risk and Insurance Office, P.O. Box 163500, Orlando, FL 32816-3500 (407) 823-6300. The University of Central Florida is an agency of the State of

Florida for purposes of sovereign immunity and the university's and the state's liability for personal injury or property damage is extremely limited under Florida law. Accordingly, the university's and the state's ability to compensate you for any personal injury or property damage suffered during this research project is very limited.

Information regarding your rights as a research volunteer may be obtained from Barbara Ward, Institutional Review Board (IRB) University of Central Florida (UCF), 12201 Research Parkway, Suite 501, Orlando, FL 32826-0150, (407) 823-2901.

If you decide to participate in this research study, please sign the consent form. The signed consent form will be collected either in person at the time of our first meeting, or, it can be mailed to the address below or faxed to 407.823.4880. Mail to: Carolyn Kinsell (formally Prickett), c/o Dr. Atusi Hirumi, P.O. Box 161250, Orlando, FL 32816-1250.

A second copy of this consent form will be provided for your records.

Sincerely, ___________________________ (Principle Investigator)

Carolyn Kinsell (formally Prickett) (Printed Name)

Contact information:
xxx-xxx-xxxx
cjkinsell@gmail.com

Consent Form

Project title: INVESTIGATING THE EFFECTS OF SIMULATION ON TRANSFER OF LEARNING IN A HIGH RISK CONFRONTATIONAL SETTING dissertation study for the University of Central Florida

___I am 18 years of age or older

___I agree to pay a maximum fee of $20 to participate

___I voluntarily agree to participate in the paintball study

___I voluntarily agree to be video taped

___I do not agree to be video taped (if you do not agree to be video taped, you will be dropped from the study)

___I understand that participation in this study may result in minimal harm, such as bruising by being hit by a paintball or by running into objects on the playing field. To make a claim against such harm would be minimal based on state laws but to do so would be through the State of Florida: UCF Environmental Health & Safety, Risk and Insurance Office, P.O. Box 163500, Orlando, FL 32816-3500 (407) 823-6300.

___I voluntarily agree to participate in the reaction questionnaire.

___I have read the procedure described above. I have read the consent form and agree to allow the researchers to use the information I provide for related presentations and publications.

Participant__________________________________

Date__________________________________

APPENDIX D: CLASSIFICATION MATRIX

Classification Matrix

> We are taking a quick snapshot of your capabilities in playing personal computer type games and in your physical abilities and shooting experience (if any). By answering these few questions, we will be able to have equal distribution of novice players between two teams. There is no right or wrong answer. If you have no capabilities in an area, please mark Low as your answer. Your name is required so that we may identify you as to the group in which you will belong.

Name: ____

Directions: Select the best answer that applies to you by placing an 'X' in the appropriate box.

START HERE

Do you consider yourself to have high or low computer skills?
□ High Computer Skills
□ Low Computer Skills

Do you consider yourself to have a high or low physical ability?
□ High Physical Abilities
□ Low Physical Abilities

Do you consider yourself to have a high or low shooting ability?
□ High Physical Abilities
□ Low Physical Abilities

Select your appropriate age range.
□ 18 – 30
□ 35 - older

Please return your answers either by email or fax to Carolyn Prickett
Email: cjkinsell@gmail.com
Fax: xxx-xxx-xxxx

END HERE

APPENDIX E: GROUP EMAILS

Email for Group A

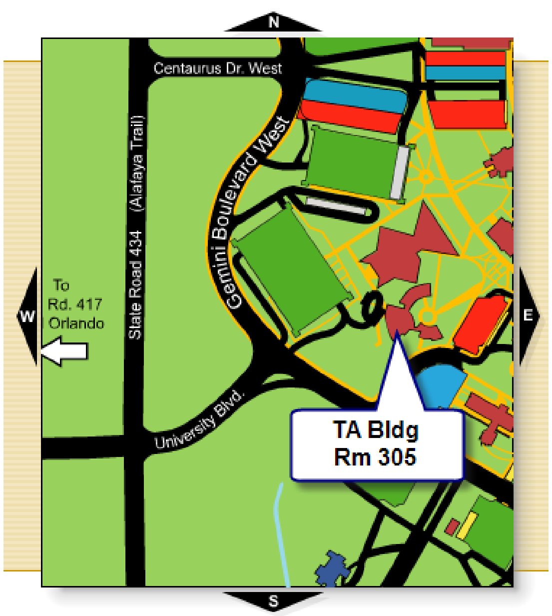
Thank you for your desire to participate in my research study. You have been randomly assigned to Group A. As a group, we will be meeting at UCF in room TA 305. The room has been reserved from 1:00pm through to 4:00pm. I have pre-selected a time for you to participate in a simulated networked play of paintball. If your assigned time is not appropriate for your needs, please advise via email if you can or show up at the time that best fits your schedule.

___ 1:15 – 1:50pm
___ 1:55 – 2:30pm
___ 2:35 – 3:10pm
___ 3:15 – 3:50pm

Direction to UCF are attached. The building is the Teachers Academy (TA), Room 305. If you need assistance in finding the location, please call me on my cell at xxx-xxx-xxxx.

University of Central Florida
400 Central Florida Blvd.
Orlando, FL 32816

UCF
400 Central Florida Blvd.
Orlando, FL 32816



The next stage of this study will be a separate email with date, time and directions to participate in the live paintball games. Thank you so much for your participation in this study and for the amount of time you have provided.

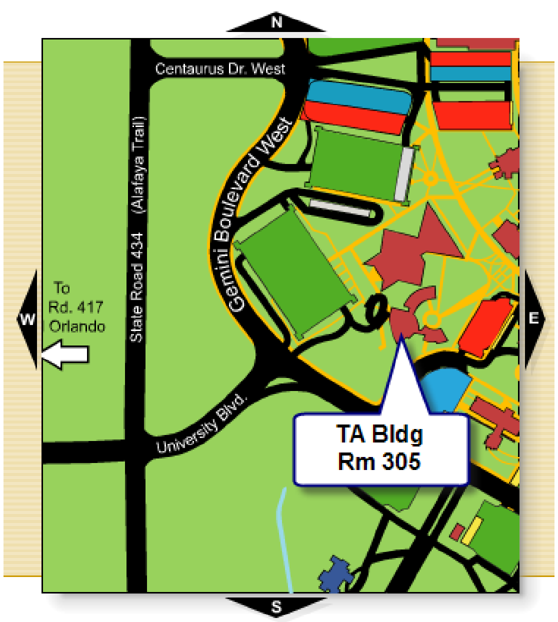
Email for Group B

Thank you for your desire to participate in my research study. You have been randomly assigned to Group B. As a group, we will be meeting at UCF in room TA 305. The room has been reserved from 1:00pm through to 4:00pm. I have pre-selected a time for you to participate in the non-simulated, print based version, on target acquisition. If your assigned time is not appropriate for your needs, please advise via email or cell phone. If need be, show up at the time that best fits your schedule.

___ 1:15 – 1:50pm
___ 1:55 – 2:30pm
___ 2:35 – 3:10pm
___ 3:15 – 3:50pm

When on the UCF campus, the TA building is located near University Blvd. If coming from University, turn right on to Gemini Blvd. The building is the Teachers Academy (TA), Room 305. If you need assistance in finding the location, please call me on my cell at xxx-xxx-xxxx.

University of Central Florida
400 Central Florida Blvd.
Orlando, FL 32816



UCF
400 Central Florida Blvd.
Orlando, FL 32816

The next stage of this study will be a separate email with date, time and directions to participate in the live paintball games. Thank you so much for your participation in this study and for the amount of time you have provided.

APPENDIX F: PAINTBALL FACILITY DIRECTIONS

Orlando Paintball Meeting Information

Date:	15 Jan 08
Day:	Tuesday
Start Time:	6:00 pm
End Time:	approximately 9:00 pm

After the study has concluded, you are welcome to continue playing until closing (which should be midnight).

Directions:
Orlando Paintball
7215 Rose Ave
Orlando, FL 32810
(407) 839-3839

http://www.orlandopaintball.com

Directions acquired from Orlando Paintball website:

LOCATION

ORLANDO PAINTBALL IS LOCATED JUST MINUTES FROM DOWNTOWN ORLANDO.

GET OFF LEE RD (EXIT 88) ON I-4 AND HEAD WEST. TURN RIGHT (NORTH) ON ORANGE BLOSSOM TRAIL (441), AFTER 2 MILES. THEN, TURN RIGHT ON ROSE AVE, AFTER 1 MILE. WE ARE 200 YARDS ON THE RIGHT SIDE, LOOK FOR A SET OF BRIGHT YELLOW BUILDINGS!

7215 ROSE AVE. OFF OF ORANGE BLOSSOM TRAIL.

APPENDIX G: REACTION QUESTIONNAIRE TRAINING METHODS

Reaction Questionnaire Training Methods

Directions: Please select the response for each item that best reflects your opinion.

START HERE

1. Have you ever practiced shooting at a target in the past?

   ☐ No ☐ Yes

2. If yes, how accurate do you feel you were at hitting your target?

   - ☐ Very accurate
   - ☐ Accurate
   - ☐ Neither accurate nor inaccurate
   - ☐ Inaccurate
   - ☐ Very inaccurate

3. Which training method did you receive ☐ PC game ☐ Text based

4. Do you feel the training method you received will be of help to you during the live play sessions? ☐ No ☐ Yes

   Why? ____ ____

   ____

5. Was the training method you received mentally challenging?

   ☐ No ☐ Yes

   Why? ____

   ____

END HERE

APPENDIX H: REACTION QUESTIONNAIRE LIVE PLAY

Reaction Questionnaire Live Play

Directions: Please select the response for each item that best reflects your opinion.

START HERE

1. Have you ever practiced shooting at a target in the past?
   □ No □ Yes

2. How accurate do you feel you were at hitting a target on the field during live play?
   - □ Very accurate
   - □ Accurate
   - □ Neither accurate nor inaccurate
   - □ Inaccurate
   - □ Very inaccurate

3. Which training method did you receive □ PC game □ Text based

4. Do you feel the training method you received was of help to you during the live play sessions? □ No □ Yes

   Why? _____ ____

   ____

5. Were the live paintball sessions mentally challenging to play?
   □ No □ Yes

   Why? ____

   ____

END HERE

APPENDIX I: IRB APPROVAL LETTER

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901, 407-882-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Notice of Expedited Initial Review and Approval

From : **UCF Institutional Review Board**
FWA00000351, Exp. 5/07/10, IRB00001138

To : **Carolyn Prickett**

Date : **December 07, 2007**

IRB Number: **SBE-07-05338**

Study Title: **INVESTIGATING THE EFFECTS OF SIMULATION ON TRANSFER OF LEARNING IN A HIGH RISK CONFRONTATIONAL SETTING**

Dear Researcher:

Your research protocol noted above was approved by **expedited** review by the UCF IRB Vice-chair on 12/6/2007. **The expiration date is 12/5/2008.** Your study was determined to be minimal risk for human subjects and expeditable per federal regulations, 45 CFR 46.110. The category for which this study qualifies as expeditable research is as follows:

6. Collection of data from voice, video, digital, or image recordings made for research purposes.

7. Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

The IRB has approved a **consent procedure which requires participants to sign consent forms.** Use of the approved, stamped consent document(s) is required. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Subjects or their representatives must receive a copy of the consent form(s).

All data, which may include signed consent form documents, must be retained in a locked file cabinet for a minimum of three years (six if HIPAA applies) past the completion of this research. Any links to the identification of participants should be maintained on a password-protected computer if electronic information is used. Additional requirements may be imposed by your funding agency, your department, or other entities. Access to data is limited to authorized individuals listed as key study personnel.

To continue this research beyond the expiration date, a Continuing Review Form must be submitted 2 – 4 weeks prior to the expiration date. Advise the IRB if you receive a subpoena for the release of this information, or if a breach of confidentiality occurs. Also report any unanticipated problems or serious adverse events (within 5 working days). Do not make changes to the protocol methodology or consent form before obtaining IRB approval. Changes can be submitted for IRB review using the Addendum/Modification Request Form. An Addendum/Modification Request Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at http://iris.research.ucf.edu .

Failure to provide a continuing review report could lead to study suspension, a loss of funding and/or publication possibilities, or reporting of noncompliance to sponsors or funding agencies. The IRB maintains the authority under 45 CFR 46.110(e) to observe or have a third party observe the consent process and the research.

On behalf of Tracy Dietz, Ph.D., UCF IRB Chair, this letter is signed by:

Signature applied by Janice Turchin on 12/07/2007 04:17:46 PM EST

Janice m Turchin

IRB Coordinator

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