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Effects of Virtual Reality on the Cognitive Memory and Handgun Accuracy Development of Law Enforcement Neophytes

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Effects of Virtual Reality on the Cognitive Memory and Handgun Accuracy Development of
Law Enforcement Neophytes

by

Richard A. Wright

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
Department of Adult, Career and Higher Education
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Dedication

I would like to thank my family who inspired me to continue my education and supported my efforts for the last several years. I would like to dedicate this dissertation to my children, Eli, Alexandra, and Jordan who have missed their father for so many nights and sometimes even the weekends. Although I have not always been there for the last several years, I hope this will serve as an example of what you can do, despite what others may say. All you have to do is believe that you can.

I would also like to thank Dr. Wayne James for believing in me and more importantly, for teaching me to believe in myself. Thank you for putting me under your wing the first night I reached out in desperation—believing that I had made a mistake. Because of you, my academic and professional career has gone farther than I had ever hoped.

Finally, I would like to thank my parents, Dee and Art for simply just listening to my frustrations when I had to vent. Although I may have had to learn how to believe, the both of you taught me a work ethic that gave me the fuel I needed to travel this long road. Now that it is over, I promise to pass on what you have taught me to my children so that they too can achieve anything their heart's desire.

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Abstract

The purpose of this research was to investigate the effects of virtual reality training on the development of cognitive memory and handgun accuracy by law enforcement neophytes. One hundred and six academy students from 6 different academy classes were divided into two groups, experimental and control. The experimental group was exposed to virtual reality training for a period of 8 hours. The control group was exposed to the traditional, non-interactive training that occurred on a gun range, also for a period of 8 hours. After exposing the groups to their respective training, a counter-balance technique was utilized to expose both groups to a series of 3 law enforcement related scenarios. The time and number of shots that each participant used to cognitively process and solve the scenarios were collected and analyzed by group and gender. There was a significant difference, by group, in both time and accuracy, with the virtual reality group using less time and posting more accurate scores. Mean accuracy scores indicated that the males participants were more accurate in their response to the scenario administration.

Chapter 1

Introduction

In 2008, the U.S. Department of Justice, Bureau of Justice Statistics reported that there were 17,985 state and local law enforcement agencies in the United States. These agencies employ approximately 765,000 sworn law enforcement officers. During a four-year period, from 2004-2008, the total number of law enforcement officers nationwide increased by 33,000 officers or 4.6% (Reaves, 2011).

The training of new officers is a responsibility charged to an institution that provides the minimum training standards set by the governing State. This institution is most commonly known as a law enforcement academy, but is often affiliated with larger organizations such as colleges, universities, technical colleges, or a municipal police agency.

In 2002, the U.S. Department of Justice, Bureau of Justice Statistics (2005) conducted a census of law enforcement academies throughout the United States. As of yearend 2002, a total of 626 state and local academies were operating in the United States that offered basic law enforcement training to individuals recruited or seeking to become law enforcement officers. Included in these 626 academies were: (a) 274 county, regional, or state academies; (b) 249 college, university, or technical school academies; and (c) 103 city or municipal academies. The total expenditures of training academies during fiscal year 2002 was an estimated \$725.6 million, including \$351.2 million among

county, regional, or state academies, \$299.4 million among city or municipal academies, and \$75.1 million among college, university, or technical school academies (United States Department of Justice [USDJ], 2005).

The 2002 census also reported that the median class size among all academies ranged from 21-32 neophytes. Larger academies generally had larger class sizes, ranging from 27-50 neophytes among those academies having 100 or more full-time training personnel. Further, among all academies nationwide, a total of 53,302 neophytes successfully completed the basic law enforcement recruit training.

The curriculum for these academies is extensive and encompasses an average of 720 hours of training. The national figures stipulate a range of 620-840 hours. Instructional topics included in the training are, but not limited to, firearms, basic first-aid/CPR, emergency vehicle operations, self-defense, criminal law, use of non-lethal weapons, community policing, etc. The largest portion of this training was related to firearms where a median of 60 hours was reported.

This research study was conducted in the state of Florida; therefore, it was appropriate to note that 387 law enforcement agencies from Florida were represented in the national statistics. These agencies included 46,105 sworn law enforcement officers (USDJ, 2011). Additionally, the state of Florida included approximately 6.5% of the nation's law enforcement academies. This figure equated to 41 academies throughout the state.

Virtual reality is a training tool that is available to 78% of law enforcement training academies nationwide. Fifty-eight percent of the nation's academies reported that this tool was part of their facility (USDJ, 2005). Published statistics did not report on

the number of firearm simulators exclusive to Florida academies; however, queries to Ti Training, Inc., a vendor holding accounts in Florida, reported that as of yearend 2009 their company had supplied simulators to at least six different county or municipal agencies (T. Brown, personal communication, September 29, 2010).

This research study used a firearms simulator, known also as virtual reality. Numerous terms have been associated with virtual reality and it appears that the definition is consistent with the software's application. For the purpose of this study, the following definition was used: a technologically-created environment that incorporates representations of real-world elements such as human beings, landscapes, and other objects (Kock, 2008).

Virtual reality training for law enforcement neophytes is an area that has not been thoroughly researched. Based on the reported availability to law enforcement academies, relevant research on its effects would be beneficial to a broad spectrum of training personnel. This study was designed to broaden the body of knowledge in the use of virtual reality in law enforcement training.

Statement of the Problem

There has been no research on the cognitive memory and handgun accuracy development of law enforcement neophytes through the use of virtual reality. Additionally, traditional training of police officers has been an evolving process. Previously, if there was inadequate training of a law enforcement neophyte it was subsidized by experienced trainers and mentors who often trained by example. Generational attrition has created a gap in experienced mentors once used for guidance by newer officers (T. Hughes, personal communication, February 2010). Through the

multitude of available scenarios, virtual reality provides a repetitive learning process that can fill the void created by natural attrition.

Scenario-based training is a technique used by a vast majority of law enforcement academies throughout the United States. Supporters of this type of training would argue that it is a realistic approach to real-world problems encountered by a law enforcement officer. This technique is designed to promote cognitive growth through scenarios that employ live actors/instructors. Critics of this training technique argue that it is time consuming and cost prohibitive. The time consumption prohibits repetitiveness required for long-term development and the cost associated with the number of required instructors makes this technique difficult for smaller institutions.

Despite these arguments, based on the 2005 data, approximately 90% of law enforcement academies used reality-based scenario training to teach arrest techniques and 93% used scenario-based training to teach self-defense. Only about 65% of the academies used scenario-based training for cognitive development. Eighty-eight percent of law enforcement academies used scenario-based training as a means of teaching firearms skills (USDJ, 2005). There was some indication that law enforcement academies have been using virtual simulations as a means to teach firearms skills; however the effects of virtual reality on the cognitive memory and handgun accuracy development of neophytes has not been thoroughly researched.

Learning-style research suggests that students learn best when they are taught in a way that matches their dominant learning style. This modality matching is sometimes referred to as aptitude-by-treatment interaction (Smith, 1996). The process of virtual training offers each learner a plethora of learning-style modalities, yet the literature only

reveals evidence of its existence in law enforcement academies. It does not address the effects that it has had on the neophyte.

Hiring standards for law enforcement neophytes are detailed. Restrictions on criminal records, driving habits, financial stability, and even social stability are among the many factors that govern administrators in their decisions to confirm or deny applicants requests for employment. It would seem likely that the candidate with the most realistic chance for selection is that person(s) who has been sheltered from the environment where they will ultimately work. The virtual environment can offer the neophyte simulated circumstances where cognitive and skill development will promote professional growth. Early identification of developmental deficiencies can also provide additional opportunities to prepare the neophyte for professional activities.

Purpose of the Research

The purpose of this research was to investigate the effects of virtual reality training on the cognitive memory and handgun accuracy development by the law enforcement neophyte. This research study used an experimental design. The use of a stratified randomly assigned sample was designed to quantitatively compare the effects of virtual reality to the existing forms of traditional training.

Law enforcement educators, trainers, and administrators may find the results beneficial for program, curriculum, and staff development, and educational enhancement through the integration of technologically-advanced training techniques for their existing programs. The increasing societal demands on civil protectors and ever depleting resources made it incumbent upon police trainers and administrators to study these results in order to prepare the next generation of law enforcement professionals.

Research Questions

The effects of virtual reality on the cognitive mapping and development of handgun accuracy in law enforcement neophytes have not been thoroughly research. As such, the intent of this study was to address the following research questions:

1. To what extent, if any, is handgun accuracy developed by neophytes who are trained with virtual reality different than those trained in the traditional, non-interactive formats?
2. What are the differences in handgun accuracy development between male and female neophytes who are trained with virtual reality and those trained in the traditional, non-interactive formats?
3. To what extent, if any, is the development of cognitive memory in neophytes who are trained with virtual reality different than those trained in the traditional, non-interactive formats?
4. What are the differences in cognitive memory development between male and female neophytes who are trained with virtual reality and those trained in the traditional, non-interactive formats?

Significance of the Study

The effects of virtual reality on the development of cognitive memory and handgun accuracy by law enforcement neophytes have not been thoroughly researched. As such, this research study should be of interest to a broad spectrum of law enforcement trainers, administrators, and also, adult educators who wish to enhance the learning environment. The use of virtually reality offers the potential of an alternative to traditional training techniques that are currently being used.

According to the U. S. Department of Justice, more than half of law enforcement academies have some form of virtual reality equipment; yet, the traditional formats of training are still widely used in cognitive memory and handgun accuracy development. Expenditures for training exceed millions of dollars on an annual basis. Expenditures ranged from \$261 thousand to \$1.2 million per academy during fiscal year 2002. The range of expenditures per neophyte was from \$5,400-\$13,100 and the cost per instructor ranged from \$17,900 - \$41,800 (USDJ, 2005). Virtual reality offers supplemental training opportunities at a fraction of the cost.

Law enforcement trainers and administrators would find this research of particular interest as virtual reality offers a host of various scenarios that in some cases cannot be replicated through the traditional scenario-based training. The ability of the software to continuously repeat the training provides the neophyte an opportunity to develop at their own pace. Due to its visual and audible portrayal of law enforcement service calls, the neophyte can experience the realism of the incident. In any case, a *virtual death* is overcome simply by hitting a reset button which offers the opportunity for a successful learning environment. In contrast to the traditional formats of training, the virtual classroom also offers an opportunity for collaborative learning through an evaluated process of each virtual event.

This study also has implications for those who are working in and for organizations that develop software for law enforcement applications. Adapting software that can meet individual learning styles, enhance the transfer of learning, promulgate skill development (specifically in the use of a firearm), develop

communication skills, increase cognitive mapping abilities, and finally, create intrinsic motivation are among the various business opportunities.

In a substantial disaster situation, the psychological, physiological, and cognitive states of individuals are increasingly stressed, leading to the introduction of new unfamiliar and possibly unidentified human stressors that could negatively dictate the quality of response (McCauley-Bell, Platt, & Clark, 2008). The virtual learning environment offers the human operator/instructor extra assistance in performing learning tasks that identify the stressors and teach the response.

Winchester and Ntuen (2008) describe virtual learning as augmented reality where human interaction is combined with computer-generated agents, in real time, to become modalities of interface. Augmented reality systems generate large amounts of information, multiple solutions in less time, and perform far better in time processing. During their discussion, Winchester and Ntuen identified problems associated with augmented reality as a standalone instrument of instruction.

An instructional design that is interactive and energetic can stimulate deep learning. The virtual learning environment provides flexibility and diversity, which are also key elements to implementing virtual learning in the classroom. Virtual learning is not a single standalone approach to learning, rather a tool that can be used with almost any educational theory (Haren, 2007).

Considering virtual reality's flexibility and seemingly endless realm of possibilities, this research should have relevance to a broad spectrum of educators, trainers, and instructors outside of the law enforcement profession. Currently, virtual reality has been used in aviation, the United States Armed Forces, driving instruction, the

medical field, etc. Since this research focused on both the cognitive as well as the physiological response to virtual training, it could provide insight into the benefits associated with computer-assisted learning.

Limitations of Study

This research study has certain limitations:

The sample was limited to academy-level neophytes from a single institution in central Florida. All of the participants were enrolled in a law enforcement academy sponsored by the Florida Department of Law Enforcement and the Criminal Justice Standards and Training Commission (CJSTC). Because the sample was composed of participants from a single institution, care should be taken in making broad generalizations to the entire law enforcement population.

Assumptions of the Study

Assumptions that were made regarding this study included:

1. The instructors who were appointed by the host institution were used as safety officers during data collection and did nothing to bias the results of the testing procedure.
2. The virtual reality equipment that is owned by the central Florida law enforcement organization and used as a testing instrument was accurate for the purpose of this study.

Definitions of Terms

The following operational definitions were used to clarify terms used in this study:

Academy Class: The groups of adult students who were enrolled in a specialized training program that prepares the student for law enforcement operations.

Administration Order: An alternating presentation of simulated scenarios where the neophyte was required to respond during the final intervention.

Cognitive Memory: A time-based physiological response to a life threatening scenario that was measured by response time.

Final Intervention: A scenario-based exercise where the neophyte responded to law enforcement situations for the purpose of collecting data.

Handgun Accuracy: The ability of a law enforcement neophyte to place accurate shots within the vital areas/upper torso of a human subject that was measured by the number of scoreable hits.

Neophyte: A academy-level law enforcement recruit.

Reaction Time: The time required for a law enforcement neophyte to respond to a lethal encounter with lethal force.

Scenario Category: Three simulated situations were presented to the neophyte during the final intervention. They were identified as Scenario A (traffic stop), Scenario B (emotionally disturbed person), and Scenario C (domestic violence encounter).

Test Group: This research used two groups (experimental and control) of participants during the treatment process and final intervention. The experimental group included participants exposed to virtual simulations. The control group included participants exposed to the curriculum used by the Florida Department of Law Enforcement/Criminal Justice Standards and Training Commission during the discretionary portion of firearms training.

Traditional Training: Training techniques that are lecture based, non-interactive, and follow a pre-test, test, and post-test format.

Virtual Reality: Technologically-created environments that incorporate representations of real-world elements such as human beings, landscapes, and other objects.

Organization of the Study

Chapter 1 introduces the study by examining law enforcement academies in the United States and presenting the problem to be researched. Included in this chapter are the purpose of the research, research questions, and significance of the study, limitations and assumptions of the study, operational definitions of terms, and the organization of the study.

Chapter 2 contains the review of related literature for this research study. The literature reviewed for this study examines adult education, the application of virtual reality and, a summary of the review of literature.

Chapter 3 contains details of the procedures that were utilized in this study. Included in this chapter are the research questions, population and sample, treatments, validity and reliability, collection of data, data analysis, and a summary of methods.

Chapter 4 presents the results of the data analysis. The demographic characteristics of the participants are described, findings of the data analysis, observations, and summary of results.

Chapter 5 includes a summary of the study, discussion, the conclusions, the implications of the study, and recommendations for further research.

Chapter 2

Review of Related Literature

The purpose of this research was to investigate the effects of virtual reality training on the development of cognitive memory and handgun accuracy by law enforcement neophytes. Chapter two contains the review of related literature for this research project. The literature reviewed for this study examines: (a) adult education, (b) the application of virtual reality in the law enforcement profession, and (c) a summary of the literature review.

Law enforcement responsibilities have changed since inception of the profession. Today, law enforcement officers are identified as professionals who are faced with numerous career challenges. The job of a police officer has become so complex that training programs have become fundamental components in the assurance that police behavior is both professional, accepted, and respected by the public (Traut, Feimer, Emmert, & Thom, 2003). Crime suppression, the primary objective in their job task descriptions, consumes a majority of time, but it is intertwined with the growing trend of community-oriented policing that result in higher levels of exposure to the general citizenry. This exposure creates an increased sense of awareness for the general public that scrutinizes decisions made by police across the country.

Training law enforcement professionals has become more and more challenging. There are changes in societal demands, laws and requirements, administrative policies,

and procedures that impact the training of law enforcement officers from the basic entry-level academy to in-service training. Virtual reality training has become a recognizable tool in an arsenal of training opportunities that is changing the scope of traditional police training. To that end, the following review of literature discusses the history, impact, and application of virtual reality in the training of police officers.

During an era, ranging from the 1840s to the early 1900s, law enforcement officers received little training if any at all. Only in the last 50 years has police training become synonymous with terms such as marksmanship, defensive tactics, and the mechanics of arrest (Chappell, 2008). During the last half century, law enforcement training has been reformed; however, 90% of police training still focuses on the high liability areas such as firearms training and other skill development techniques while ignoring cognitive development, reasoning, and even communication skills. High liability tasks are the focal point of training, because it is assumed by police administrators that the greatest risk of a civil tort comes from the use of protective action.

The first of many challenges with traditional law enforcement training is that it is widely lecture based and relies heavily on pedagogical principles. Even the basis for skill development, such as firearms training or defensive tactics stems from classroom lecture. Information from these classroom sessions are largely committed to short-term memory until such time that the participant passes a state required exam. The basis for a lifetime of split-second, life-and-death, life-changing decisions, using short-term memory is problematic. Therefore, the challenge in changing law enforcement training is stimulating the cognitive development in not only the academy-level learner, but also the veteran officer through an entire career of in-service training.

Adult Education

Cognitive development is defined as the construction of thought processing, including remembering, problem solving, and decision making from childhood through adolescence to adulthood (Hartman, 2001). Though law enforcement professionals are considered adults, this theory is applicable as each stage of development in an officer's career is much the same as human development.

Piaget's (1952) theory of cognitive development has four emerging themes: (a) Sensory-motor (infancy), (b) Pre-operational (toddler and early childhood), (c) Concrete operational (elementary and early adolescence), and (d) Formal operation (adolescence and adulthood) (Hartman, 2001). The formal operational stage of Piaget's theory is of primary concern in the development of police training as research in this stage focuses on intellectual development, successful intelligence, motivation, teaching for understanding, self-regulated learning, and meta-cognition (Perkins, 1993).

The application of andragogical principles can aid in the cognitive development of both basic recruits and veteran officers. Adult learning principles associated with the concept of andragogy better serve the law enforcement professional in these five basic assumptions: (a) they increase self-directedness, (b) they allow the experiences of the learner to become an active part of the learning process, (c) the learner becomes stimulated to learn by immediate life situations, (d) the learner is intrinsically motivated, and (e) the learning is problem centered (McCoy, 2006). White (2007) examined the effects of andragogy on law enforcement trainees and argues that the andragogical approach: (a) draws on the trainee's past experiences, (b) treats trainees as adults, (c) adapts to the participant, and (d) fosters critical thinking and creativity.

Although the aforementioned principles remain as a solid foundation for adult learning, it is unknown how much influence the technology of today may have changed the theory of Andragogy, since Knowles (1980) published his theory over 35 years ago. Today, more training and education is taking place through and with the use of computers.

As early as the 1950s, computer simulation had been in development (Robinson, 2005). Two-dimensional images were displayed by computer hardware for the learner to view and, in 1995, the Canadian Museum of Civilization, in Hull, Quebec helped to create a 3-D virtual-reality exhibit of Ice Age figurines (Deitz, 1995).

The history of virtual simulations can be identified in four distinct periods: pioneering, innovation, revolution, and evolution. In the late 1950s and into the 1960s, the development of simulations and virtual reality was in its infantile stages. The developers were laying the groundwork of generations to follow. In the 1970s, software and hardware continued to evolve. However, it was during this period that the potential of computer simulations came to fruition. During the revolution period of the 1980s, practical applications of the computer simulation started to reveal itself; however, the cost of associated components limited the use of these instruments. This all changed in the 1990s as the cost effectiveness of computerized components became more practical. Added to this was the development of Windows software that revolutionized the personal computer and its practicality. Finally, in the last 15 years, virtual animations have become an integral part of any virtual-reality package (Robinson, 2005).

Application of Virtual Reality in the Law Enforcement Profession

The term virtual reality is used synonymously with terms such as: simulation, second life, avatar, cyberspace, artificial reality, virtual world, etc. Research has shown that, with as many applications for which the software was written, there are distinctly different definitions. For example, in the medical field and the gaming industry, computer simulations have characters often referred to as avatars. The definition found to be best suited for this research was: technologically-created virtual environments that incorporate representations of real-world elements such as human beings, landscapes, and other objects (Kock, 2008).

In Kock's definition, the virtual world is considered an environment. This is an aspect of virtual training that is critical for law enforcement professionals since it is the environment for which the officers must cognitively train. Lewenski, editor of *Force Science Institute*, is a researcher of the law enforcement profession and widely known in the criminal justice community for his research on all aspects of law enforcement training. During a personal interview with B. Lewenski (October 15, 2009), he summarized that a vast majority of traditional law enforcement training focuses on skill development. He referred to the work of Gladwell who expected a normal adult to repeat a specific task nearly 3,000 times before expert status can be achieved. Though Lewenski does not concur entirely with Gladwell's work, he does admit that repetition is a key essential. Virtual training gives law enforcement officers the chance to continuously repeat a skill to enhance the development. Lewenski also referred to the work of Pickers whose research has shown that gaming helps to develop skills only so far that it is a game to the officers who are training. Research has shown improvement in

skill development when the learner is learning while having fun. Lewenski stated that even though virtual training has real-life application, it is still an adult video game.

Motivation. Virtual training is arguably a game, but it has serious implications in police training as it reinforces one particular element of Piaget's theory--motivation. Research has shown that cognitive development includes two types of motivation, extrinsic and intrinsic. Extrinsic motivation is typically characterized as traditional law enforcement training in that its usual reward is a mandated certification required for continued employment. Extrinsic motivation can have a negative impact on learning; it is entrenched in the traditional classroom, with students working for impersonal and external reasons. On the other hand, intrinsic motivation provides the foundation for long-term learning. This type of learning can be recalled, twisted, and applied in different dimensions' for the life of the learner. Intrinsic motivation is the experience of enjoyment with feelings of competence and self-determining with a perception of locus of causality (Pintrich, 1995). Virtual training could provide the intrinsic motivation through an interesting, informative, challenging delivery, and a varied and creative application of teaching. It focuses on higher-order learning outcomes and it transfers the responsibility of learning to the student.

Although motivation in learning is essential, it does provide the foundation to teach for understanding. Teaching for understanding, also known as performance perspective, is the understanding of information in a variety of thought demanding ways. It is understanding information in such a way that predictions about the information can be made or understanding performances (Perkins, 1993). In the practice of law

enforcement, understanding performances can be interpreted as those actions of the police or threats of a violent offender.

Cognitive reasoning and decision making. Academy-level students have very little exposure to training that is associated with cognitive reasoning or, in law enforcement terms, threat assessment. The Florida Department of Law Enforcement, for example, defines threat assessment only as a footnote in the defensive tactics section of their academy curriculum. Training for a threat should focus on the when, what, and how to identify the impending attack. The opportunities provided in the virtual world illustrate an environment where the police officer can reason through and respond to multifaceted indicators that warn of a threat. Early detection of these indicators exposes the participant to social circumstances leading up to the use of protective action. This training opportunity provides an individual with repetitive attempts to seek cover, protect themselves or others, and even take other action that may prevent the use of protective action.

According to Lewenski (personal communication, October 15, 2009), virtual training offers other benefits concerning the exposure to social circumstances; circumstances that are not provided during two stages of an officer's life. The first stage is the social exposure to the non-conformant element of society during the officer's upbringing. In that, Lewenski stated that standards for applicant hiring are so constringent that men and women who survive the hiring processes were often sheltered from the criminal element that is prevalent in many urban environments. This eliminates the would-be officers' real-world experience and their ability to identify threats before and sometimes even while they happen. Secondly, during the training process itself, in-

service opportunities for training do not offer the repetitiveness required for the officer to become an expert. In most situations, field training is not finite. If Gladwell's (2008) research is precise, then an officer would essentially need to work for several years before gaining the experience necessary to efficiently identify a threat.

The virtual simulation can offer opportunities for an officer to evaluate the totality of the circumstances and learn to read social circumstances despite their lack of social and professional experience. The training offers repetitiveness in conjunction with expert instruction. Some virtual simulators offer what is referred to as a picture in a picture. This tool allows participants to visually see themselves as they perform while being constructively critiqued by the instructor. A visual representation is an essential tool for the development of meta-cognition as it demonstrates the skills the instructor wants the student to learn. The virtual world creates a storybook for the learner to follow. Bonds, Bonds, and Peach (1992) indicated that there are two sub-core strands within the story: (a) the characters and (b) the setting. As the student reads or, in the virtual world, lives the story, a mental map is completed showing the relationship to the two strands. The activity helps the student organize content information into an understandable whole allowing also for the development of visualized relationships.

The policing environment is filled with complexities stemming from conflicts in the law enforcement function. The conflicts are inherent to the job tasks for which officers are required to make split-second decisions that will affect citizens and other officers alike. Despite the complexities, however, the cognitive reasoning of officers needs to be evaluated as any other decision-making process because the outcomes themselves are based on judgments people have made. Decision-making research has

compared the rationality of a person's intuitive judgments under uncertainty with analytically derived answers produced by formal models (Can, 2006). As is the case with decisions made by police, the intuitive judgments are more applicable to law enforcement training. Can (2006) conducted a qualitative research, where interviews were conducted with law enforcement trainers. It was determined that, while making vital decisions during an unanticipated event, law enforcement officers used both intuitive and analytical decision-making processes. It was further shown that during the initial stages of the problem solving, tasks errors were equally distributed between all participant demographics. Analytical cognition increased the amount of errors under time constraints without managing to implement other decisions and contingencies. When the learner implemented intuitive cognition that corrected several types of decisions during the same time period until they got the desired outcome, it was too late. The most critical conclusion of Can's study is those officers who had previous incident experiences and more in-service training hours made less errors and made better decisions in a simulated process.

Skill development. In a study conducted in Washington State, the research focused on pre- and in-service training and the satisfaction level of the instructors who gave the training. At the time of the study, the Washington State Criminal Justice Standards and Training Commission only required 440 hours of academy level training; 60 of the 440 hours was dedicated to firearms training. Little attention, if any, was given to the decision-making processes used in the deployment of the weapon during a life-threatening confrontation. There were two noted reasons for the level of attention given to firearms training during this study. The first reason was that familiarity and the motor

skills associated with marksmanship and gun handling require many hours to refine. Second was that decision-making training often requires one-on-one instruction. This is a process that is sometimes cost prohibitive in an academy level setting as the monetary demands of such training are usually too high (Morrison, 2006).

The virtual classroom offers an integral tool to simultaneously instruct multiple officers in the development of their skills. Since multiple participants can train at the same time, one-on-one instruction can be subsidized by collaborative learning, where both visual and auditory stimuli are present for all of the participating learners. A 1993 study of 712 entry-level candidates to the Israel Police Force confirmed the need for an integral tool of collaborative learning. The research study concluded that evaluations by peer candidates are vital in achieving a good predication of future police behavior success (Dayan, Kasten, & Fox, 2002).

A handgun is the primary weapon used by officers in the field, hence, the largest portion of firearms training is dedicated to its use. It is usually the first weapon used by officers because it is the most accessible and, to overstate the obvious, it is carried on the side of the hip. However, Morrison (2006) warned that handgun qualifications are primarily a test of marksmanship and a limited test of gun handling. Although this situation is not unique to the state of Washington, Morrison added that the notion about being “qualified” to carry and use handguns does not include meaningful measures of the breadth of critical elements that bear on police competency in field confrontations. It should be noted that the Washington State Criminal Justice Training Commission increased the number of training hours for their Basic Law Enforcement Academy from 440 to 720 as a result of Morrison’s research.

Since the September 11, 2001 terrorist attacks, training in domestic terrorism has become increasingly available to teach and train police departments to defend against attack as well as gather intelligence from suspected subjects. During a 2003 conference on terrorism hosted by the United States Secret Service, the host speaker, who for the security of his position will remain anonymous, made this observation, “the unfortunate reality of terrorism is that the law enforcement community has to get it right all of the time; and, the terrorist only has to be right once” (personal communication). The reality of this comment is that terrorism has no rules and no concern about who is affected by the violent act. Striking fear in the victim and secondary victims is the basic premise of the concept. Law enforcement officials are regulated by laws and policies during any conflict, yet no research was located that revealed where scenario-based training was used to expose even experienced officers to the threat of terrorism. Deitz (1997) indicated that in the space of minutes or even seconds, officers on rapid-response missions must distinguish terrorists from hostages, sort out surrendering criminals from those who are still dangerous, and protect both the hostages and any innocent bystanders. Their duties may also include identifying the wounded and ensuring that medical personnel can perform triage and save lives and no one can forget the necessity of protecting the officer’s own lives. Deitz sums up the complexities of an officer’s involvement during a deadly confrontation, the importance of decision making, skill development and cognitive reasoning.

In his 2005 article titled *The Impact of Using Virtual Reality Technology to Train for Law Enforcement Critical Incidents*, Bos agrees with Deitz indicating that experience is the best teacher. Further, Bos says that virtual reality training can engage the officer

into the realistic training they need to respond to, think through and successfully end a critical incident. Bos categorizes virtual reality training into three categories: immersion, interactivity, and information intensity. Immersion is the ability of the technology to isolate the senses and give the illusion of being transported to a new location or environment. Interaction is the technology's ability to change the scene from the point of view of the participants and the ability to alter their physical position and to manipulate objects. Information intensity means that the virtual world includes artificial entities that demonstrate a certain degree of intelligent behavior.

Bos (2005) admits that the bombings of September 11, 2001 were the catalyst that has increased federal funding in the sum of \$4.4 billion for grants since March 1, 2003. Funds totaling \$566 million have been made available to states and cities for equipment, training, planning and exercises. This funding has made available the use of technology to increase the opportunities of the law enforcement training in terms of the virtual world.

Scenario-based training. Currently, the state of Florida, through the Criminal Justice Standards and Training Commission, requires scenario-based/simmunition training during the basic law enforcement academy. This type of training can be costly, instructor intensive, and time consuming.

Descriptively, this training incorporates live actors (law enforcement trainers) into a shoot/no shoot incident to the learner. Ammunition carried by both the actors and the learners is a marking substance dispersed from their handgun. This product is uncomfortable to the individual who is struck. Supporters of this type of training will argue that the associated discomfort from the projectiles impact is incentive for making shots count and the right decisions. Yet little research could be found that articulated the

amount of learning that was occurring during this process. Research could surmise that this type of training would be an effective test; yet, further research would be needed to conclude the effectiveness of learning.

Bos (2005) also noted that one of the key advantages to virtual reality training is that the officer can experience a real-world scenario in a controlled environment. The discomfort associated with scenario-based training is avoided, it is more flexible than other training methods, and an officer can practice tactics over and over again. The experience of a virtual death is a lesson that may not be forgotten, but is easily overcome by pressing a reset button. Another goal of virtual training does not focus on the learner as much as the instructor/teacher. That said the virtual classroom provides the instructor the means and the capability to teach analytically and creatively while at the same time monitoring the environmental response.

Sternberg and Grigorenko (2002) point out that analytical teaching encourages the learner to analyze, critique, judge, compare, evaluate and assess. Creativity, on the other hand, encourages the learner to invent, discover, imagine suppose, and predict. The virtual simulation provides the instructor a means to respond to the learning environment by adapting to the skills and learning style of the learner. The uniqueness of the virtual simulation is less restrictive to that which bounds traditional parameters in training that are nonconforming to the speed of which a learner is progressing.

Although most of the noted research has centered on the use of firearms, research also revealed that virtual simulations for law enforcement are now being used for pursuit driving, high-risk incident management, incident recreation, and even crime scene processing (Hormann, 1995). Simulations provide real-world experience, at a fraction of

the cost, in a risk-free environment that provides the challenges, developmental processes, and training required of law enforcement personnel.

Cognitive memory. The issue with replicating the real world is putting people into a realistic training environment and replicating in the virtual world what could happen in the real world (Simon, 2005). The realism creates a cognitive memory or map of areas which are familiar to the officer: a sports arena, shopping mall, a local street, or bar that the officer has responded to a dozen times before. A cognitive map is a realistic model of perception (Hill, Han, & Van Lent, 2002). The virtual training environment accelerates individual development by increasing the motivation of the learner with a learning foundation for which to build. In that, the learner is learning in a simulation with familiar settings where the officer works on a daily basis. Trying to recreate a unique environment using current and traditional techniques of scenario-based training would be time consuming.

Operational decision making across professions can be conceptualized as a two-stage process. The first requires an assessment of the current situation--what is the problem? On the basis of this judgment, the second is determining the appropriate reaction--what to do in response? Little research has been conducted into police decision making, despite its critical role in effective operational policing and well-publicized cases where erroneous decisions have been made by police officers (Flin, Pender, Wujec, Grant, & Stewart, 2007). The requirements of the learner to adjust, innovate, or simply cope with issues in the simulation exercise, without prior guidelines for behavior, have been observed to evoke defensiveness and rationalizing denials of the relevance to the exercise (Danielian, 1967). In other words, simulated scenarios that did not have the

appearance of realism were categorically denied any merit on behalf of the learner. The virtual world has not only the capability, but the expectation of realism for the learner to develop judgments and react to stimuli of the environment in lieu of real-world experiences.

Summary of the Review of Literature

Virtual reality, second life, avatar, and cyberspace are all terms that have been universally used to explain the process of creating an environment that immerses the learner into a real-world scenario that cannot be duplicated, in its entirety, without living the real thing. Virtual training is designed to be visually attractive, allows a high degree of customization, can facilitate learning processes by providing in some cases three-dimensional, visually intensive, information-rich, and dynamic learning environments (Taylor & Chyung, 2008).

There has been little research that shows the long-term effects of virtual reality training and the impact it is having or will have on the law enforcement community. However, with technology becoming more simplified in its application, the end users with little or no knowledge of simulation theories can very quickly learn to use simulation software and develop useful models (Lehaney, Kogetsidis, Platt, & Clarke, 1998). Even though computerized simulations and training have now been available for over 25 years, a 2007 study showed that there was only a moderate willingness to explore the use of virtual simulation in a variety of different professions. In the law enforcement profession, however, the aid of federal funding has been changing the level of willingness as the profession explores more beneficial alternatives to traditional training (Taylor & Chyung, 2008).

The aforementioned discussion has made several points. There is a high degree of risk associated with the essential tasks required of police officers. Decision making is based on the officer's ability to process threats, risks, weigh alternatives, and act according to applicable policies and laws. Research has shown that experience is the best teacher and that officers' cognitive reasoning abilities coincide with their experience. The challenge for trainers and administrators is to develop ways of introducing real-world training to officers who are presented with these challenges.

Virtual training offers an environment that is real world. Its actors are simulated, but portray realism in their actions and language and are placed in a setting that is familiar to the officer who develops motivation and a cognitive map in the learning process.

In addition to the realism that is offered by a virtual simulation, the interaction by the instructor/facilitator is both immediate and constructive. The facilitator can use the software as does a football coach who would replay video footage of previous games against their opponents. The simulation can be rewound and played over again stressing individual problems or mistakes. Some virtual training instruments also offer the facilitator a mechanism known as a picture in a picture where video footage of the participant can be replayed next to the simulation where the actions of the individual can be critiqued. The facilitator's role during the instructional portion of this training does not change; however, the transfer of learning is enhanced by the addition of visual and auditory teaching tools. Further, virtual training can offer a collaborative learning environment as multiple learners can participate and evaluate each other while listening to the instruction given by the facilitator.

Virtual reality offers a plethora of opportunities for training the use of firearms, high-risk management for specialty units, driving simulations, and crime scene processing. These high liability areas of training carry with them a major threat to the law enforcement administrator's risk of civil torts. Teaching for understanding is beneficial when eliminating the unnecessary byproducts of education and focus on the elements that will affect the learner the most. By virtue of its design, the virtual classroom focuses on a specific task and reinforces the targeted concept.

Chapter 3

Methods

The purpose of this research was to investigate the effects of virtual reality training on the development of cognitive memory and handgun accuracy by law enforcement neophytes. Chapter three contains the methods that were used for the collection and analysis of data for this research project. This chapter specifically examines the following: (a) research questions, (b) population and sample, (c) treatments, (d) validity and reliability, (e) collection of data, (f) data analysis, and (g) a summary of the methods.

Research Questions

To investigate the effects of virtual reality training on the development of cognitive memory and handgun accuracy by law enforcement neophytes, this study examined the following research questions:

1. To what extent, if any, is handgun accuracy developed by neophytes who are trained with virtual reality different than those trained in the traditional, non-interactive formats?
2. What are the differences in handgun accuracy development between male and female neophytes who are trained with virtual reality and those trained in the traditional, non-interactive formats?

3. To what extent, if any, is the development of cognitive memory in neophytes who are trained with virtual reality different than those trained in the traditional, non-interactive formats?
4. What are the differences in cognitive memory development between male and female neophytes who are trained with virtual reality and those trained in the traditional, non-interactive formats?

Population and Sample

There are 41 certified training centers that operate in the State of Florida and provide basic law enforcement training. Basic recruit training is offered to those wishing to join Florida's law enforcement, Department of Corrections, or Probation and Parole. Individuals who are pursuing the opportunity to participate in a basic law enforcement training program must first pass the basic abilities test. The purpose of the basic abilities test is to predict the likelihood of success in basic recruit training and the State Officer Certification Examination. The Florida Department of Law Enforcement (FDLE) contracts private test providers to create, manage, and administer the basic abilities test at certified training centers, criminal justice selection centers, and criminal justice agencies. FDLE manages testing scores, contractual issues, program clarification, and enforcement. The basic abilities test assesses written comprehension and expression, information ordering, spatial orientation, memorization, problem sensitivity, and inductive and deductive reasoning. It is a multiple-choice test in a computer-based or paper-and-pencil format (FDLE, 2010).

Participation in a basic law enforcement training program is a regulated process. The admission process can exceed the state mandates by the governing directors (e.g.,

physical fitness requirements, prior work history, polygraph exams, or additional agency requirements if hosted by a municipality). Though it is beyond the scope and intent of this research, it is notable to mention that recruits can also earn college credits for an Associates level degree for their participation in a basic law enforcement academy.

Reviews of the training center's admission requirements have identified established standards for acceptance to the basic recruit program.

These requirements are as follows:

- Be at least 19 years of age.
- Be a citizen of the United States.
- Have earned a high school diploma or equivalent (GED) for law enforcement and corrections applicants.
- Not have been convicted of any felony or of a misdemeanor involving perjury or false statement. Any person who, after July 1, 1981, pleads guilty or nolo contendere to, or is found guilty of a felony, or of a misdemeanor involving perjury or a false statement, shall not be eligible.
- Never have received a dishonorable discharge from any of the Armed Forces of the United States.
- Pass a physical examination by a licensed physician, physician assistant, or certified advanced registered nurse practitioner.
- Have good moral character as determined by a background investigation under procedures established by the Criminal Justice Standards and Training Commission.

In addition to the aforementioned criterion, this study extrapolated demographic information about each participant using a paper/pencil questionnaire. The questionnaire did not record the identity of participants. The principal and co-investigator were the only members of the research team collecting and reviewing this data. The data included:

- Gender,
- Ethnicity,
- Age,
- Level of education,
- Former military experience,
- Former law enforcement experience,
- Any other professional training in the use of a firearm.

This study was conducted at a facility operated by a medium-sized training center located in Central Florida. This training center is part of a state college which serves as a host institution for one of the Criminal Justice Standards and Training Commission's [CJSTC] designated regions in the central Florida area. The institution hosts approximately 150 academy-level students, for all of its programs, which include: basic law enforcement, corrections, probation and parole, and equivalency of training (for out-of-state officers trying to convert their standards). The institution houses a fairly extensive education program which includes: line level and middle management training, high-liability training, and a plethora of instructor certification programs. The institution's staff consisted of one Director (holding the rank of Captain), five coordinators (three holding the rank of Sergeant and two civilian coordinators), and additional clerical personnel.

The scope of this research targeted neophytes enrolled in a law enforcement program. The institution hosts two of these classes quarterly, with approximately 25–30 students per class. The number of students can fluctuate for a variety of reasons: student drop out, injuries, failing exams at exit points, etc. There is a full-time day academy and for the career-minded adult, a night-time academy where nightly courses are shorter per day; however, the program takes longer to complete. The classes require in excess of 700 hours of training before the student qualifies to take the Officer Certification Exam, hosted by the state of Florida. The demographics of each class are mixed. Neither type of class favors a particular demographic despite the institution's attempts to offer classes more conducive to the older, working adult. The process of admission to a basic law enforcement academy replicates an open enrollment format used by collegiate

institutions. Therefore, there was no established control to the sample that was obtained for use in this study.

Participants in this study were academy-level recruits who were ending their 80-hour block of firearms training. Since this study was conducted in conjunction with state-mandated training, a three-day window for collection of data had been granted by the host institution. Participation in this study was strictly voluntary. Any recruit found to have had previous law enforcement experience was excluded. All participants were briefed regarding the study and given a written consent form before being enrolled in the study. See Appendix A for a copy of the informed consent agreement form. There were no associated expenditures for any of the participants and the participants were not compensated for their participation. All equipment and materials used for the collection of data were provided and funded by the host institution.

The participants represented a convenience sample and were limited to the number of students in each academy class. Class sizes varied and a total of six classes were necessary to obtain a sample of 106 participants with 53 members in both the experimental and control groups. This sample size is required for a medium effect size of .50 and a power of .71 (Cohen, 1992). To ensure confidentiality, each participant was coded with a number for which they were referred to during the reporting of data or any subsequent discussion. A stratified random assignment of each participant was used to assign each participant to the control or experimental group. The random assignment was accomplished by drawing the names of each participant from a hat and assigning the first selected name to the experimental group, the second selected name to the control group, etc., until all the participants had been assigned.

Treatments

There were two treatments used for this study. The first treatment included a traditional discretionary shooting course used in the current training format outlined in the academy curriculum from the Florida Criminal Justice Standards and Training Commission. This treatment was used for the control group. The second treatment utilized a virtual reality simulator owned and operated by a large law enforcement organization in central Florida. Both treatments were conducted after the law enforcement neophytes had successfully completed their firearms block of training and passed the qualification exam with a score of 80% or higher.

Academy instructors provided by the host institution were all Florida state-certified high liability instructors who were trained to deliver instruction in firearms as mandated by Florida's CJSTC. Instructors used for the virtual simulation held all of the aforementioned certifications, but also had been trained in the use of virtual simulation programs. The instructor cadre included experienced operators from the law enforcement profession. They included a mix of municipal police officers/supervisors and county Sheriff's Office deputies/supervisors. Their backgrounds and specialized training included, but were not limited to Special Weapons and Tactics, Canine, traffic enforcement, tactical shooting, etc. Most of the instructor cadre used by the host institution was predominantly male with a mean age of 35-45 years. Their tenure varied slightly, but most of the selected instructors had 12 or more years of experience.

Prior to the experiment, the group of instructors who were provided by the host institution was divided equally. One half of the instructors were randomly assigned to the control group and the other half was assigned to the experimental group. After one half of the 8-hour treatment period was completed, each of the instructors changed

groups. This ensured that no one participant received an advantage over the other from the experiences or instruction of a single group of instructors.

Treatment one (traditional) and the final intervention scenarios were outdoor activities. As such, weather did become an inhibiting factor during the experiment only once. To that end, the host institution provided covered training areas such as a shoot house, five-story tower, and individual classrooms that were used during the inclement weather.

Although the virtual simulator used in treatment two was a unique instrument; inclement weather was not an inhibiting factor as it was used indoors. During this research study, the equipment operated flawlessly and the treatment was carried out successfully.

Treatment one. The objective of firearms training for the basic law enforcement neophyte is to learn how to carry, use, defend, and demonstrate safe gun handling techniques. The end of the training is signified by a test of marksmanship where the recruit is required to shoot a 48-round course of fire and pass with a minimum score of 80% on a standardized paper silhouette target. Successful completion of this marksmanship test satisfies the state of Florida's mandate to demonstrate proficiency. Firearms training then progresses into its final stage of development. This training is known as discretionary shooting.

The purpose of the discretionary shooting activity was to develop cognitive memory. Its process was designed to promote intuitive and analytical decision making. It was a traditional form of instruction that had no interaction, no feedback, and no

reward or consequences for making decisions. The process of the discretionary shooting course was as follows:

1. The neophyte was provided with one semi-automatic handgun and one fully loaded magazine, a duty belt, and holster.
2. The neophyte walked parallel to targets that were 48 inches tall and grouped in pairs and triplets.
3. As the neophyte approached each target group, the target system turned and exposed both a threatening and/or benign image for two and four second intervals. Two seconds was provided for each two target group and four seconds for the three target group. See Figure 1 for a graphic depiction of the discretionary shooting course.
4. The neophyte's objective was to identify and shoot the threatening image before the targets turned away without striking one of the benign images.

Treatment two. Virtual training is a process that exposes the recruit to an interactive image, conducive with the training objective. The virtual equipment consisted of a standard computer key board, a hard drive tower, a projector, and a monitor. The software program was based on Microsoft Windows. The computer was loaded with a variety of simulations, such as representations of robberies, burglaries, domestic violence incidents, suspicious persons, domestic terrorism, emotionally disturbed citizens, and traffic stops.

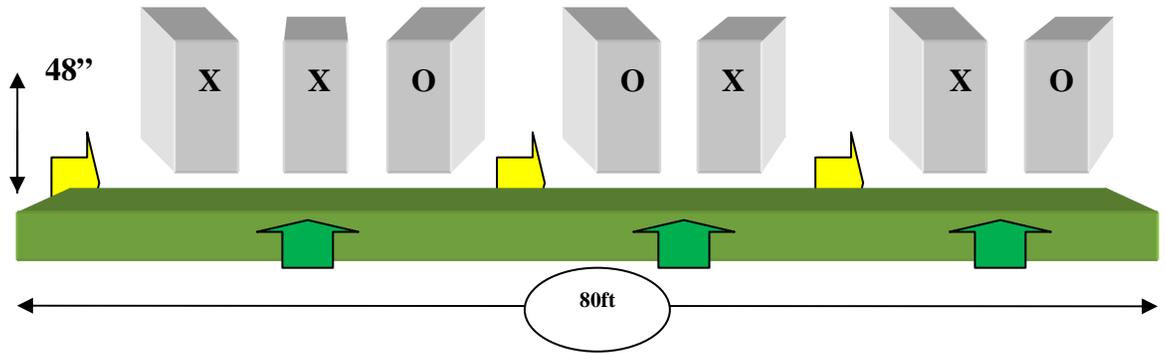


Figure 1. An example of the discretionary shooting course. The horizontal arrows indicate the neophyte’s direction of travel. The vertical arrows indicate the points that the neophyte would engage a group of targets. The targets that are marked with an “X” would be those that have a threatening image.

The uniqueness of this system was that every weapon carried on a police officer’s duty belt was simulated by specially designed equipment. The equipment was designed to exact specifications of the police weaponry that included the same size, weight, and functionality as the real item. Optional weapons included, but were not limited to, military-style rifles, handguns, Taser® (also known as a stun gun), chemical agents (commonly known as mace), and shotguns.

Rather than firing a projectile, each weapon regardless of its intended purpose fired a pulsating laser beam that was invisible to the naked eye. Through a hit detection camera, the computer registered the location of the shot, the time the shot was made, the number of shots, and the interval between shots if multiple shots were fired.

To replicate night-time firearms training, the computer had the ability to turn any daytime simulation into a lowlight or no light simulation. The recruits identified and engaged their threat through the use of an inferred lighting system that was transferred into a visible white light and illuminated only that portion of the view screen that the

learner shined. The light used for this portion of training was mounted under the weapons barrel. Since every agency does not offer a gun-mounted light, the system's developer offered a handheld flashlight that operated in the same manner. Further, the standard 48-inch target used in traditional firearms training was replaced for the virtual world with a view screen that is 12' x 7' providing interaction with life-size images.

The interactivity of this system was controlled by a certified trainer/instructor. The instructor had several options in each computerized scenario, known as branches. The operator, known as the driver, chose the specified branching option either by a predetermined script, objective, or by the manner in which the recruit was handling the scenario. For example, if the recruit did not interpret a threat correctly, the driver had an option to make the incident a life-threatening problem or provoke the threatening image to surrender.

Essential to any learning process is the ability to review information that was presented in a learning opportunity. That said, the virtual simulator offers an option known as a picture in a picture. The simulator was programmed to video each participant so that the images can be recalled and reviewed as many times as necessary to review and describe an error, a valid point, or communication problems with the learner. This system also provided a plethora of sound effects to ensure that the realism of the scenario was complete.

The treatment process through the use of the virtual simulation is described below:

1. The neophyte entered an empty room containing only the virtual equipment.

2. The neophyte was provided a duty belt, Glock, Model 22, .40 caliber, semi-automatic handgun wherein the barrel had been replaced with a laser system. Magazines that normally contained additional bullets were replaced with a magazine that contained a CO₂ canister that simulated recoil for each fired round.
3. The neophyte was provided with simulated scenarios that represented the same shoot/no shoot decision-making requirements as the traditional format.
4. To ensure external validity, the driver ran pre-selected scenarios that represented personal one-on-one or one-on-two simulations as the traditional format only offered a maximum of two threats simultaneously.
5. Each simulated scenario was 20-30 seconds in duration.

Final intervention. Following the completion of the aforementioned treatments, the neophytes participated in an intervention known as scenario-based training. The collected data measured the effects of both the traditional and virtual treatments.

This intervention used real people (instructors) who presented a life-threatening encounter. The neophytes were exposed to a scenario where a lethal response was required to protect their life or that of another. This intervention included the addition of marking rounds. These marking rounds were used by both the instructors and the neophyte as a means of firing upon one another as an attack or defense of one another. When struck by the marking round, an obvious colored spot appeared on the individual which indicated contact. During this intervention, all safety precautions dictated by the host institution, FDLE (2008) and the CJSTC were in effect. They included:

- A quarantined area for training.
- Signage indicating “Law Enforcement Training--In Progress”.
- Safety Officers in:
 - Staging areas

- Perimeter and
- In the scenario
- Safety officers were all identified by red shirts.
- Participant protection that included chest, head, eye, neck, and groin protection.

To ensure reliability of the collected data, the participants engaged in three scenarios. These scenarios simulated calls for service that officers might face during their normal course of duty: a traffic stop, a domestic violence incident, and an emotionally disturbed person.

The scenarios progressed as explained below.

Scenario A--Traffic Stop: The subject (instructor) was pulled over. The subject stepped out of the vehicle leaving the driver's side door open with a handgun concealed in the pocket of the door. The subject walked to and remained at the rear of the vehicle until such time that the neophyte exited the patrol car and made contact with the apparent violator. As the neophyte approached the vehicle, the subject became increasingly irate. Unwilling to listen to the neophyte's instructions, the subject returned to the vehicle, retrieved the weapon, pointed the weapon at the neophyte, and engaged the neophyte in a lethal encounter.

Scenario B--Emotionally Disturbed Person: The neophyte approached an individual who replicated the actions of an emotionally disturbed person. The individual was ranting uncontrollably and making no sense to the recruit. The individual had on a long-sleeve shirt with a handgun concealed in the rear waistband. As the neophyte attempted to determine the best course of action, the disturbed person retrieved the handgun and pointed it at the neophyte and forced a lethal response.

Scenario C--Domestic Violence: The neophyte entered into a room that contained two related persons, verbally arguing. One subject (instructor) already possessed a

concealed firearm. During the neophyte's attempt to resolve the domestic disturbance, the armed subject removed the weapon from concealment, pointed it at the neophyte, and forced a lethal response.

Since this study was an experiment wherein the effects of the treatments were being measured, the study extrapolated the following information as a means to investigate the aforementioned goals: (a) cognitive memory was measured by response time and (b) handgun accuracy was measured by the number of scoreable hits. Cognitive memory was measured by the time it took for the neophyte to recognize the threat. Handgun accuracy was measured by the number of rounds that struck the vital/upper torso areas of the threat. A single round was considered successfully delivered if it struck a vital area of the threatening subject. Shots that landed on the extremities, such as the hands, arms, legs, or feet were not considered successful. Data collected for handgun accuracy were calculated on a percentage basis so that variances in the number of shots fired by each participant could be compared. The cognitive memory was measured by the neophyte's response time using a digital stop watch. The response time began as soon as a visible threat with a weapon was made. The response time stopped when the neophyte fired the first marker round. The marker round made a distinct audible sound that was clearly evident to the data collector. See Appendix B for a copy of the data collection work sheet.

Validity and Reliability

Validity. Validity represents appropriateness, meaningfulness, and usefulness of specific inferences made from test scores (Gall, Gall, & Borg, 2007). Although this study

was an experimental design, which is considered a strong research tool, it is not irrefutable unless extraneous variables control threats to internal and external validity.

In order to insure that performance measures of the participants were valid, the design and procedures set for this study were carefully constructed. To minimize the historical threat to the validity, treatments one and two were conducted simultaneously for a period of one day or eight hours of exposure to the treatment(s). The final intervention was hosted the following day. The treatments were conducted during sequential week days so that a weekend would not interrupt the fluidness of the data collection.

In order to prevent test-wise participants from adapting to the three separate final interventions, the scenarios were designed with three separate and distinct scripts. The first intervention was a traffic stop, the second was an emotionally disturbed person, and the last was a domestic disturbance.

To prevent bias, the data collection instrumentation was designed to collect only two pieces of quantitative data: the time it took for the neophyte to engage the threat and the number of scoreable hits. The two pieces of data provided the necessary information to calculate the effects of the treatments after the intervention, yet prevent the investigator(s) from skewing scores if the neophyte increased his/her performance level.

The rater was isolated from the participants who were participating in the intervention. The rater was not informed to which group the participant had been assigned. The protective head gear (a helmet with a full face mask) worn as a safety precaution by the participant also served as a means for hiding the identity of the participant.

Rater fatigue was not problematic. The rater was not required or expected to perform any activity and was provided frequent breaks. The digital timing equipment required nothing more than the application of finger pressure to operate.

To control the participants' accelerated performance beyond their natural abilities, there was no debriefing or evaluation of performance during the final intervention. To prevent interaction between the neophytes, the control and experimental groups were maintained in separate buildings during the final intervention. Finally, to prevent treatment diffusion, the neophyte groups were isolated in separate buildings.

Reliability. Reliability is the extent to which other researchers would arrive at similar results if they studied the same case using the same procedures as the first researcher (Gall et al., 2007). Simply put, reliability is consistency of the measurement. Careful consideration went into the design of this study to ensure reliability.

Observer reliability was carefully controlled in the data collection. Two quantitative measures: time and number of scored hits were the only data being collected. This type of data collection prevented the investigator from skewing the data based on observations.

Consistency was determined in the final intervention with a test of three separate scenarios that measured the effects of each treatment. This measurement process provided an opportunity for an analysis of variance to determine the differences, if any, in each training technique.

Reliability was also maintained by the standardization of the measurements. All participant performance was measured using the same criterion: scored hits and the time that it took for the neophyte to engage the suspect with the first shot. Time began as soon

as a lethal threat was presented to the neophyte. Data were collected three times for each participant in scenarios A, B, and C.

The participants used in this study were coming from individual law enforcement academy classes with numbers that do not typically exceed 30 members. As such, one entire control group would finish a scenario, and then the other group would complete the same scenario. The instructors then begin another scenario. This process continued until all three scenarios were completed. To ensure the continued reliability of the data collection, a counter balance technique was used for each succeeding academy class.

Collection of Data

Participation in this study was voluntary. Consent for this study was obtained by the principal investigator just prior to the discretionary shooting instructional block of training. All participants were provided and read a printed informed consent form (Appendix A) before being enrolled in the study. Details concerning the observations for this study were not provided until the conclusion of the data collection so that the validity of this study could be maintained. Data were collected from a convenience sample of basic law enforcement neophytes. The collection of data was limited to two 8-hour days for each academy class.

Academy-level neophytes are recruited and permitted entry into the program through a variety of sources. Although a basic law enforcement academy is typically designed for the beginner, some students had previous experience as law enforcement officers. Repeating a basic law enforcement academy is common when officers come from other states and the state for which the applicant is requesting employment does not accept the previously completed standards.

In addition, experienced law enforcement officers may repeat the basic law enforcement academy if they had left the profession and the term limits for their annual recertification process had expired. The focus of this study was on the academy-level neophytes; therefore, those who were determined to have previous experience were excluded from this study. See Appendix C for a copy of the demographic questionnaire.

Consideration for participation in this study was restricted to those recruits who had no previous law enforcement experience. Age was not a restriction nor was former military experience. The United States military may provide additional weapons training; however, there were no other similarities that would otherwise have compromised the scope and purpose of this study (M. Butler [U.S. Army], M. Hughes [U.S. Army], personnel communication, April, 2011).

Sample size was limited to the number of academy students provided by the host institution at the time of testing and who met the aforementioned qualifications. The collection period lasted over a nine-month period and included six separate academy classes.

Data Analysis

The data were analyzed using SAS through proc freq, proc means and proc glm procedures. Descriptive statistics were determined from each scenario. The data were analyzed using a three-factor repeated measures ANOVA in which individuals were randomly assigned to two treatment groups, control and experimental.

The advantage of this mixed design was that it allowed the researcher to determine whether the independent variables interacted in their effect on the dependent variable (Smith, 1996). The advantage of the repeated measures design was that it

required fewer participants since the participants served as their own control. The error variance attributed to individual variation was removed, resulting in more statistical power. The primary source of error variance was the subjects. Removing the variance due to individual differences between levels was due to the treatment itself and not the participants (Lamb, 2003).

Summary of Methods

In this chapter, the research methods that were used in this study were described. This chapter began with an explanation of informal observations that were conducted prior to the beginning of this research study. These observations formulated the idea that the cognitive memory and handgun accuracy development of law enforcement neophytes needed to be studied.

The population and sample that were used were described and discussed. The sample of this study was described as a convenience sample from a central Florida police academy. The location where this study occurred was a central Florida law enforcement training facility that possessed the required equipment for this experiment.

Treatments and the final intervention were also discussed and described. Adjunct investigators who were used to facilitate this study were also described to include their qualifications and accompanying certifications required by the state of Florida to conduct high liability training.

The reliability and validity of data collection were described and discussed. The careful design of this study was described so that threats to internal and external validity could be controlled. The use of quantitative measures were described as a means of

determining if any interaction occurred between or within the groups as a result of the treatments.

The demographics of the sample were described as well as the stratified random assignment procedures that were implemented. Finally, the procedures for the collection of data were described as well as the statistical tests that were used to analyze the data for the findings.

Chapter 4

Results

The purpose of this research was to investigate the effects of virtual reality training on the development of cognitive memory and handgun accuracy by law enforcement neophytes. In this chapter, the results of the research are discussed and the findings are presented. The chapter is organized into four major sections: (a) demographics of participants, (b) the findings of the data analysis as they relate to the research questions, (c) additional observations, and (d) a summary of the chapter.

Demographics of Participants

The data collection for this research took place during a 9-month period. During that time frame, a total of six academy classes were examined. Preparation for the study began with the collection of demographic characteristics that all of the potential candidates provided. During the course of the data collection, two candidates were excluded from this study as they had prior law enforcement experience. The remaining pool of candidates qualified for the study, having no prior law enforcement training or experience ($N = 106$).

As illustrated in Table 1, the participants were predominantly white (non-Hispanic) males with only 18.87% ($n = 20$) females candidates. The predominant ages of the participants were reported between 19 years and 30 years of age with 72.64% ($n = 77$)

Table 1

Demographic Characteristics of Study Participants

Characteristics		<i>N</i>	%
Gender	Male	86	81.13
	Female	20	18.87
Ethnicity	African American	15	14.15
	White (non-Hispanic)	71	66.98
	Asian	2	1.88
	Hispanic	18	16.98
Age	19-21 years	19	17.92
	22-25 years	35	33.02
	26-30 years	23	21.70
	31-35 years	10	9.43
	36-40 years	9	8.49
	41-45 years	6	5.66
	46-50 years	2	1.88
	51-55 years	2	1.88
Education Level	High School	25	23.58
	Some College	41	38.68
	Associates Degree	19	17.92
	Bachelor's Degree	18	16.98
	Master's Degree	3	2.83
Military Experience	Yes	20	18.87
	No	86	81.13
	Males	19	----
	Females	01	----
Law Enforcement Experience	Yes	0	0
	No	106	100

N = 106

of the group represented. Education levels were relatively comparable. Those reporting “some college” were the majority at 38.68% ($n = 41$); however, 37.73% ($n = 40$) reported having at least a two-year or Associates degree. Three of the participants reported having a Master’s degree and there were no reports of Doctoral-level education. Eighty-six percent of the participants had no military experience and none of them reported any prior law enforcement experience or training, since they were already eliminated from the study.

The final question on the demographic information sheet requested the participants to report any other professional training in the use of a firearm, tactical deployment, or engagement techniques. As illustrated in Table 2, 42.45% ($n = 45$) of the participants reported a source of additional firearms training, as well as training in tactical deployment or engagement techniques. There were only four sources of additional training that were reported: hunter education, concealed weapons classes, the United States military, and training through an armed security program. Nineteen participants reported that they had received training through a hunter’s education program and 19 also reported that they had received training through a concealed weapons class. There were nine of the 45 participants who reported that they received additional training through multiple sources; however, only 1.9% ($n = 2$) indicated that they had received training from a hunter’s education program, concealed weapons class, and the United States Military. This study had 20 female participants. Of the 20 female participants, 4 reported additional sources of training. Two reported having had a hunter education course, one reported having completed a concealed weapons class, and one received additional training through the United States Military. None of the female participants reported multiple sources of training.

Table 2

Number and Percentages of Individuals Experiencing Additional Sources of Training

Source	<i>N</i>	%
Hunter's Education (HE)	19	17.92
Concealed Weapons Class (CCW)	19	17.92
United States Military (USM)	20	18.87
Armed Security Class	1	.94
Multiple Sources	9	8.50
HE/CCW	5	4.70
CCW/USM	2	1.90
HE/USM/CCW	2	1.90

N = 45

Data Analysis

The data for this study were analyzed using a repeated measures experimental ANOVA design. This design offered greater statistical power relative to sample size. The research compared the same subjects under several different treatments, or followed performance over time and "within" variables. Using a three-way ANOVA for repeated measures, an examination of gender and test group (experimental and control) across scenarios was completed to assess how the participants progressed with regard to time taken (cognitive memory) and number of hits (accuracy).

The mean times of each scenario administration, by gender, were calculated and represented in Table 3 and illustrated as a line graph in Figure 2. The administration of each scenario included a traffic stop, a mentally disturbed person, and an incident of domestic violence; however, a counterbalance technique was implemented and although

each individual academy class experienced the scenarios in the same order, the order of the scenarios was different from class to class. Time for gender started nearly equal with a mean time of 10.56 seconds for the female and 10.66 seconds for the males. In scenario administration 2, the females' mean response time decreased by 1.95 seconds; however, at the conclusion of scenario administration 3, the time had risen by 5.71 seconds from scenario administration 2. The male participants had an increase of 2.10 seconds from scenario administration 1 to scenario administration 2; however, unlike their female counterparts, their time was reduced by 2.05 seconds at the conclusion of scenario administration 3.

Table 3

Mean Time Across Scenario Administration by Gender

Gender	Scenario Administration	<i>M</i>	<i>SD</i>
Female (<i>N</i> = 20)	1	10.56	9.89
	2	8.61	6.62
	3	14.32	17.06
Male (<i>N</i> = 86)	1	10.66	8.59
	2	12.76	12.31
	3	10.71	15.88

N = 106

Because the administration of the scenarios was completed using the aforementioned counterbalance technique, the times noted for scenario administration 2

cannot be explained by any particular scenario and no apparent explanation for the differences in time was available.

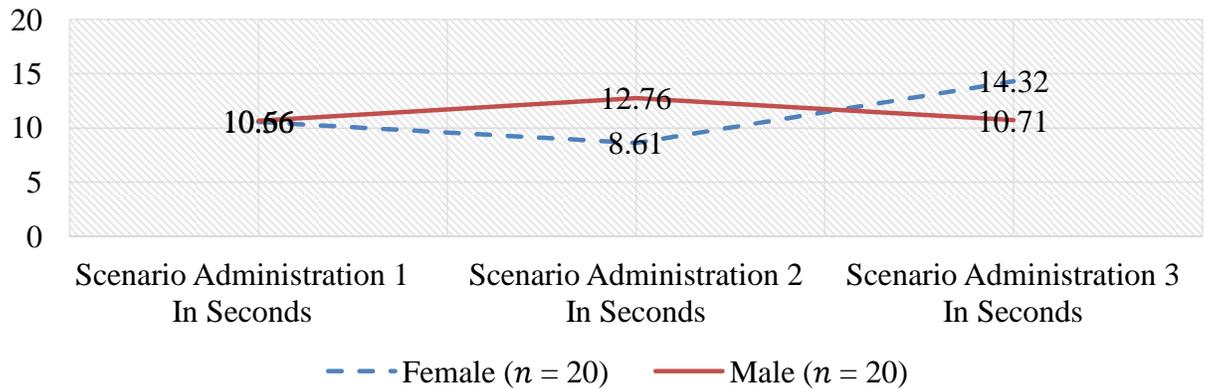


Figure 2. Line graph illustrating mean time in seconds across three scenario administrations based on gender.

Additionally, the mean numbers of hits by gender were also calculated. As noted in Table 4 and again in Figure 3, the mean accuracy scores by gender group were almost parallel with the males achieving a slightly higher mean accuracy score in each scenario administration.

In scenario administration 1, the males achieved a mean accuracy score of 2.03 hits while the female participants achieved a mean score of 1.25 hits, a difference of 0.78. Scenario administration 2 showed a slight improvement for both groups. The male participants had a mean score of 2.52, or an increase of 0.49. Similarly, the female participants showed a mean increase score of 0.65 from scenario one to scenario two. Once again, both gender groups were parallel in their result in scenario three; however, this time both gender groups showed a decrease in accuracy. The mean decrease is

negligible with the females showing a decrease of only 0.10 and the males showing a decrease of 0.03.

Table 4

Mean Hits Across Scenario Administration by Gender

Gender	Number of Hits	<i>M</i>	<i>SD</i>
Female (<i>n</i> = 20)	1	1.25	1.29
	2	1.90	1.07
	3	1.80	1.32
Male (<i>n</i> = 86)	1	2.03	1.40
	2	2.52	1.43
	3	2.49	1.38

N = 106

Mean scores for time in seconds is depicted in Table 5. Mean times across the test groups indicated that the experimental group responded to the intervention more rapidly than the control group, indicating that the exposure to the virtual reality and the interaction that was provided within the virtual reality-based training aided in the participant's ability to cognitively process the scenarios and respond accordingly.

During the treatments, the control group, on average required 15.94 - 17.17 seconds to cognitively process the scenarios and respond; whereas the experimental group responded faster, averaging between 5.34 – 5.68 seconds. The range between the two groups was 10.6 – 11.49 seconds.

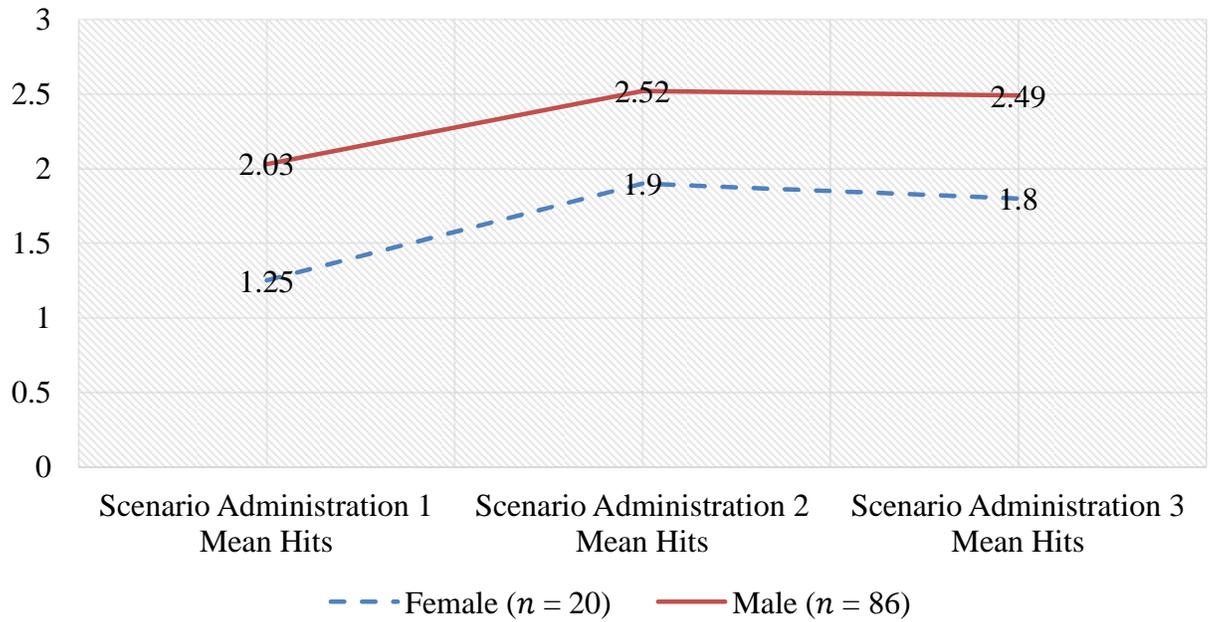


Figure 3. Line graph illustrating the mean number of hits across scenario administration by gender.

Table 5

Mean Time in Seconds Across Scenario Administration by Test Group

Test Group	Scenario Administration	<i>M</i> In Seconds	<i>SD</i>
Control (<i>n</i> = 53)	1	15.94	8.80
	2	18.85	19.54
	3	17.17	19.54
Experimental (<i>n</i> = 53)	1	5.34	3.90
	2	5.41	5.54
	3	5.68	8.62

N = 106

As illustrated in Figure 4, the experimental group completed all three scenario administrations more rapidly than the control group. Time was calculated in seconds.

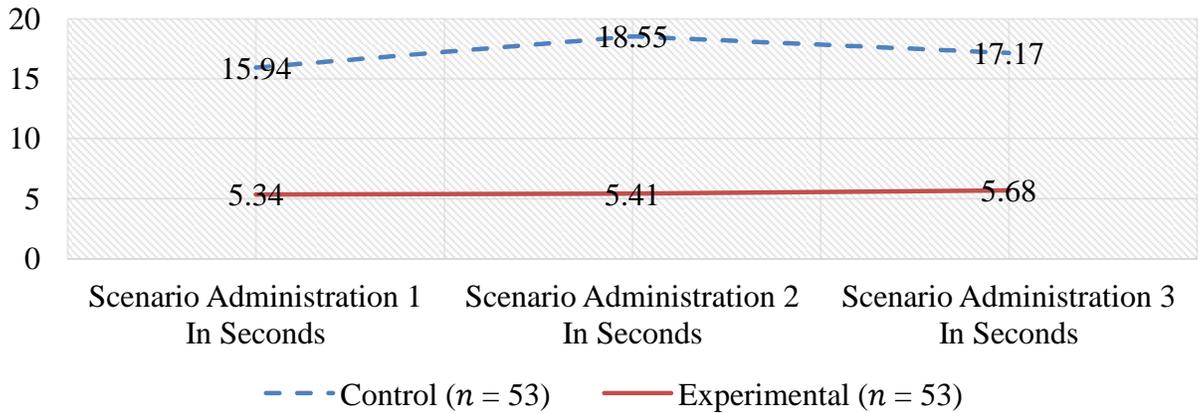


Figure 4. Mean time in seconds across scenario administration of test group.

The mean scores across scenarios by test group were evaluated for number of hits. As illustrated in Table 6 and Figure 5, the experimental group finished scenario administration 1 with a higher rate of accuracy than did the control group. The control group, however, finished scenario administration 1 with 0.87 shots lower than the experimental group, but increased their scores to 2.25 shots on average. On the second scenario their scores declined slightly in their accuracy rate for scenario administration 3 with a mean number of hits calculated at 2.08.

Three-way repeated measures ANOVA designs, as used in this study, had two repeated measures factors (gender and test group) and one non-repeated factor (scenario). This study attempted to determine if gender and testing group and their interactions had different effects on participants across scenario administration. A three-way repeated measures ANOVA was performed to determine whether gender and test group and their

interaction had significant effects on a subject's score on the number of hits and time taken across three scenario administrations.

Table 6

Mean Hits Across Scenario Administration by Test Group

Group	Number of Hits	<i>M</i>	<i>SD</i>
Control (<i>n</i> = 53)	1	1.45	1.10
	2	2.25	1.33
	3	2.08	1.25
Experimental (<i>n</i> = 53)	1	2.32	1.55
	2	2.57	1.43
	3	2.64	1.47

N = 106

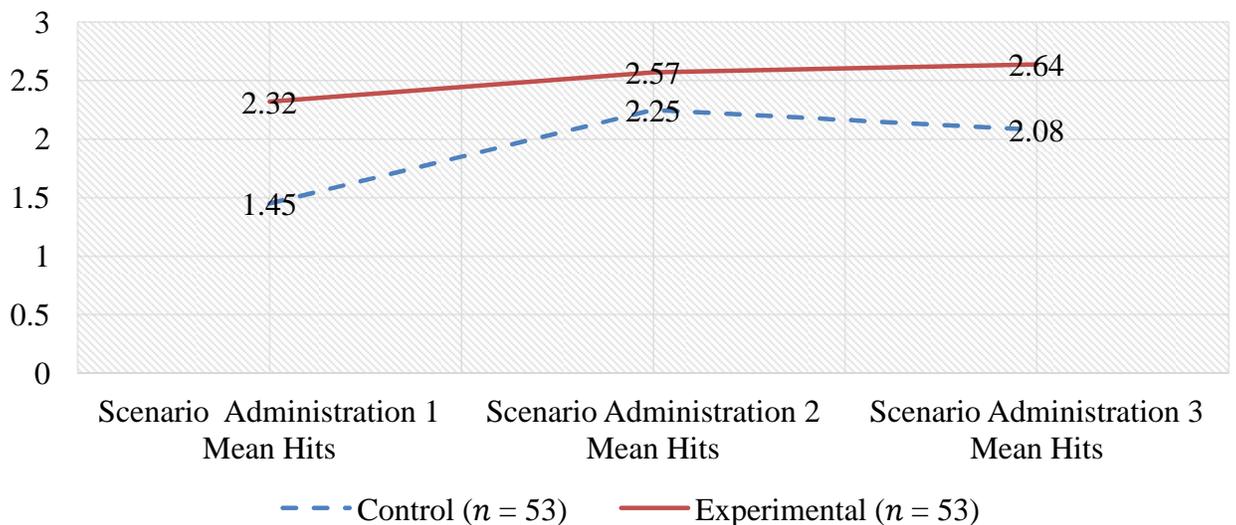


Figure 5. Line graph illustrating the mean number of hits across scenario administration by test group.

As illustrated in Table 7, the accuracy scores during the scenario administration were calculated. There was significance in the between-subject factors for both gender ($p = .0036$) and also by group ($p = .0205$). Also observed in Table 7 is significance in the within factors by scenario ($p = .0120$). Based on the previously reported scores, the data would indicate that accuracy scores were higher during the scenario administrations for the experimental group for both gender and group.

Tables 8 and 9 and Figure 6 reflect the data that were analyzed for the time it took for the participants to cognitively process the scenario administrations. The only significant difference was between the groups ($p = .0001$), indicating that the experimental group that was exposed to the virtual reality training responded faster than the control group. There was no difference by gender.

Table 7

ANOVA Summary Table for Accuracy During the Scenario Administration

Statistic	Source	Sum of Squares	df	Mean Square	F	p	GG	HFL
Between Subjects	Gender	23.80	1	23.77	8.86	.0036*		
	Group	14.90	1	14.85	5.54	.0205*		
	GxGp	.13	1	.13	.05	.8240		
	Error	273.59	102	2.68				
Within Subjects	Scenario	12.55	2	6.28	4.52	.0120*	.01	.01
	SxGn	.21	2	.11	.08	.9256	.92	.92
	SxGp	3.80	2	1.90	1.37	.2570	.26	.26
	SxGxGp	.51	2	.26	.19	.8311	.82	.82
	Error	283.17	204	1.39				

Note. $N = 106$. S = scenario administration; G = gender; Gp = group; GG = Greenhouse-Geisser Epsilon; HFL = Huynh-Feldt-Lecoutre Epsilon. Greenhouse-Geisser Epsilon = 0.9470; Huynh-Feldt-Lecoutre Epsilon = 0.9644.

*Significance at .05 level.

Table 8

ANOVA Summary Table for Time During the Scenario Administration

Statistic	Source	Sum of Squares	df	Mean Square	F	p	GG	HFL
Between Subjects	Gender	1.07	1	1.07	.01	.9373		
	Group	6486.44	1	6486.44	37.79	.0001*		
	G x Gp	4.88	1	4.88	.03	.8664		
	Error	17508.16	102	171.65				
Within Subjects	Scenario	167.34	2	83.67	.87	.4225	.40	.40
	S x G	514.67	2	257.34	2.70	.0723	.87	.87
	S x Gp	23.13	2	11.57	.12	.8329	.83	.84
	S x G x Gp	211.10	2	105.55	1.09	.3244	.32	.33
	Error	19726.08	204	96.70				

Note. $N = 106$. S = scenario administration; G = gender; Gp = group; GG = Greenhouse-Geisser Epsilon; HFL = Huynh-Feldt-Lecoutre Epsilon. Greenhouse-Geisser Epsilon = 0.7646; Huynh-Feldt-Lecoutre Epsilon = 0.7739.

*Significance at .05 level.

Observations

The intent of this research study was to determine the effects, if any, on the cognitive memory and the handgun accuracy development of the law enforcement neophyte through the use of virtual reality. However, as much as the participants were taking part in a research study, they were also actively involved in a learning process for career development in the law enforcement profession. Likewise, the instructors used as actors, safety officers, scribes, and time keepers. were also evaluating the neophytes as they participated in the research treatments and intervention.

As this research study began to develop, the instructors used for the previously mentioned purposes started making several notable observations that, although outside the scope of this study, are very important in the development of law enforcement

Table 9

Mean Time in Seconds Across Scenario Administration by Test Group by Gender

Group	Scenario Administration	<i>M</i>	<i>SD</i>
Control Group			
Males (<i>n</i> = 43)	1	15.85	8.88
	2	19.93	13.68
	3	16.08	19.60
Females (<i>n</i> = 10)	1	16.34	9.08
	2	12.58	5.92
	3	21.60	19.65
Experimental Group			
Males (<i>n</i> = 43)	1	5.45	4.15
	2	5.54	5.74
	3	5.16	8.13
Females (<i>n</i> = 10)	1	4.78	3.99
	2	4.48	4.80
	3	7.38	10.83

N = 106

neophytes and critical to their survival. These observations were discussed in detail with participants of both the control and experimental groups following the conclusion of each final intervention with each academy. These same observations were used as building blocks for further instruction in later stages of the academy instruction.

The design of this experimental research was carefully planned so that information related to the intent of this study would be unknown to the participants. Therefore, the data that were collected would measure the practicality of virtual reality as a tool to aid in the cognitive memory and handgun accuracy development of the law

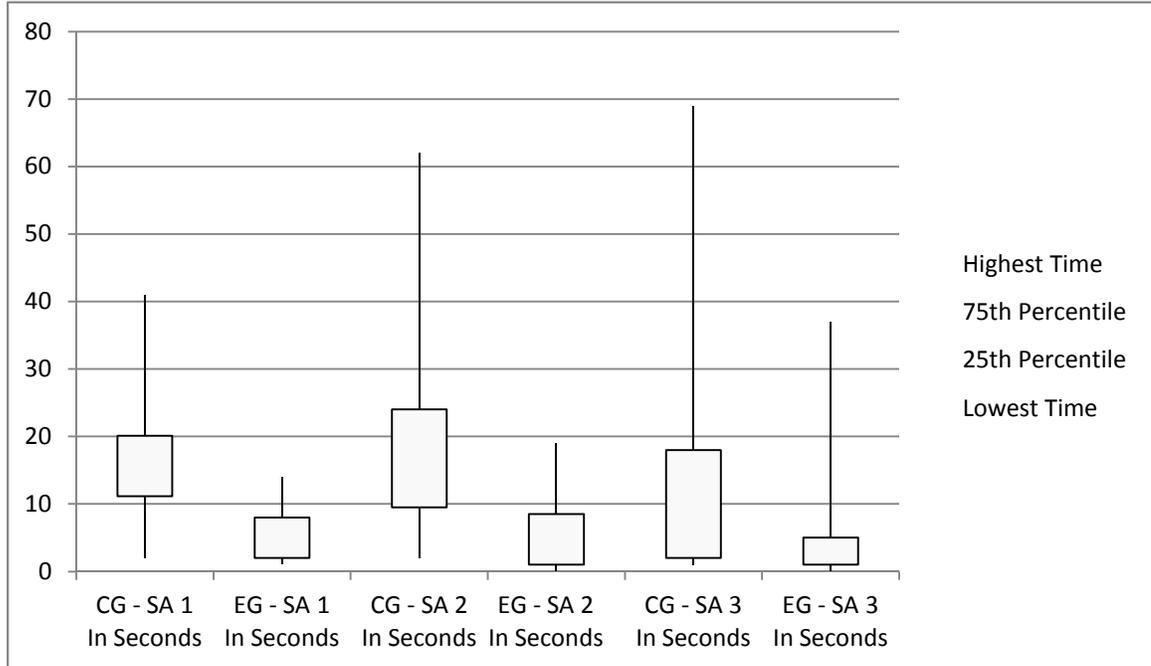


Figure 5. Plot illustrating time in seconds by group across all three scenario administrations. Note. CG = control group; EG = experimental group; SA = scenario administration.

enforcement neophyte. There were several observations that were made during the data collection period that may have influenced the anonymity of the study’s purpose as well as influenced the participant’s responses during the final intervention. These observations could explain some of the results.

Cover and concealment. It was noted by several instructors that some participants from the control group did not utilize cover (an object that would stop a bullet) or concealment (simply put, hiding from the offender’s line of sight). These would have been objects such as the vehicle in the traffic stop scenario, natural barriers such as bushes and trees, walls within buildings, etc. Although there were participants in

both groups that chose to engage the offender without moving to cover or concealment, this was largely in part due to the speed with which they chose to react to the confrontation. It was noted that after exposure to the virtual interaction, several participants from the experimental group would either first move to cover or concealment as they began to engage the offender, as they were actively engaging the subject, or as they were moving to cover after their initial shots were fired.

Communication. Communication skills during the final intervention had some of the most notable differences between the groups. Clearly, participants who had been exposed to the interaction of the virtual reality had developed, to the extent possible after only eight hours of treatments, communication skills that exceeded that of the control group.

Participants of the experimental group were much more confident in their communication; meaning they provided clear directions to the offender, telling him what was expected or the consequences if directions were not followed. Although the communication from the experimental group may not have been that of an experienced officer, those participants from the control group who did communicate with the offender were more likely to enter into negotiations, rather than control and direct the incident.

Some members of the control group made deals with the offender, entertaining the idea of a mutual surrendering of weapons. Other members made repeated ultimatums, such as “this is the last time I will tell you to drop the gun”—even though it was the third or fourth time the participants had told the offender it was the last time they were going to say it. Some chose to give a count of 3, a count of 5, and even a count of 10; only to repeat the countdown when the offender did not comply. Then there were

those control group participants, who after pointing their gun at the offender, who was pointing his at them, decided to move closer so that they could hear better during their negotiations.

Members of the experimental group seemed to follow the conversation more clearly with less confusion under the stressful conditions of each scenario. This was most prevalent during the scenario where participants were confronted with a mentally disturbed person. Members of the control group often hesitated, having to think longer before responding to something that the disturbed individual might have said that made “no sense at all”. To the contrary, experimental group participants carried out continuous conversation up and to the point where a gun was made visible.

Awareness of surroundings. Law enforcement officers are trained to take note of their surroundings in any situation. There are often threats to the safety of a law enforcement officer that are not always known at the time a call for service is received or even after his or her arrival. Other persons who are on scene, hidden objects, or even natural barriers that conceal threats from sight can pose a risk to the officer.

An awareness of surroundings was particularly noted during the domestic violence scenario, where for the only time during the final intervention, there were two actors rather than just an offender alone. Participants from the experimental group were observed deliberately trying to keep distance between the male/female actors (husband/wife) as well as between themselves and the two subjects with which they were communicating. It should be noted that during this scenario the male actor was the offender with whom the lethal encounter would eventually occur. There was an assumption made by nearly all 106 neophytes that the male was the primary aggressor.

The outcome of this scenario might have been considerably different had the female been chosen to engage the neophyte in the lethal encounter. Clearly, this is something that should be considered in future training to eliminate any potential deadly mistakes or assumptions.

Informed consent. The design of this experimental research was carefully planned so the intent of this study was concealed from the participants. This concealment of information was to collect data during the final intervention that had not been influenced by preconceived notions/ideas of the participants. Unfortunately, institutional policies required that an informed consent form be signed by each of the participants. This form contained the title of the research study that outlined the purpose and intent to use virtual reality.

Although a pre-study briefing with all of the participants outlined a “no-disclosure” policy until after their participation was completed, some of the assisting instructors did report vocalizations of curiosity from the control group regarding the virtual simulation room where the experimental group was exposed to treatment one. The principal investigator was also approached by a limited number of participants during the data collection period and asked if the control group would be able to experience the virtual simulation when the data had been collected for their academy class. This indicated that there was some knowledge of the known processes that the study’s design was trying to prevent.

Principal investigator. The principal investigator for this research study was a member of the agency that provided the training center where this research study took place. During the first part of this study, the principal investigator held the rank of

Lieutenant (a middle manager) and, in the final two academy classes that were studied, he held the rank of Captain (a senior staff level position). During the previously mentioned pre-study briefing, each participant was vocally assured that their participation would not in any way influence their status in the academy program, their grades, or future employment. They were also informed that this research study was for data collection purposes only and, although their activities would earn them hourly credit for attendance in the academy, it was not a test for which they would be further evaluated.

To further prevent the existence of any unforeseen influence on behalf of the principal investigator, he removed himself, in every degree possible, from the immediate area of the final intervention. The principal investigator maintained an observation point for the purposes of reporting the data, but allowed only the assisting instructors to direct and control the process.

Safety equipment. Although the use of virtual reality may not have been concealed from the control group, by virtue of the informed consent which included the title of the dissertation, the process associated with the final intervention was a mystery to both groups until moments before the processes began. In doing so, each participant was provided protective equipment for their eyes, head, neck, throat, and chest. Finally, moments before walking to the scenario administration, they were provided with a weapon that was charged with live simulated ammunition.

There was a degree of uncertainty observed in each of the candidates as they proceeded to the area. This was very noticeable by the increased and rapid breath from the participants of both groups that habitually fogged up the protective face gear. This rapid and increased breath was also noticeable during the administration of their second

and third intervention scenarios, yet by the last presented scenario during data collection, this erratic breathing and fogging of the face masks seemed to dissipate for both groups. The physiological response could have accounted for the unanticipated increase in response times associated with scenario administration two.

Summary of Results

In this chapter, the results of the research were discussed and the findings presented. This chapter began with a report of the participant's demographics: gender, ethnicity, age, educational level, and military and law enforcement experience were all reported. Professional training outside the law enforcement academy for which they were currently enrolled was also reported. It was determined that hunter education and concealed weapons training were the largest sources of additional training.

Analysis of the data was then described. This study attempted to determine if gender and testing group and their interaction had different effects on participants across scenario administration. The statistical analysis concluded that gender did not reach conventional levels of statistical significance in either time or accuracy. However, it can be concluded that that gender x test group had a significant effect p value $>.05$ for both time and accuracy.

Additional observations associated with the participants' performance as well as observations that may have created unwanted side effects during data collection were also described. Observations associated with the participants' performance included the use of cover and concealment, communication skills and, an awareness of individual surroundings. Finally, the presentation of the informed consent form, the principal

investigator, and the use of safety equipment were all discussed as having added to the uncertainty of the participants and as an explanation to the decrease in performance during scenario administration one and two.

Chapter 5

Summary, Conclusions, Implications and Recommendations

The purpose of this research was to investigate the effects of virtual reality training on the development of cognitive memory and handgun accuracy by law enforcement neophytes. In this chapter, the findings and results of the research project are discussed and presented. The chapter is delineated into the following sections: a summary of the study, a discussion of the findings, conclusions related to the research questions, implications, and recommendations for further research.

Summary of the Study

The purpose of this study was to identify the effects of virtual reality on the development of cognitive memory and handgun accuracy by law enforcement neophytes. Virtual reality training for law enforcement neophytes is an area that has not been thoroughly researched. Therefore, no hypotheses were stated. The study addressed the following four questions:

1. To what extent, if any, is handgun accuracy developed by neophytes who are trained with virtual reality different than those trained in the traditional, non-interactive formats?
2. What are the differences in handgun accuracy development between male and female neophytes who are trained with virtual reality and those trained in the traditional, non-interactive formats?

3. To what extent, if any, is the development of cognitive memory in neophytes who are trained with virtual reality different than those trained in the traditional, non-interactive formats?
4. What are the differences in cognitive memory development between male and female neophytes who are trained with virtual reality and those trained in the traditional, non-interactive formats?

This study was conducted at a facility operated by a medium-sized training center located in Central Florida. This training center is part of a state college which serves as a host institution for one of CJSTC's designated regions in the central Florida area. The institution hosts approximately 150 academy-level students, for all of its programs, which include: basic law enforcement, corrections, probation and parole, and equivalency of training.

Participants in this study were academy-level recruits who were ending their 80-hour block of firearms training. Since this study was conducted in conjunction with state-mandated training, a 3-day window for collection of data had been granted by the host institution. Participation in this study was strictly voluntary. Any recruit found to have had previous law enforcement experience was excluded.

The participants represented a convenience sample and were limited to the number of students in each academy class. Class sizes varied and a total of six classes was necessary to obtain a sample of 106 participants with 53 members in both the experimental and control groups.

The data were analyzed using SAS software. Descriptive statistics were determined from the scenario administrations in the final intervention. The data were

analyzed using a three-factor repeated measures ANOVA, in which individuals were randomly assigned to two treatment groups, control and experimental.

Discussion

A discussion of the findings related to each of the research questions is presented. The discussion from this study includes, but is not limited to, those results which were found to be statistically significant.

Discussion of research question one. This question was examined by collecting the number of scoreable hits from both the treatment and experimental groups during the scenario administration. The control group had a lower mean score of hits than that the experimental group during the administration of all three scenarios. The experimental group had increases in their mean accuracy scores from scenario administration 1 through scenario administration 3; however, the mean accuracy scores for the control group did not follow the same trend.

The control group's mean accuracy scores did increase from scenario administration 1 to scenario administration 2. However, the accuracy scores decreased during scenario administration 3. The control group's mean accuracy score for scenario administration 3 was less than those recorded for scenario administration 2. Because the administration of the scenarios were completed using a counterbalance technique, the decrease in accuracy for scenario administration 3 cannot be explained by any particular scenario and no apparent explanation for the difference is available. However, there was a significant difference between groups for accuracy scores related to the virtual reality training and the traditional non-interactive format of training to promote handgun accuracy in the law enforcement neophyte.

Discussion of research question two. This question was examined by collecting the number of scoreable hits from both the treatment and experimental groups during the scenario administration and was categorized by gender. The mean scores from the male participants of both groups were higher than those of their female counterparts.

Mean accuracy scores from both genders followed the same trend. Male participants ended scenario administration 1 with a higher mean accuracy score than females, yet both groups increased their accuracy during scenario administration 2. During scenario administration 3, the accuracy of both genders decreased slightly. Because the administration of the scenarios were completed using a counterbalance technique, the decrease in accuracy for scenario administration 3 cannot be explained by any particular scenario. The summary for accuracy by gender showed that there was a significant difference between genders for accuracy scores between the virtual reality training and the traditional non-interactive format of training.

Discussion of research question three. This question was examined by collecting the reaction time of the participants during the scenario administration. The collected time was the interval between the moment the weapon was presented to the participant to the point at which the participant fired the first shot. This time was measured in seconds and collected for both the control and experimental groups.

Mean times across the test groups indicated that the experimental group responded to each scenario administration more rapidly than the control group. This would indicate that the interaction with the virtual reality-based training aided in the participants' ability to cognitively process the scenarios and respond accordingly. The control group's mean times increased from scenario administration 1 to scenario

administration 2; however, the mean times decreased during scenario administration 3. The experimental group's mean times increased across all three scenario administrations; however, the increases were nominal. A comparison of the mean times by group was significant. The experimental group cognitively processed the scenarios and responded faster than the control group.

Discussion of research question four. This question was examined by collecting the reaction time of the participants during the scenario administration and categorizing these results by gender. The collected time was the interval between the moment the weapon was presented to the male and female participant and ended when the first shot was fired. This time was measured in seconds and collected for both the male and female participants.

The end of scenario administration 1 resulted in mean times that were nearly identical; however, the females responded to the scenario administration faster than their male counterparts. The end of scenario administration two resulted in decreased mean times for the females and an increased response time for the males. At the conclusion of scenario administration 3, the mean times for the males decreased while the mean time for their female counterparts increased. Because the administration of the scenarios were completed using a counterbalance technique, the fluctuating times for scenario administration cannot be entirely supported. The previously mentioned physiological effects could have had an influence on the response by the neophytes. Gender had no significance to the interaction of virtual reality and the traditional non-interactive format of training in the development of cognitive memory in the law enforcement neophyte.

Conclusions

The conclusions related to this research study are presented below.

The virtual reality trained group performed better on accuracy than that of the traditionally trained group. Accuracy by gender showed that there was a difference between genders for accuracy scores between the virtual reality training and the traditionally trained group. Both males and females performed better on accuracy from the virtual reality group than males and females in the traditionally trained group. Males in both groups also performed better than the females.

The virtually reality group performed faster as compared to the time of the traditionally trained group. Gender was not a factor in the amount of time it took to respond to the scenarios for either of the two groups.

The virtual reality training was more successful than the traditional training to prepare the law enforcement neophyte to cognitively and accurately respond to life-threatening situations.

Implications

This study was conducted at a large law enforcement training center and hosted by a law enforcement academy in central Florida; however, the findings of the study have implications for providers of law enforcement training in other venues. All of the participants in this study did not have any previous law enforcement experience and were equal in their experience of law enforcement training where appropriate to the content. The participants were selected at a given point in their training so that the impact of the virtual reality could be measured as a training tool. Growing popularity in technology-based training and the nationwide availability of virtual simulation reflects the

opportunities to develop the law enforcement neophyte skill-oriented learning beyond that which has been available through traditional, non-interactive forms of training.

Administrators of adult education and law enforcement programs could use the results of this study as a basis for designing curriculum, instructional techniques, and implementing in-service training. The virtual interaction provided in this type of training can provide the ability to not only enhance the neophyte's skills, but identify weaknesses in the individual and mitigate those deficiencies prior to the neophyte's service in the community. Relative to the cost of new technology, administrators may use the results of this study as justification to pursue funding for interactive technology in the law enforcement arena or even the adult education classroom.

Trainers and educators alike may use the results of this study to modify their educational techniques to include the use of interactive formats. In addition to identifying the cognitive memory and handgun accuracy development through the use of virtual reality, this study examined virtual reality as a tool. Although outside the scope of this research, the intent was not to replace human interaction from a professional trainer/educator but to use the virtual interaction as a supplement to training techniques. Virtual reality will provide visual and audible interaction that would address a gamut of learning styles so that each learner would learn at a more accelerated rate and develop long-term, deep-rooted memory. The virtual interaction identifies both the strengths and weaknesses of the individual and allows for repetitiveness through the use of a simple reset button. Through the use of interactive formats, the educator becomes a facilitator of information, breaking away from the traditional lecture-based formats. The participants become active in their learning process, have control of their learning, and understand the

immediate need to learn the decision-making process and the skill sets which are being taught. In the law enforcement community, these decision-making processes and skills sets are meant to save lives. The interaction of a visual scenario that may lead to a virtual death provides the learner an opportunity to learn the ramifications of not making a decision. It also provides the facilitator the means to support the learning message.

Outside the law enforcement profession, the results of this study may be used for administrators and educators in several other professions. Some of these professions have previously been identified as the medical field, aviation, the armed forces, and even driving simulations that could enhance safety on the streets and highways. The implications of cognitive memory as it relates to the development of thought processing is a key component to many professionals who are required to make decisions that will affect others as much as themselves.

Recommendations for Further Research

The primary research recommendation of this study is the need for continued research in the field of technology-based learning for the law enforcement profession. Although virtual reality training is available to 78% of law enforcement training academies nationwide, only 58% reported that this tool was part of their facility (USDJ, 2005). There has been very little research that supports virtual reality as a law enforcement training tool or its viability among the 78% of training academies.

An experimental design, incorporating law enforcement neophytes with no previous experience was used, so that a measure of the tool itself could be achieved. It is recommended that this study be used as a template for research related to experienced law enforcement professionals in the form of in-service training.

The results of this study contained unexplainable differences in both the mean accuracy scores and times. This study used a counterbalance technique in the scenario administration where scenarios A, B, and C were not given to the participants in the same order. The resulting mean accuracy score data by gender indicated increased accuracy through scenario administration 2, but decreased at scenario administration 3. The mean scores for accuracy by group also followed the same trend; increasing from scenario administration 1 to 2, but decreased from scenario administration 2 to 3.

Data demonstrating the mean times by gender followed no explainable pattern. Both genders ended scenario administration 1 with nearly identical mean times. The male participants demonstrated longer response times from scenario administration 1 to scenario administration 2. At the conclusion of scenario administration 3, the mean scores indicated a role reversal with the male participants decreasing the response time and the females time increasing. A mean time data comparison by group followed a similar trend for the control group; increasing from scenario administration 1 to scenario administration 2. A decrease in response time was noted, however, from scenario administration 2 to scenario administration 3. Data representing mean response times for the experimental group showed an increase in times from scenario administration 1 to 2 and then again to scenario administration 3. Although the mean response times for the experimental group were lower than that of the control group this pattern is unexplainable. Since this research study was being conducted in a learning environment intended to train law enforcement officers, simple logic would conclude that adult learning would be taking place during the transition from each scenario administration to the other and decreased response times and increased accuracy scores would have been

noted by gender and group. As a result, it is recommended that a comparison of the administration of scenarios A, B, and C be completed to determine if the unexplained differences can be linked to the scenarios. This could assist in determining if additional training is required/recommended for traffic stops, domestic violence encounters, or dealing with the mentally disturbed.

This study used law enforcement neophytes so that an accurate measure of the virtual reality tool could be measured. It is recommended that experienced officers be subjected to the same or a similar experimental design to note any improvement to the cognitive memory or handgun accuracy.

This study also contained a sample population that was provided by the host institution. There was no control over the number of males and females. Although females represented nearly 20% of the sample population, it is recommended that an increased number of females be utilized to determine if gender differences between and within groups are different.

The data collection took place in the central Florida area and represented a small portion of the law enforcement community. Based on laws in effect from state to state, a response continuum might fluctuate and create a different response. The study of virtual reality in other parts of the country may be warranted to determine the effects of virtual reality as compared to traditional formats of training in other locations. In a broader spectrum, it would be advantageous to conduct this study in other countries where laws and, moreover, the response to lethal encounters could be drastically different than those within the United States.

The scenario administration within this study included a traffic stop, a domestic violence situation, and a confrontation with a mentally disturbed individual. The setting for the traffic stop was outside, similar to how a traffic stop would occur; however, the domestic violence and mentally disturbed scenarios occurred indoors. It may also be prudent to replicate this study using different scenarios and settings to determine if the results are similar.

While analyzing the demographics of the participants, it was determined that weapons training had occurred with some of the participants in other venues such as hunter's education programs, security training, and the United States military. It is a recommendation for further research in these areas to determine the effects of virtual reality or performance in other venues. Since virtual reality is a computer-based program, the images could be altered to reflect the venue which they are targeting.

As discussed previously, this study was conducted with law enforcement neophytes during six academy programs. A limited amount of time was available to conduct this study so as not to disrupt the progress of the academic curriculum; therefore, only three scenarios were used. It is a recommendation of this study to utilize additional scenarios to determine if the results are similar under longer term training.

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Appendices

Appendix A: University of South Florida's Informed Consent to Participate in Research Form



Informed Consent to Participate in Research

Information to Consider Before Taking Part in this Research Study

IRB Study # Pro00007128

Researchers at the University of South Florida (USF) study many topics. To do this, we need the help of people who agree to take part in a research study. This form tells you about this research study.

We are asking you to take part in a research study that is called: Effects of Virtual Reality on the Cognitive Memory and Handgun Accuracy Development of Law Enforcement Neophytes.

The person who is in charge of this research study is *Richard A. Wright*. This person is called the Principal Investigator. However, other research staff may be involved and can act on behalf of the person in charge.

The research will be done at the Polk County Sheriff's Office: Burnham/McCall Training Center located at 2201 Old Bartow/Eagle Lake Road Bartow, Florida 33830.

Purpose of the study

The purpose of this study is to

- To compare the differences, if any, in the cognitive, and handgun skill development of male and female law enforcement neophytes who are trained in a traditional, non-interactive format and those who are trained through the use of virtual simulation.
- This study is being conducted as part of dissertation research for the Principal Researcher.

Study Procedures

If you take part in this study, you will be asked to

- Participate in a two day study that will include:
 - Day 1:

Appendix A (Continued)

- Participate in the traditional firearms training, known as discretionary shooting, and is currently an established part of the firearms curriculum that you are currently being provided or
- Participate in a series of virtual simulations that will substitute for the aforementioned training.
 - Day 2: Participate in scenario-based training where you will be asked to utilize the skills for which you have been taught during the day one treatment.
- This study is expected to last for 2 eight hour days.
- This research will be conducted during the last two days of your firearms block of training. It will occur at the Polk County Sheriff's Office: Burnham/McCall Training Center located at 2201 Old Bartow/Eagle Lake Road Bartow, Florida 33830.

Alternatives

You have the alternative to choose not to participate in this research study.

Only those participants who have former law enforcement experience will be excluded from this study.

Benefits

The potential benefits to you are:

- The opportunity to participate in research that may become a beneficial component in the development of innovated curriculum for the law enforcement profession.
- The opportunity to receive training not typically offered in the current academy format.
- The opportunity to receive additional training from highly skilled and educated instructors that have been certified by the State of Florida and selected as subject matter experts in the field of handgun training, tactics and deployment of law enforcement personnel.

Risks or Discomfort

This research is considered to be minimal risk. That means that the risks associated with this study are the same as what you face every day.

The following risks may occur:

- During the data collection period on day two, participants of the study will be provided tools that discharge a marking projectile. You will have the opportunity to become more familiar with the same equipment in a later part of your academy training as it is a key component to the curriculum. Although you will be provided with head, eye, neck, chest and groin protection; there may be minimal discomfort (if) struck by a marking round.

Compensation

We will not pay you for the time you volunteer while being in this study.

Appendix A (Continued)

Confidentiality

- We must keep your study records as confidential as possible. No video or audio recordings will be made.

However, certain people may need to see your study records. By law, anyone who looks at your records must keep them completely confidential. The only people who will be allowed to see these records are:

- The research team, including the Principal Investigator, study coordinator, and all other research staff.
- Certain government and university people who need to know more about the study. For example, individuals who provide oversight on this study may need to look at your records. This is done to make sure that we are doing the study in the right way. They also need to make sure that we are protecting your rights and your safety.) These include:
 - The University of South Florida Institutional Review Board (IRB) and the staff that work for the IRB. Other individuals who work for USF that provide other kinds of oversight may also need to look at your records.
 - The Department of Health and Human Services (DHHS).

We may publish what we learn from this study. If we do, we will not let anyone know your name. We will not publish anything else that would let people know who you are.

Voluntary Participation/Withdrawal

You should only take part in this study if you want to volunteer. You should not feel that there is any pressure to take part in the study, to please the investigator or the research staff. You are free to participate in this research or withdraw at any time. There will be no penalty or loss of benefits you are entitled to receive if you stop taking part in this study. Your decision to participate or not to participate will not affect your student status, course grade or job status.

Questions, concerns, or complaints

If you have any questions, concerns or complaints about this study, call Richard A. Wright at 863-287-9914.

If you have questions about your rights as a participant in this study, general questions, or have complaints, concerns or issues you want to discuss with someone outside the research, call the Division of Research Integrity and Compliance of the University of South Florida at (813) 974-5638.

If you experience an unanticipated problem related to the research call Richard A. Wright at 863-287-9914.

Appendix A (Continued)

Consent to Take Part in this Research Study

It is up to you to decide whether you want to take part in this study. If you want to take part, please sign the form, if the following statements are true.

I freely give my consent to take part in this study. I understand that by signing this form I am agreeing to take part in research. I have received a copy of this form to take with me.

Signature of Person Taking Part in Study

Date

Printed Name of Person Taking Part in Study

Statement of Person Obtaining Informed Consent

I have carefully explained to the person taking part in the study what he or she can expect.

I hereby certify that when this person signs this form, to the best of my knowledge, he or she understands:

- What the study is about.
- What procedures, interventions and devices will be used.
- What the potential benefits might be.
- What the known risks might be.

Signature of Person Obtaining Informed Consent

Date

Printed Name of Person Obtaining Informed Consent

Appendix B: Data Collection Worksheet

Data Collection Work Sheet

Title of Study: **Effects of Virtual Reality on the Cognitive Memory and Handgun Accuracy Development of Law Enforcement Neophytes**

Principal Investigator: **Richard A. Wright**

Participant Number: _____

Group:

Control Group: _____

Experimental Group: _____

Gender: _____

<i>Scenario 1</i>	<i>Scenario 1</i>	<i>Scenario 2</i>	<i>Scenario 2</i>	<i>Scenario 3</i>	<i>Scenario3</i>
<i>Number of Scored Hits</i>	<i>Time from contact to reaction</i>	<i>Number of Scored Hits</i>	<i>Time from contact to reaction</i>	<i>Number of Scored Hits</i>	<i>Time from contact to reaction</i>

Appendix C: Demographic Survey Questionnaire

Demographic Information

Please check the appropriate choice that is applicable to you.

1. Gender:
 - a. Male _____
 - b. Female _____

2. Ethnicity:
 - a. African American _____
 - b. White (non-Hispanic) _____
 - c. Asian _____
 - d. Hispanic _____
 - e. Other? Please specify. _____

3. Age:
 - a. 19 – 21 years _____
 - b. 22 – 25 years _____
 - c. 26 – 30 years _____
 - d. 31 – 35 years _____
 - e. 36 – 40 years _____
 - f. 41 – 45 years _____
 - g. 46 – 50 years _____
 - h. 51 – 55 years _____
 - i. 56 – 60 years _____
 - j. 61+ years _____

4. Highest completed level of education:
 - a. High School or Equivalence _____
 - b. Some College _____
 - c. Associates Degree _____
 - d. Bachelors Degree _____
 - e. Master Degree _____
 - f. Graduates Certificate _____
 - g. Doctoral Degree _____
 - h. Other? Please specify. _____

5. Former Military Experience:
 - a. Yes _____
 - b. No _____

Appendix C (Continued)

6. Former Law Enforcement Experience:

- a. Yes _____
- b. No _____

7. Have you received any other professional training in the use of a firearm, tactical deployment or engagement techniques prior to your attendance in the police academy in which you are enrolled? If so, what type? Please list the organization or professional from which you received the training.

Appendix D: Pilot Study

The purpose of a pilot study, also known as a feasibility study, is to test the logistics of a larger study and to ensure that its quality and efficiency are within the expectations of the researcher. It also identifies the deficiencies within the study prior to the actual research. As pilot studies are typically small in comparison to the actual research, the data can sometimes provide only limited information in regards to the final analysis.

A pilot study was conducted for this research study. The parameters of the research study require three scenarios in the final intervention. Inclement weather prohibited the completion of the third and final scenario. Although the participants were only exposed to two scenarios, the information gained from the pilot study indicated to the researcher that the feasibility of conducting an experimental study in this topic was appropriate.

Population and sample. The participants in the pilot study were all academy-level neophytes. Each of them had just completed the firearms block of training for a Florida Department of Law Enforcement (FDLE) sponsored academy. Each participant had passed the firearms block of training by shooting a score of 80% or higher as mandated by FDLE. There were no former police officers included in the sample population. The class of academy neophytes numbered 26, with 14 assigned to the control group and 12 assigned to the experimental group.

Appendix D (Continued)

The sample was predominantly inexperienced in the use of a hand gun prior to the instruction that was received during the aforementioned training. Most of the participants had no former training with a handgun. Some of the neophytes reported some training in the use of firearms through one of the following means: (a) basic military training (that did not include the use of a handgun), (b) concealed weapons classes, and (c) hunter education classes (with limited or no handgun training).

The participants were assigned to their groups by a stratified random assignment. Each participant was asked to write their name on a piece of paper. That paper was placed into a hat and was randomly drawn by a third party. The intent of this study is to use a stratified random sample; however, there were only three females in this class. This accounted for the unequal grouping of participants. Two females were assigned to the control group and one was assigned to the experimental group.

The demographics of the participants consisted of 25 white (non-Hispanic) and one participant of Hispanic origin. As previous mentioned, there were only three females in this class and their ethnicity was classified as white (non-Hispanic). None of the participants were former police officers, nor had they ever worked for a law enforcement agency. Only six of the participants had former military experience. All of the military experience was reported by the male participants. Ages of the participants as well as educational levels were varied. The mean age of the participants was 22-25 years of age with some college being the predominant education level.

Appendix D (Continued)

Treatments. Prior to the pilot study, great care was taken to ensure that the integrity of the experiment was not compromised. Communication with the assisting instructors began several weeks in advance. Further, the day before the pilot study began, a final briefing was held with the instructors to ensure that the instructions and parameters of the experiment were understood.

Eight instructors were selected by the host institution. Their experiences, certifications, and accolades qualify them as high liability instructors for the State of Florida. Their professional accomplishments include, but are not limited to: (a) SWAT team experience (for both municipal and county agencies); (b) certifications in handgun, shotgun, and rifle instruction; (c) excess of 12 years' experience per instructor (with two instructors having over 30 years of tenure); (d) in-progress shooting instructor certification; and (e) scenario-based training certification. The ages and educational levels are depicted below in Figures A1 and A2.

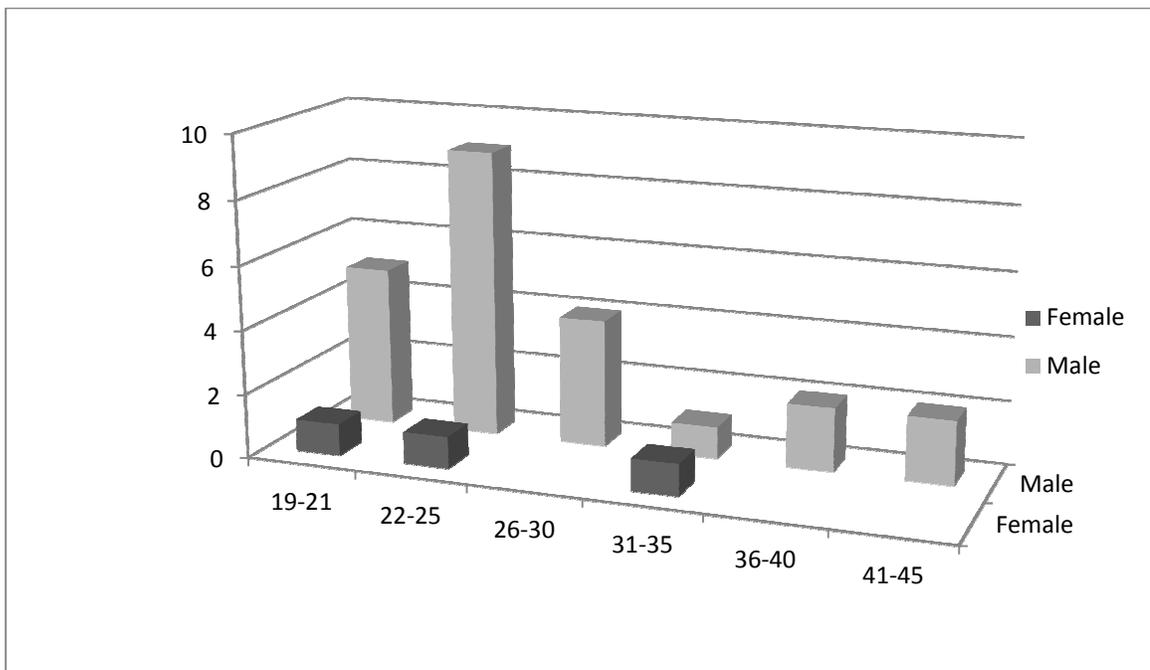


Figure A1. Chart depicting the age of male and female pilot study participants.

Appendix D (Continued)

The instructors were given assignments for both days of activities. Four of the instructors were assigned to the control group and conversely four were assigned to the experimental group for half a day. At mid-day, the instructors switched groups. This

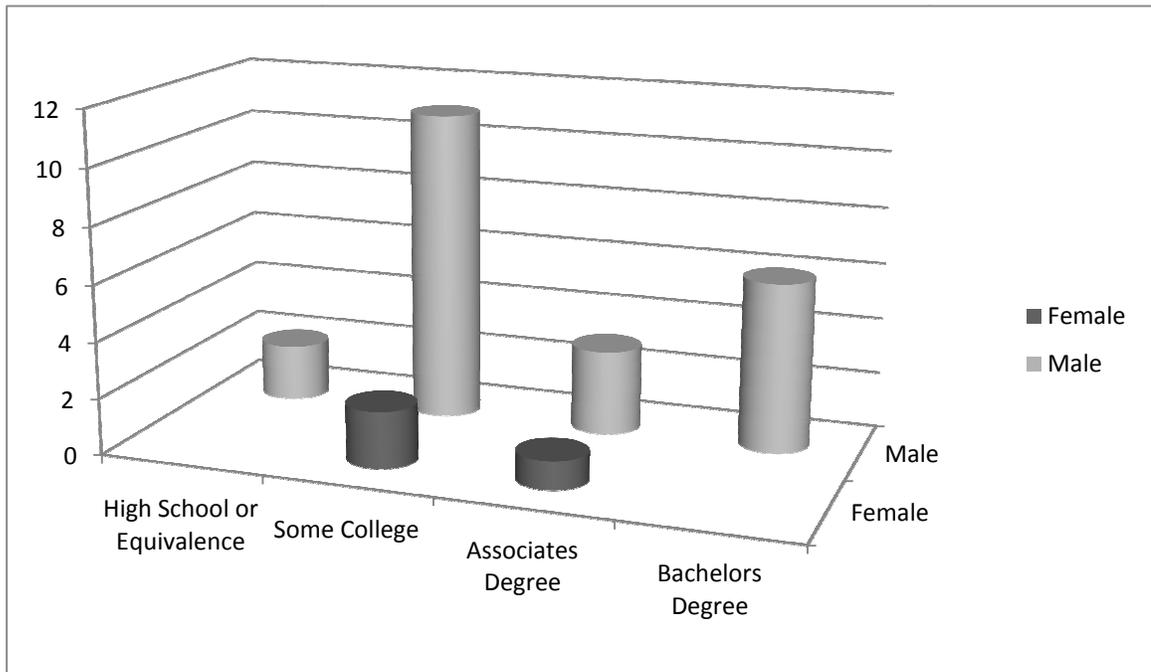


Figure A2. Chart depicting education levels of male and female pilot study participants.

change in instructor assignments was instituted to prevent any one group from developing an advantage over the other from the experiences and instruction of instructor groups.

On day two, a ninth instructor, normally used as the Range Master, remained with whichever group that was not participating in the scenario-based data collection process.

This ensured that no one from either group was watching the scenarios as they took place or communicating with each other about their experiences.

Appendix D (Continued)

All neophytes were first briefed in a single room together. The research process was explained; each neophyte completed a demographic questionnaire and signed a consent form. The entire group was offered copies of the consent form; however, each of them declined. Each of the neophytes was instructed to keep themselves separated by group and not to discuss the treatments or the final intervention until the data collection was completed.

All of the neophytes were in an academic setting where firearms' training is considered an exit point, if not successfully completed. Four times during the briefing an announcement was made, indicating that this study did not influence their academic standing or position in the academy. They would not be removed from the academy no matter how they performed and each of them was given several opportunities to refuse participation. None of the participants declined. There were no questions related to the research or data collection process.

Meal breaks and other opportunities for the neophytes to interact were arranged with the instructors, prior to the beginning of the experiment. The host institutions lead coordinator had previously informed the neophytes that leaving the training facility for meal breaks would not be permitted during the two-day process. Adequate food was either brought by the neophytes or delivered to the training facility. Restroom breaks, water breaks, and other down time were coordinated events and supervised by the Range Master.

Treatments for day 1. All of the neophytes reported to the training facility and were divided into their respective groups. The control group reported to the gun range. The experimental group reported to virtual simulation building and training commenced.

Appendix D (Continued)

For the purpose of this study, the control group was permitted the opportunity for collaborative learning. Collaborative learning is generally restricted for the purpose of concealing the target locations from the next participant or series of participants. This change was permitted as collaborative learning was also allowed for the experimental group. Just prior to the neophytes' engagement of the targets, their vision was obstructed so that the instructor could manipulate the order of the targets. The experimental group did not encounter this dilemma as the simulation is manipulated via the computer monitor that was not visible to the neophyte.

During the day's events, it was determined that the control group, though their numbers were larger than the experimental group, received five training opportunities per participant whereas the experimental group received only four virtual simulations. This is attributed to the performance evaluations/after action reviews occurring with the experimental group.

Final intervention. The final intervention began with roll-call for both groups. All of the neophytes were present. Confirmation of group assignments was completed to ensure that all of the neophytes remained in the same groups.

The same instructors used on day one were also present on day two. Instructor assignments did periodically change throughout the day. These changes only occurred to eliminate down time during the data collection process. Additional assistance was needed to move the neophytes from their secure building and equip them with protective gear.

Appendix D (Continued)

Two assignments that remained consistent were the rater and scribe. A digital stop watch was used to calculate response times. Scoreable hits to the instructor/suspect were counted only if they were in a vital area of the body. Shots to the extremities, such as the hands, arms, and legs, were not counted as they are not considered scoreable by FDLE during an attempted qualification.

Each participant was only provided six marking rounds. Limiting the number of marker rounds avoided any possibility of a long-lasting firefight that would serve no benefit to this study. The limitation of rounds still provided adequate data for analysis. Limiting the number of rounds also reduced the cost of this experiment and periods of inactivity.

The control group was selected to go first and the entire group was completed before the experimental group was allowed to proceed. Some modifications and as previously mentioned, some instructor assignments were changed for the purpose of moving the recruits to the training site, preparing the equipment for the next participant as well as dressing the recruits in the protective equipment that is mandated by the hosting agency and FDLE. This equipment included: (a) head protection (full face mask); (b) throat protection; (c) chest, back, and arm protection; and (d) groin protection. Two of the scenarios, the traffic stop and the emotionally disturbed person, were completed during the pilot study.

Data analysis. The data for the pilot study were collected and analyzed using SPSS computer software. Descriptive statistics were calculated and the data were further

Appendix D (Continued)

analyzed using a one-way analysis of variance with individuals randomly assigned to each group.

Pilot study findings. The purpose of this research was to investigate virtual reality training related to the cognitive memory and handgun accuracy development for law enforcement neophytes. The pilot study had a total of 26 ($N = 26$) participants however; the statistical analysis only reflects 25 ($n = 25$) in scenario one. One of the participants unexpectedly utilized physical restraint techniques against an armed subject. That subject was removed from the analysis of scenario one's data. Each scenario was calculated and analyzed independently from one another. The mean scores for performance of both groups was calculated for both handgun accuracy and cognitive memory (labeled reaction time).

During scenario one (the traffic stop), the mean accuracy score was calculated at .5884 or 60% while the mean reaction time was 3.7760 seconds. The maximum time of 35 seconds was recorded for one of the participants. This time was considered an outlier, but was not removed due to the small sample size. It is an assumption of this analysis that this time may have influenced the statistical significance of the data. Table A1 below depicts the descriptive statistics for the first scenario.

During the second scenario (the emotionally disturbed person), the mean accuracy score was calculated at .8604 or 86% while the mean reaction time was calculated at 12.5538 seconds. The maximum reaction time during the second scenario was 36

Appendix D (Continued)

seconds while the minimum was .10 seconds. Table A2 depicts the descriptive statistics for the entire group.

Table A1

Descriptive Statistics of the Pilot Study for Scenario One

Statistic	% Accurate	Reaction Time
Minimum	0	.1
Maximum	100	35.00
Sum		94.40
Mean	59	3.70
Range of Means	42-80	4.9-2.4

N = 25

Table A2

Descriptive Statistics of the Pilot Study for Scenario Two

Statistic	% Accurate	Reaction Time
Minimum	0	.1
Maximum	100	36.0
Sum		326.4
Mean	86	12.6
Range of Means	83-90	20.5-3.2

N = 26

A more in-depth analysis of scenario one provides a within-group analysis of the descriptive statistics. In that, the mean percentage of accuracy, or skill development, shows a .4193 or 42% accuracy rate for the control group as compared to the experiment

Appendix D (Continued)

group that performed at a .8036 or 80% accuracy rate during their first intervention, a difference of 38%. The mean reactionary time for the control group in scenario one was calculated at 4.89 seconds while the experimental group's reaction time was calculated at 2.3455 seconds; a difference of 2.5445 seconds. When comparing the Skewness and Kurtosis of both the control group and treatment group, they were not normal. The Skewness was calculated at 3.406 while the Kurtosis is 12.024. This was most likely attributed to the small sample size or the outlier in the control group of 35 seconds. The Skewness of the treatment group, -.314 is considered normal while the Kurtosis of the treatment group is almost normal at 2.025. For the purpose of this pilot study, a one-way ANOVA was used to calculate the statistical significance of both the control and experimental group. The ANOVA results, shown in Table A3, indicate that the analysis of the between groups for handgun accuracy is significant at .016. However, there does not appear to be statistical significance between groups for the calculated reaction time of .357. Again, this is attributed to the small sample size or the single outlier of 35 seconds.

A box and whisker plot, illustrated in Figure A3 and A4, depict the accumulated scores that were used to measure handgun accuracy and reaction times that were used to evaluate cognitive memory during scenario one. The illustrations indicate that there is a trend of higher handgun scores developing for the experimental group who experienced the virtual reality training. Further, the 25th-75th percentiles related to the reaction times appear to be closely related. However, reaction times from the experimental group are

Appendix D (Continued)

Table A3

ANOVA Summary Table for the Pilot Study for Scenario One

Statistic	Source	Sum of Squares	<i>df</i>	Mean Square	<i>F</i>
% Accurate	Between	.910	1	.910	6.710
	Within	3.119	23	.136	
	Total	4.029	24		
Reaction Time	Between	40.198	1	40.198	.883
	Within	1047.007	23	45.522	
	Total	1087.205	24		

N = 25

uniformly lower than that of the control group. Although there is no statistical significance between groups for the calculated reaction time, the plot does indicate that the reaction times decrease for the experimental group - supporting the assumption that the small sample size resulted in no statistical significance.

A more in-depth analysis of scenario two provides a within-group analysis of descriptive statistics. In that, the mean percentage of accuracy or skill development shows a .8264 or 83% accuracy rate for the control group as compared to the experiment group that performed at a .9000 or 90% accuracy rate during their second intervention, a difference of 7%. The mean reactionary time for the control group in scenario two was calculated at 20.5429 seconds while the experimental group's reaction time was calculated at 3.2333 seconds; a difference of 17.3096 seconds.

Appendix D (Continued)

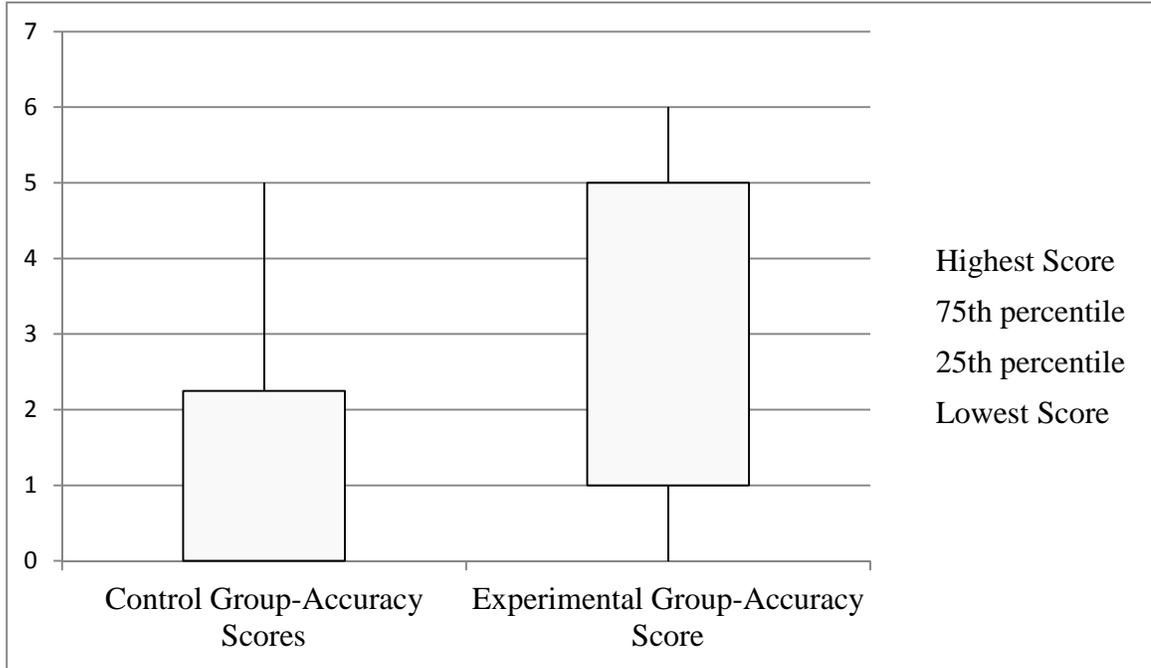


Figure A3. Plot of accuracy percentages for scenario one of the pilot study. The highest and lowest as well as the 25th and 75th percentile of collect scores are represented for both the control and experimental groups.

For the purpose of this pilot study, a one-way ANOVA was used to calculate the statistical significance of both the control and experimental group. The ANOVA results, shown in Table A4, indicate that the analysis of the between groups for handgun accuracy had no statistical significance. However, there does appear to be statistical significance between groups for the calculated reaction time. Figures A5 and A6 are plots that depict the statistical significance between the groups for scenario two. Figure A5 does not stipulate any statistical significance in handgun accuracy; however, Figure A6 does illustrate a significant difference in reaction times for scenario two. The

Appendix D (Continued)

experimental group clearly shows a developing trend of decreased reaction times from not only the control group, but from the first scenario.

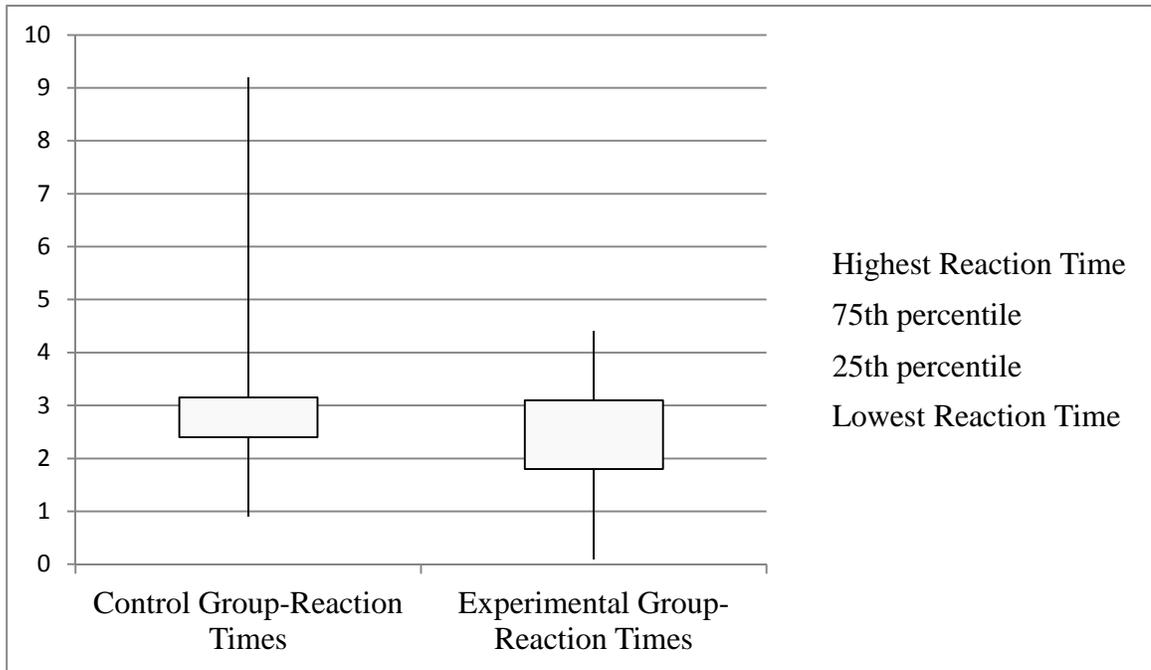


Figure A4. Plot of reaction times for scenario one of the pilot study. The highest and lowest as well as the 25th and 75th percentile of collected times are represented for both the control and experimental groups.

Appendix D (Continued)

Table A4

ANOVA Summary Table for the Pilot Study for Scenario Two

Statistic	Source	Sum of Squares	<i>df</i>	Mean Square	<i>F</i>
% Accurate	Between	.035	1	.035	.585
	Within	1.435	24	.060	
	Total	1.470	25		
Reaction Time	Between	1936.004	1	1936.004	18.595
	Within	2498.681	24	104.112	
	Total	4434.685	25		

N = 26

The purpose of a pilot study was to resolve the logistics associated with the actual study. It also provided statistical insight about what may or may not be expected from the final research. The statistical analysis seemed to be hindered slightly by the sample size, but that was expected prior to the experiment. Cohen (1992) indicates that 128 participants would be desirable, with 64 participants in each group for a medium effect size of .05 and a power of .80. This sample size will be the goal of this research study to provide statistical strength in the final analysis.

Appendix D (Continued)

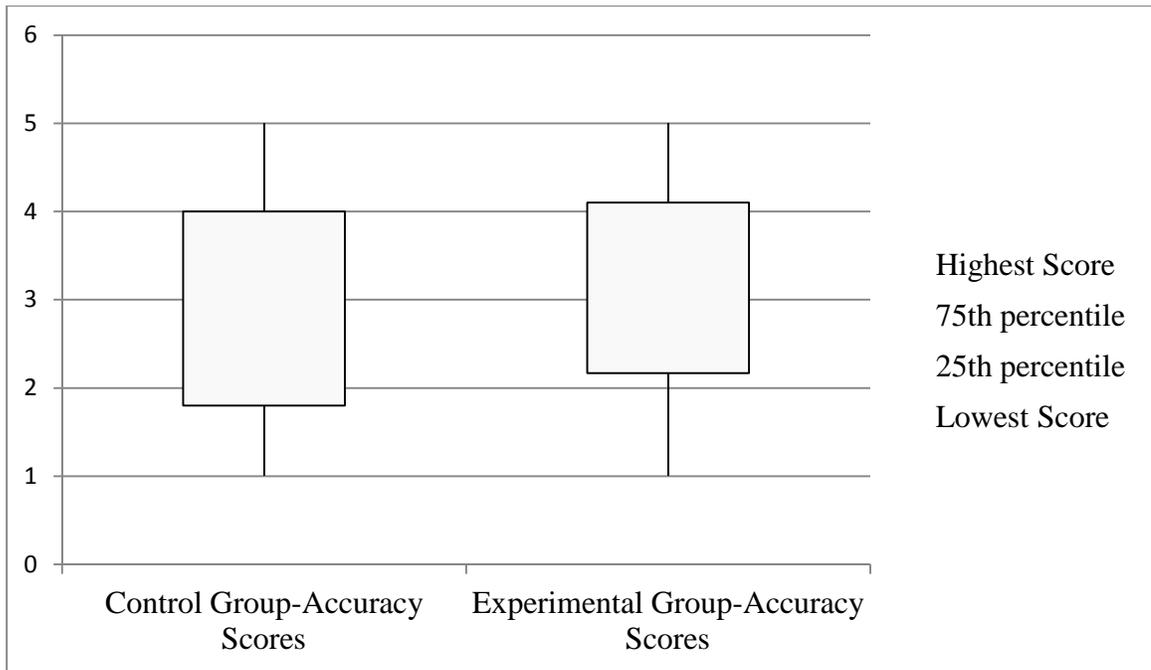


Figure A5. Plot of accuracy percentages for scenario two of the pilot study. The highest and lowest as well as the 25th and 75th percentile of collect scores are represented for both the control and experimental groups.

Appendix D (Continued)

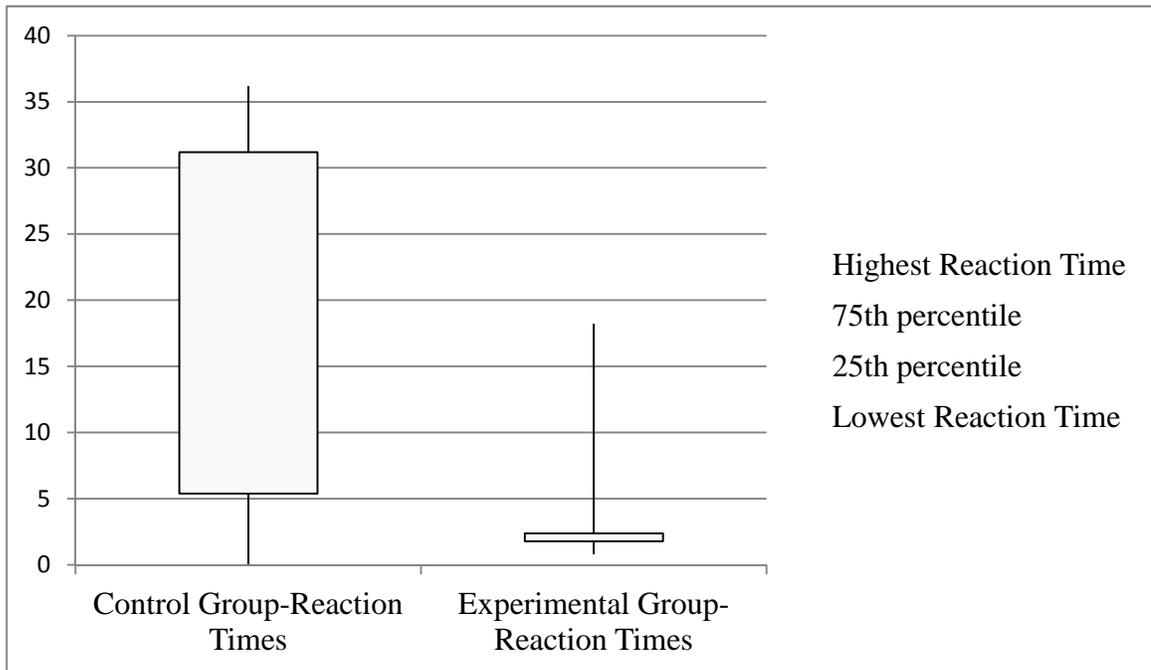


Figure A6. Plot of reaction times for scenario two of the pilot study. The highest and lowest as well as the 25th and 75th percentile of collected times are represented for both the control and experimental groups.

Appendix E: Institutional Review Board Approval Letter



DIVISION OF RESEARCH INTEGRITY AND COMPLIANCE
Institutional Review Boards, FWA No. 00001669
12901 Bruce B. Downs Blvd. MDC035 • Tampa, FL 33612-4799
(813) 974-5638 • FAX (813) 974-5618

February 16, 2012

Richard A. Wright
Adult, Career and Higher Education



RE: **Exempt Certification** for IRB#: Pro00007128
Title: Effects of Virtual reality on the Cognitive Memory and Handgun Accuracy
Development of Law
Enforcement Neophytes

Dear Mr. Wright:

On 2/16/2012 the Institutional Review Board (IRB) determined that your research meets USF requirements and Federal Exemption criteria as outlined in the federal regulations at 45CFR46.101(b):

(1) Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

As the principal investigator for this study, it is your responsibility to ensure that this research is conducted as outlined in your application and consistent with the ethical principles outlined in the Belmont Report and with USF IRB policies and procedures. Please note that changes to this protocol may disqualify it from exempt status. Please note that you are responsible for notifying the IRB prior to implementing any changes to the currently approved protocol.

The Institutional Review Board will maintain your exemption application for a period of five years from the date of this letter or for three years after a Final Progress Report is received, whichever is longer. If you wish to continue this protocol beyond five years, you will need to

Appendix D (Continued)

submit a new application. When your study is completed, either prior to, or at the end of the five-year period, you must submit a Final Report to close this study.

We appreciate your dedication to the ethical conduct of human subject research at the University of South Florida and your continued commitment to human research protections. If you have any questions regarding this matter, please call 813-974-5638.

Sincerely,

A handwritten signature in cursive script that reads "John A. Schinka, Ph.D.".

John A. Schinka, Ph.D., Chairperson
USF Institutional Review Board

About the Author

Dr. Richard A. Wright was born in Ft. Lauderdale, Florida and has earned an Associate's Degree in Criminal Justice from Polk Community College, a Bachelor's Degree in Criminology, a Master's Degree in Adult Education, and a Ph.D. in Curriculum and Instruction – all from the University of South Florida, Tampa. Dr. Wright is a graduate of the 123rd Administrative Officers Course from the Southern Police Institute located at the University of Louisville, Kentucky. He also holds a graduate certificate in Certified Public Management from Florida State University. He has been a law enforcement officer since 1990 and has held many positions within the law enforcement community to include supervising law enforcement Training Section for a large organization that is populated with more than 1,680 members. His responsibilities included supervising the coordination and facilitation of training mandates for advanced and specialized training in three different disciplines. He was also responsible for the implementation of the virtual simulation training being used by the Polk County Sheriff's Office and many other municipalities within Polk County, Florida. As of the writing of this document, Dr. Wright is a District Commander, holding the rank of Captain.