An Analysis of Firearms Training Performance among Active Law Enforcement Officers

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AN ANALYSIS OF FIREARMS TRAINING PERFORMANCE AMONG ACTIVE LAW ENFORCEMENT OFFICERS
AN ANALYSIS OF FIREARMS TRAINING PERFORMANCE AMONG ACTIVE LAW ENFORCEMENT OFFICERS

A dissertation submitted in partial fulfillment of the requirements for the degree of
Doctor of Philosophy in Kinesiology

By

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ABSTRACT

Firearms proficiency is an implicit expectation, held by the public of police officers, due to presumption that the required firearm training is an adequate preparation for a deadly force encounter. However, anecdotal evidence and available data on police shootings suggest that conventional, unrealistic training methods are wholly inadequate. To present stress into firearms training, some departments have opted for exercises such as physical exertion and shoot-house training as a substitute for realistic simulation of force-on-force confrontations.

To determine whether such exercises are comparable, an observation of performance and heart rate levels was conducted on a group of eight police officers, performing four different firearms exercises. The results of the observation strongly suggest that there is a significant difference between the group of exercises in both measures, with more realistic exercises producing substantially decreased performance and raised heart rate levels. The implications for firearms training and qualification are discussed.
This dissertation is approved for recommendation to the Graduate Council.

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Chapter One

Background of the Problem

In the qualification and training of law enforcement officers, firearm training is arguably one of the most important aspects due to the public’s expectation of protection and the potential liability involved with the improper use of a weapon. The perceived necessity of realistic training is so great that multiple court rulings have decided that, for law enforcement firearms training to be sufficient, officers must take part in realistic training.

It is necessary, however, to explore the effects of increasing levels of realism in training in order to compare the extent that various training techniques affect stress and handgun proficiency relative to real force-on-force situations.

Shoot-no-shoot houses, made up of cardboard or paper silhouettes presenting threatening or non-threatening stimuli, have become more prevalent in law enforcement training in order to prepare officers for situations in which they must quickly decide whether deadly force is needed. One possible issue is that, compared to what a law enforcement officer would experience in a real combat situation, it would still seem to leave something to be desired from a training perspective due to the fact that there are some elements of a force-on-force situation that are still absent. Namely, the fact that a cardboard or paper silhouette does not shoot back, nor is a high degree of stress inherent in the "killing" of paper targets, regardless of how realistic they may be. As Shelford Bidwell (1973, as cited by Holmes, 1985) pointed out, the primary issue in finding what takes place in combat is on 'dangerous ground because the union between soldier and scientist has not yet passed beyond flirtation' (p. 19).
As it pertains to law enforcement within the U.S., the use of deadly force is tied to the rights and privileges guaranteed by the United States Constitution. Civil lawsuits can be brought against law enforcement officers or their supervising agencies under United States Code Title 42 § 1983. According to the statute, any officer acting under the color of the law, who subjects another person to a deprivation of rights guaranteed by the Constitution, may be held liable to the injured party.

In *McClelland v. Facteau* (1979), the court ruled that although a single incident cannot prove inadequate training, a lack of adequate training for police can result in the finding of negligence on the part of a police chief. According to the court, this duty is the responsibility of the police chief and thus, a failure to oversee proper training is a breach of duty on his or her part. Although the court did not outline what constituted adequate training, the ruling set an important precedent which highlighted the importance of adequate training in order to prevent the violation of the constitutional rights of citizens. Such instances, as were seen in later court rulings, involve the correct identification of threats in order to justify the legal use of deadly force.

Later that year, a separate ruling, in *Popow v. City of Margate* (1979), heard arguments from a plaintiff asserting inadequate firearm training on the part of a law enforcement agency. The event at hand involved a police officer in pursuit of a suspect and, upon discharging his handgun, struck and killed an innocent bystander in a residential neighborhood.

The court noted the testimony of the officer involved in the accidental shooting, who claimed in his deposition that he was originally trained on deadly force at the police academy ten years prior to the incident and, according to the officer, additional firearms training consisted of...
going to the firing range twice per year. Based on the fact that the city of Margate was largely residential, it was concluded that it wasn't unreasonable to assume that a law enforcement officer could find themselves pursuing a suspect in poor lighting and in a residential neighborhood. Therefore, it was the opinion of the court that handgun training for law enforcement should consist of practice on moving targets as well as tactics for low light and residential neighborhoods.

Perhaps the most notable case in the legal record, dealing with the importance of adequate handgun training, came in Tuttle v. Oklahoma (1984) in which the issue of training officers properly for firearm operation under stress was a major factor. In the situation, a police officer with minimal experience and training answered a call concerning an armed robbery at a local club. When he responded, the unarmed suspect disregarded a command by the officer to stay where he was and left. Despite the fact that the suspect made no overt threat, the officer fired one shot, hitting the suspect in the back and killing him. This case helped to display the importance of training under stress and shoot/no-shoot training.

Despite the legal requirements for training to be more practical to constitute validity, it is common for law enforcement firearms qualifications courses and training to consist of static shooting exercises, opting for paper targets rather than realistic, dynamic training methods (Siddle, 1995, p. 98). This method of training, as noted in the ruling in Tuttle v. Oklahoma (1984), offers little resemblance to scenarios that would likely be experienced during the course of day-to-day duties for a law enforcement officer and, thus, does not prepare law enforcement officers for the extreme levels of stress inherent in deadly combat.

A disconnect between training practices and their similarity to actual conflict situations
can be postulated simply by analyzing the available statistics of police involved shootings. Although statistics are kept by a few police departments and other law enforcement agencies, most do not keep detailed records.

The NYPD, one of the few agencies that has attempted to consistently keep shooting statistics, has a program called "Standard Operating Procedure #9" (SOP-9) which was implemented in 1970 as a way to track police-involved shootings from incidents as wide ranging as confrontations to suicides. These statistics have shown a low hit percentage (15%) for officers shooting at suspects and, as would be expected, an even lower hit ratio for shots taken at longer distances (4% at 25+ yards between 1994 and 2000).

From the years 1990 to 2000, according to data collected from the NYPD's SOP-9 (as cited in Aveni, 2003), the NYPD recorded only a 15% hit ratio when shooting at suspects. Many firearms trainers and law enforcement officers believe that more realistic training techniques involving various scenarios and force-on-force, non-lethal weapons would better prepare officers for the demands placed on an officer during a high stress deadly conflict.

It must be noted, however, that these statistics do not outline what counts as a "hit". Therefore, the possibility exists that hits which count as "acceptable" in training or qualification are different than shots which are recorded as "hits" for the purposes of record-keeping. For instance, in training scenarios, officers are taught to fire at an area consisting of the upper torso or head in order to damage the Central Nervous System, vital organs, or pelvis and thus, stop any threat that the suspect may have presented. For the purposes of training, a hit to any area outside of those mentioned does not count as an acceptable hit since suspects have previously shown the ability to continue fighting after being hit in non-vital areas. Furthermore, the level of reliability
in these statistics is questionable due to a wide range of variables such as the evolution of acceptable uses of force and the accuracy of departments' record keeping.

Within the realm of kinesiology and, more specifically motor learning, the principle that training conditions should closely resemble an expected practical situation is known as the Specificity of Practice Hypothesis. A precursor to this principle known as the Identical Elements Theory dates back to the early 1900s. According to Magill (2006), the identical elements theory proposed that the more elements that skills or scenarios have in common, the greater the amount of transfer between the two will be.

Likewise, the specificity of practice hypothesis proposes that practice conditions should resemble expected performance characteristics in areas such as perception, performance context, and cognitive processes that are necessary to perform adequately. This principle has been widely utilized in both sports and helping to train people to perform skills ranging from driving to flying (e.g. Fisher et al., 2002; Stewart, Dohme, & Nullmeyer, 2002).

Various forms of simulation have been utilized in training for both law enforcement and military (Grossman & Christensen, 2008; Holmes, 1985; Watson, 1978) yet, the level at which these methods are able to compare to actual combat or other training methods, is unknown. The use of a firearms simulator seems to have shown positive results among law enforcement trainees (Saus et al., 2006) however, it is unknown to what degree firearms simulators reflects practical force-on-force situations.

Due to the legal requirements of adequate firearms training, as well as simulation research in the field of motor learning, it is recommended among various experts that training
have a high degree of realism (Artwohl & Christensen, 1997). As a result of budget issues and other limitations, some police departments are unable to implement training methods with high levels of realism and must rely on other methods to introduce stress (McKnight, 2012).

**Statement of the Problem**

As a result of the safety and liability issues that are associated with adequate handgun training for law enforcement, as highlighted by the mentioned court cases, it is incumbent upon law enforcement agencies to train their officers as adequately as possible. Therefore, research which seeks to quantitatively measure training exercise performance, through assessment of how the incorporation of various stressors in each training exercise affects performance relative to other training exercises and actual combat data, is needed. By examining proficiency in varying degrees of realism using a standard measure of performance, comparisons can be made to what limited shooting data exists and conclusions can be formed as to the level of preparation offered by each method.

**Purpose of the Study**

The purpose of this study was to examine the handgun performance of active police officers, in training techniques which incorporate progressively greater degrees of realism, in order to identify performance levels in each training exercise and how they compare to other training exercises and actual shooting data. Such a comparison will provide a quantitative indication of similarity and thus, expected transfer from training exercises to actual shootings.
**Research Questions**

How does performance in firearms training methods with progressively increasing qualitative realism compare when using hit ratio as a standard quantitative performance measure?

How do training methods with progressively increasing qualitative realism compare to each other in the level of stress experienced by the officers, as measured by heart rate?

**Significance of the Study**

This study will further the understanding of firearms training methods for law enforcement officers through an examination of performance and stress. Although federal courts have ruled that officers must be trained under stressful conditions, some states continue to provide fairly vague guidelines as to firearms training. This allows departments to continue training under conditions which provide an element of stress but not so much as to compare to actual combat situations, thereby sidestepping the intent in order to stay within budgetary and logistical constraints. By comparing performance and stress levels from each training exercise, it can be determined if exercises which are dissimilar to combat situations but provide some element of stress, are comparable to those with a greater degree of realism. If it is shown that currently-used methods are significantly different from those which incorporate high levels of realism, further research should be performed to examine training methods and how training requirements could potentially be revised.

**Limitations**

This study is limited by a small sample size as well as the inability to use a randomized
sample.

**Delimitations**

This study is delimited to active law enforcement officers, taking part in four firearms training exercises which are split into two sessions. In order to utilize similar performance standards across all exercises, only shots hitting vital areas (upper torso, head, and neck) will be counted as a “hit” in simulated combat drills. Measurement of stress will be delimited to heart rate only.
Chapter Two

Literature Review

Simulation

It is fairly well established that varying levels of simulation can be effective tools in the practice and perfection of skills in the context of sports as well as the improvement of other skills. In the athletic realm, for instance, coaches and athletes rely on simulation as a useful training method for multiple reasons. Practice incorporating increasing levels of likeness to competitive situations has become commonplace at virtually all levels of athletics. Additionally, it must be noted that although it is difficult to perfectly simulate an actual scenario that an individual or athletic team is training for, the addition of various qualitative characteristics can still be useful during preparation.

An example of an increasingly prevalent method of simulation in practice for athletics teams of all levels, for instance, is the use of artificial noise during practice in order to prepare for important games at an opponent's home field or arena. Most notably, the practice of trying to simulate external conditions, such as crowd noise, can be found with football and basketball teams (Cacciola, 2011; Harvey, 2011; Limón, 2009; Parker, 2012) due to the significant effect that crowds and artificial noise can have on a team's level of play. Although this method of simulation only provides one qualitative parallel to actual competitive situations, it has become popular in order to allow for preparation of a salient element of athletic performance.

The example of using artificial noise to simulate auditory conditions is a prime representation of a way in which simulation can be presented employing only one element of a
competitive situation in a more genuine fashion. However, more than just simulating auditory or visual experiences, the use of simulation in practice settings can also be extremely useful for other practical purposes. Rather than simulation, this technique is more commonly known as "scrimmaging" to athletes and coaches. One benefit of scrimmaging is the opportunity to not only review strategies in game-like situations, but to also focus on tactical training, which helps athletes prepare for various strategies that opponents may use during the course of a competition and be able to react accordingly (Wrisberg, 2007). Much like the example of presenting simulation of only one element, such as artificial noise, scrimmaging can also be applied using varying degrees of realism.

Another benefit, which is subtle but highly important, is the opportunity to provide athletes with experience in competition-like situation alongside their teammates. In the athletic arena, it is common to hear a coach, player, or commentator attribute either success or failure as a result of two or more players' level of comfort playing alongside each other (e.g. Rittenberg, 2012; Shelburne, 2011; Windhorst, 2011).

One of the more common descriptions of this relationship in sports is the discussion about the "timing" between a quarterback and a receiver in football. The ability to practice together enables quarterbacks and receivers to predict what their teammate will do in certain situations, even if a play breaks down.

Two-time Super Bowl MVP Eli Manning describes the importance of this connection: "What happens in a game when things that you prepared for, all of a sudden you get a different technique or something that maybe that hasn't happened before occurs? Can you tell by their body language, by the stem of their route, exactly what they are going to do? You have to
scramble or move in the pocket and the timing is a little off, how are they going to react to those situations?" (Sando, 2012, para. 9)

Regardless of the term used to describe this relationship among players, be it chemistry, timing, experience, etc., ultimately, the best way to improve this relationship is experience. According to Wrisberg (2007), the best way to prepare players is by "...exposing them to information and experiences that will enhance their decision-making capabilities" (para. 3).

Although scrimmages will rarely be able to perfectly simulate a game-day experience, Magill (2006) claims that practice techniques which have more in common with a competition that an athlete is training for will result in a greater amount of transfer.

It would seem that the same argument which is made for the use of simulation training in sports can also be made for the benefits related to realistic, dynamic methods of combat training. Just as can be seen in the realm of athletics, combat training which allows officers to experience the speed of action and visual and auditory sensations which would be expected in deadly-force encounters, as well as allow a development of "chemistry" between fellow officers in combat situations, would seem to be of greater benefit to law enforcement officers and have more comparable performance levels than training methods which provide less similarity.

**Simulation in Task Learning**

In addition to being useful in training for sports, various forms of simulation have been found to be useful in task learning for other endeavors as well. Virtual reality simulators, for instance, have proven to be a useful tool in teaching people to drive cars (e.g. Fisher et al., 2002). Additionally, simulators have become common in training pilots of airplanes and helicopters
(e.g., Stewart, Dohme, & Nullmeyer, 2002) due to the ability to gain experience in realistic situations in a safe and cost-effective manner.

The use of flight simulators have also shown similar arousal reactions, among pilots, to those experienced during the course of real flight-time in measures of heart rate, heart rate variability, and respiratory frequency (Veltman, 2002). All measures, for both simulation and real flight, were significantly higher than baseline measures. This study suggests that simulation may provide an analogous measure of stress to that which a pilot would experience in real flight.

**Stress-Performance Relationship**

Any examination of the effects of realism in firearms training would be incomplete without at least a brief examination of the underlying psychological effects of stress on skill performance.

Perhaps the most commonly adhered to theories on the effects of psychological stress on performance situations is the inverted-$U$ hypothesis, which is based upon the work of Yerkes and Dodson (Graydon, 2002). According to the inverted-$U$ hypothesis, if arousal is too low or too high, performance is negatively affected, which would lead to the conclusion that a person would perform optimally in a relatively moderate state of arousal.
The inverted-\( U \) hypothesis has been utilized by Grossman and Christensen (2008) and Siddle (1995), prominent trainers and consultants for law enforcement and military units, as a general rule of thumb to predict performance. In discussing the effects of stress on skill performance, Siddle (1995) cites the work of Gutin and Levitt (1971, as cited in Siddle, 1995) and Levitt (1972, as cited in Siddle, 1995).

In graphical representation of the results from both studies, it was found that a sort of inverted-\( U \) pattern emerged, describing the optimal levels of stress at which subjects were able to process information and perform tasks. Levitt (1972, as cited in Siddle, 1995) controlled the levels of stress with physical exercise by having subjects exercise on a treadmill and monitoring their heart rate. Tests were performed at levels of 80, 115, 145, and 175 beats per minute with task performance peaking between 115 and 145 b.p.m.

It must be taken into account for the purposes of trying to relate this research to combat, however, that the stress that subjects were placed under was due to physical exertion rather than a combination of physical exertion and high levels of psychological stress that would almost assuredly be experienced in a combat situation; Siddle (1995), Grossman and Siddle (1997), and
Grossman and Christensen (2008) all make this distinction as well. Grossman and Siddle (1997) point out that the key characteristic that distinguishes stress in combat situations from physical stress, brought about by exertion, is the activation of the Sympathetic Nervous System, which triggers the "fight or flight" mechanism.

Different theories have been proposed to replace the inverted-\(U\) hypothesis, which has been rejected by a few sport psychologists (Eysenck, 1982; Hardy, 1996; Hockey & Hamilton, 1983; Jones & Hardy, 1990; Neiss, 1988). Although the inverted-\(U\) hypothesis has its skeptics, Landers and Arent (2001) point out that to some extent, the inverted-\(U\) hypothesis has been somewhat misinterpreted by some of its detractors such as Fazey and Hardy (1988).

According to Landers and Arent (2001), the ability to produce an idealized bell-shaped curve for the arousal-performance relationship would "require extremely large numbers of participants and numerous small incremental levels of arousal manipulated within the range of low to high arousal". The inability to do so is, therefore, a methodological limitation rather than a flaw in the hypothesis itself. Furthermore, the inverted-\(U\) hypothesis is descriptive rather than explanatory (Neiss, 1988) so although it has limitations, it is able to adequately describe the arousal-performance relationship. For this reason, although a perfect bell-shaped curve may not always be observed in a relationship between arousal and performance, the main point of the inverted-\(U\) hypothesis is simply that the arousal-performance relationship is curvilinear and optimal performance typically occurs in an intermediate range of arousal.

Regardless of the prevailing view, we know that the ability to perform a skill at a high level is dependent upon different variables such as somatic stress, cognitive stress, and task complexity. For instance, the optimal level of arousal for a weight lifter would be much higher
than that of a golfer.

In the case of a law enforcement officer operating a handgun, it would seem that optimal performance of the skill would require a fairly intermediate level of arousal; certainly lower than that of a weight lifter but probably a bit higher than that of a golfer putting a ball. However, given the circumstances of a deadly force encounter, it may be impossible to consistently lower the perceived stress and thus, arousal level of combat participants. Rather than attempting to drastically affect the level of arousal, research is needed to determine if improvements in performance may come as a result of helping law enforcement officers learn to operate under such high levels of stress through training in high-stress conditions.

As previously noted, a difference exists between psychological and physiological stressors, both of which may be encountered in varying levels within commonly used firearms exercises. Physiological stress, as discussed using the work of Levitt (1971, as cited in Siddle, 1995) and Levitt and Gutin (1972, as cited in Siddle, 1995), certainly causes difficulty in task performance at high enough levels while a moderate level of arousal shows improvement in performance. Lazarus, Deese, and Osler (1952) discuss the detrimental effects of psychological stress upon performance of both motor and cognitive tasks, yet none of these tasks implements high degrees of stress such as would be experienced in combat situations or training which seeks to simulate combat.

A combination of the two stressors, however, has shown to have a synergistic effect which works together to cause a greater stress response than either of the stressors cause individually (Rousselle, Blascovich, & Kelsey, 1995; Webb et al., 2008).
Causes of Combat Stress

It is fairly obvious that a fear of death or injury is one of the root causes of combat stress. Brigadier General S. L. A. Marshall (1980) points out that we can't accept "...the superstition that under danger men can be expected to have more than their normal powers and that they will outdo their best efforts simply because their lives are at stake" (p. 73). Watson (1978) came to a similar conclusion when he stated that "combat stress, with its real fear of death, is quite different from other kinds of stress" (p. 195).

Martens (1977) defined stress as "the process that involves the perception of substantial imbalance between (environmental) demand and response capability, under conditions where the demand has important consequences" (as cited in Liukkonen, 2007, p. 59). From this definition, we can take away three important points. First, the perception of a threat initiates a response. Secondly, the response to a threat depends upon the ability of the responder to react appropriately and competently to it. Lastly, the level of expected consequences has a degree of effect on the level of stress experienced.

In taking Martens' definition into consideration, it seems that stress, to some extent, could be reduced by improving the response capability relative to the perceived level of threat. Druckman and Swets (Eds.) (1988), in discussing the effects of stress on performance, state that "people's stress levels will be high if they correctly perceive themselves to be deficient in the behavioral skills necessary to accomplish a task" (p. 125). It would seem to follow, then, that the best method of preparation would be to utilize methods which provide increased levels of similarity to combat situations. Comparing the degree of homogeneity of performance in training methods to that reported for actual combat situations will allow for trainers to better
grasp the disparity in stress and difficulty that is provided by the different training methods.

Bourne (1970) points out, while discussing the importance of superior training that soldiers in the Vietnam War were able to have confidence in the quality of training and equipment they received. As he notes, "Not only is the G.I. in Vietnam well trained but, perhaps more important, he thinks he is well trained" (p. 76). Additionally, he goes on to give partial credit of the relatively low incidence of psychiatric casualties among American combat troops to the quality of training that soldiers had received.

Although it is impossible to control the degree of danger which officers will experience in real-life situations, some anecdotal evidence suggests that it is possible to improve their ability to respond to a threat due to a reduction in the degree of stress associated with the fear of injury or death that is experienced.

Considerably realistic training could possibly be expected to abate after considering results of various surveys conducted by Shalit (1988) to determine what soldiers' greatest fears were during combat. After posing this question to Israeli troops that had just come from combat, the most common answers weren't the fear of injury or death but rather, "letting others down." Similar questions were posed to troops that hadn't yet seen combat experience for which, the primary response received by Shalit was, in fact, the fear of injury or death. This led him to conclude that as combat experience increases, the fear of death or dying will decrease or could possibly be eliminated. It may be presumptuous as to whether a reduction in fear of injury or death could result from highly realistic training but it would seem to be a possibility which warrants research.
The implementation of various methods of combat simulation has been useful in a variety of scenarios. Much like scrimmaging, which was previously mentioned as being useful in training for sports, high degrees of realism can sometimes offer a more comparable training situation to prepare in and thus, improved ability to respond to a threat could be expected after training under such conditions, although further research is needed. Similarly, officers unaccustomed to such training methods would be expected to exhibit a gradual decrease in performance under increasing levels of realism and stress though the degree to which this can be expected is unknown.

Resistance to killing another human has been believed throughout the years to be another possible problem that must be approached with modern training techniques in order to condition the combat participant to be prepared to use deadly force if needed. Marshall (1950, as cited in Grossman, 2009), after studying the performance of troops in World War II, controversially concluded that "the average and healthy individual...has such an inner and usually unrealized resistance towards killing a fellow man that he will not of his own volition take life if it is possible to turn away from that responsibility" (p. 29).

According to Watson (1978), Marshall found a firing rate of 15-20 percent in American riflemen during World War II while studying the performance of troops. Interestingly enough, after the military implemented modern training techniques such as using human silhouettes rather than targets in training based on Marshall's findings, firing rates among U.S. Army riflemen increased to approximately 95 percent in the Vietnam War.

The U.S. Air Force realized the same issue during World War II when they realized that less than 1 percent of their pilots were responsible for shooting down between 30 and 40 percent
of enemy aircraft. Even more surprising is that, according to Gabriel (1986, as cited in Grossman, 2005), the majority of fighter pilots "never shot anyone down or even tried to" (p. 31).

Not just limited to the military, it appears this issue has affected police departments as well. Artwohl and Christensen (1997) mention that one large law enforcement agency found, through unscientific observation that approximately 20 percent of applicants would not commit to using deadly force when asked during interviews. Fortunately, police applicants which fall into this group are typically eliminated from consideration based on this inability to use deadly force if needed.

Despite the fact that candidates are generally denied entry into law enforcement if unable to use deadly force, if modern training techniques have improved the ability of soldiers to use deadly force if needed, then it begs the question why these training techniques are not commonplace among law enforcement agencies as well. At minimum, it would seem to improve reactions by officers during or after shootings.

In recent years, horrifying anecdotal evidence can be cited as further proof of the reality of desensitization to taking another human life. Violent video games, serving as a form of simulation, have been noted as having a causal relationship with aggressive behavior (Anderson et al., 2010).

Law enforcement has also taken notice of the effectiveness of simulation through video games as a training tool. Not long after the shooting at Columbine High School in Littleton, Colorado, the American Sniper Association's training periodical in April, 2000 (as cited in
Grossman & Christensen, 2008) made mention of the use of video games as a training method for the school shooters and urged law enforcement not to dismiss video games as a form of training.

Video games have been cited in multiple other cases as a form of desensitization to violence. According to Grossman and Christensen (2008), the U.S. military has even taken notice of the advantages of video games as a training tool and desensitization technique, which led to them purchasing and modifying the classic Nintendo game Duck Hunt to operate with more realistic guns and shoot at man-shaped silhouettes. The use of video game simulators, known as Multipurpose Arcade Combat Simulators (MACS), has also been well described by Broom et al. (1989).

Although becoming desensitized to violence or death is not something to be sought out, in and of it, the reality is that it is somewhat of a "necessary evil" for law enforcement officers and soldiers. If an officer is placed in a situation which requires the use of deadly force immediately, even a moment of hesitation can result in the injury or death of themselves or other innocents. Much like the training techniques implemented between World War II and the Vietnam War, realistic training may be useful in preparing individuals for deadly conflict. Further research which focuses on these training techniques among law enforcement is needed to better determine how these methods should be implemented.

**Performance Effects of Stress in Combat**

According to the Advanced Law Enforcement Rapid Response Training handbook (2005), the national average hit rate for officers training in fixed positions and shooting static paper targets is above 90%, while that hit rate drops to somewhere between 12-18% for officers
involved in a deadly force encounter. These statistics are fairly consistent with the statistics on handgun operation kept by the NYPD's SOP-9 (as cited in Aveni, 2003).

Despite the possible issues with various shooting statistics, it is safe to assume that the stress experienced in a potentially deadly conflict, coupled with the high degree of unpredictability and need for quick and decisive tactical action, clearly has a detrimental effect upon performance with a handgun for many law enforcement officers.

The conclusion that stress has a significant effect upon combat effectiveness has been made, not only through years of anecdotal evidence and statistics, but through the results of several studies regarding task performance under stress. One such study, performed by Kramer (as cited in Watson, 1978) at the U.S. Army's Human Engineering Laboratories, found that stress caused by simulated artillery fire had "a considerable effect on firing....more on accuracy than on rate of fire..."

Other studies have found similar results in non-combat situations. Berkun (1958, as cited in Watson, 1978) found a 10% reduction in the ability to complete paperwork while in an aircraft making an emergency landing. Another in the series of studies performed by Berkun found that soldiers experienced a high degree of difficulty in repairing radio transmitters while simulated artillery rounds exploded at a gradually decreasing proximity.

Siddle (1995) has defined combat stress as perceiving an imminent threat of serious personal injury or death, under conditions where there is little response time. The extreme nature of combat stress has been demonstrated in conditions intended to simulate combat, in which drastic changes in heart rate have been observed (Grossman & Siddle, 1997). According to the
authors, changes in pulse from a normal range (approximately 70 beats per minute) to more than 200 beats per minute have been observed as occurring in only seconds. For individuals unable to manage such high levels of stress, some cases have shown that heart rate can continue to increase to rates as high as 300 beats per minute during these simulated combat situations.

Besides the extreme changes coming as a result of psychological stress that have been observed, an important consideration that must be noted is that it is possible, through extensive training, to become acclimated to performing certain tasks proficiently at much higher levels of psychophysiological stress than normal. Grossman and Christensen (2008) note that in 2001, a U.S. Army Special Forces (Green Beret) officer working alongside Dr. Morgan of the Yale Center for Post-Traumatic Stress Disorder and U.S. Army special operations psychologist Gary Hazlett, conducted "heart rate variability research" on special operations soldiers.

Soldiers were put through a series of tests made up of force-on-force, close-quarter battle techniques to measure stress levels. While wearing full combat equipment and using firearms equipped for use with paint-bullets along with the use of full contact fighting methods for "non-lethal" situations, the Special Forces soldiers were assaulted in a simulated combat environment including extreme noises and poorly lit surroundings. Additionally, soldiers were equipped with equipment used to provide an electrical shock to the upper body in order to simulate gunshot wounds from enemy fire.

Although each soldier performed at high levels, heart rate levels reported were quite different than normal; much higher than would be expected for such high performance levels. According to Grossman and Christensen (2008), the soldiers that performed at the highest levels had maximum heart rates of 175 beats per minute while, some who performed at a slightly lower
level averaged levels of 180 beats per minute.

Of note is that some skills, requiring fine-motor abilities, were noticeably difficult for some soldiers. For instance, soldiers were required to restrain role players that were simulating enemy combatants with "flex-cuffs" after either subduing them in hand-to-hand combat or shooting them with paint bullets in designated "kill" areas. Soldiers who had pre-threaded their flex-cuffs were able to quickly perform this task without issue while scanning the environment for other threats. Those who hadn't pre-threaded their flex-cuffs experienced a high level of difficulty in performing the skill and some were even visibly unable to perform the task at all.

Similar results in heart rate levels and performance have been noted elsewhere. For instance, a report in *Popular Science Magazine* (Lyons, 1998) has mentioned that it is common for NASCAR and Formula One drivers to maintain a heart rate of approximately 175 beats per minute for extended periods of time. Grossman and Christensen (2008), commenting on this unusual phenomenon, point out that these drivers have few skills (right turn, left turn, accelerate, brake) that they are required to perform repeatedly at high speeds, which would explain why they are able to maintain performance under such high levels of stress. The combination of constant practice along with very few necessary responses enables these drivers to perform highly under high levels of stress.

The ability to perform these skills successfully while in a high state of arousal has been explained well and contrasted to low states of arousal by Dr. Seymour Epstein (1994, as cited in Artwohl, 2002). Low levels of arousal allow for rational, thought out responses to stimuli that individuals experience while high levels of arousal, on the other hand, result in experiential thinking. Experiential thinking, when a threat is perceived, will automatically take effect and
eliminate the ability to think logically; in such a state, a person will simply react. It is for this reason that experience is not only suggested but necessary and, if it is not possible to perfectly create exact conditions that would be experienced, then it would seem that training should be made as "real" as possible. Experiential thinking is reliant on previous experience therefore, "under sudden, life threatening stress, individuals likely will exhibit behavior based on past experiences that they automatically will produce without conscious thought" (Artwohl, 2002).

**Physiological Effects of Combat Stress**

The decrease in performance levels, which is commonly observed in combat, is undoubtedly a result of the effects that fear and psychological stress have upon the body. To prepare law enforcement officers for combat situations, it would seem necessary to not only attempt to simulate conditions and scenarios that they may encounter during the course of their work for the sake of skill practice, but also to allow them to experience the diminished ability to perceive the environment around them. Although we know that perceptual distortion is a common occurrence among law enforcement officers involved in combat situations, there is little information available on the relationships between different types of distortions (Klinger, 2002).

Distortions in perception (visual and auditory) and memory have been reported regularly among officers involved in combat situations. However, reports as to the rates of the different types of perceptual distortions taking place vary somewhat among the related research. The most prominent of perceptual distortions, based on the reports of officers after shootings, are visual and auditory chances, although sensations of time speeding up or slowing down and memory loss have been reported in significant levels as well.

Diminished sound or auditory exclusion can range from not hearing anything to noises
sounding distant to only hearing certain noises but not others. Grossman and Christensen (2008) mention several cases of auditory exclusion, ranging from completely not hearing gunfire to only hearing a gun cycling out spent casings but not the gun firing.

Visual distortion is also a common occurrence during combat. Some officers have reported experiencing tunnel vision while others have described a visual clarity, although results of various studies have differed in the rates of the types of visual distortions. Klinger (2002), for instance, reported a rate of 37% experiencing heightened sense of visual acuity while 31% reported experiencing tunnel vision and 10% reported both. This differs somewhat from Artwohl and Christensen (1997), who found a rate of 82% tunnel vision and 65% heightened visual acuity.

Solomon and Horn (as cited in Artwohl, 2008) were the first to publish data based on officer-involved shootings. Among the 86 officers that were surveyed as a part of their study, the rates of the types of perceptual distortion are as follows:

- Felt as if time slowed down - 67%
- Experienced diminished sound - 51%
- Experienced tunnel vision - 37%
- Experienced greater visual acuity - 18%
- Experienced intensified sound - 18%
- Felt as if time sped up - 15%

Artwohl and Christensen (1997) conducted a survey of 72 officers that have been involved in officer-involved shootings and found that large numbers of them experienced
distortions in either perception, memory, or both. The results are as follows:

- 88% experienced diminished sound
- 82% experienced tunnel vision
- 78% felt as if they responded without thought (autopilot)
- 65% experienced heightened visual clarity
- 63% felt as if time slowed down
- 61% experienced memory loss of parts of the event
- 60% experienced memory loss for some of their actions
- 50% experienced dissociation
- 36% experienced intrusive distracting thoughts
- 19% experienced memory distortion
- 17% experienced an intensification of sound
- 17% felt as if time sped up
- 11% experienced temporary paralysis

Honig and Roland (1998) performed a much larger study on the effects of combat situations upon the perception of officers. The authors report that of the 348 officers surveyed, 90 percent reported one or more types of perceptual distortion. The individual breakdown as to the rate of each type of distortion is as follows:

- Experienced diminished sound - 51%
- Experienced tunnel vision - 45%
• Reported an increased attention to detail - 41%

• Experienced slow motion - 41%

• Experienced intensified sound 23%

• Unable to remember parts of the incident - 22%

• Felt as if time sped up - 20%

Klinger (2002) performed a fairly comprehensive survey of law enforcement officers that had been involved in shootings during their career, including not only perceptual distortions experienced but mental and physical effects that were reported after the shooting. As his results relate to perceptual distortion, his findings are as follows:

• Experienced diminished sound - 82%

• Felt as if time slowed down 56%

• Experienced heightened visual detail 56%

• Experienced tunnel vision 51%

• Felt as if time sped up 23%

• Experienced intensified sound 20%

Among the studies reporting on the issue of perceptual distortion, there are some slight differences which may be attributable to the samples used, the amount of time after the shooting in which the interview was given, or various other issues such as injuries sustained by officers during a shooting. Despite the slight discrepancies in the findings of the different studies, it seems clear that perceptual and/or memory distortion is a real issue that needs to be prepared for rather than allowing officers to experience it for the first time in a deadly force encounter. It
would also seem apparent that these reports are not simply a case of officers neglecting to notice something, such as would be expected while in a low state of arousal. To the contrary, these must be considered physiological effects of the high stress levels that are associated with a combat situation.

As can be seen from the data collected on perceptual distortions, the two primary issues that must be confronted are those of diminished hearing and vision. The inability to perceive environmental cues can ultimately be deadly for those involved in combat. The use of protective equipment, like the equipment that is necessary for paint bullet training, can help mimic some of these distortions. Masks, for instance, inhibit the ability of an officer to use peripheral vision and diminish hearing, which could force them to develop coping mechanisms which could then be transferred into real combat situations at the onset of tunnel vision.

Despite the fact that not all officers reported experiencing diminished hearing or tunnel vision, those experiencing heightened visual acuity would still be likely to realize similar effects during simulations.

**Simulation as Stress Inoculation**

Perhaps the most beneficial aspect of greater realism in training could be the ability to experience some level of the stress of combat and learn how to cope with it. Meichenbaum (2007) points out that the concept of inoculation takes place in various forms throughout a wide range of fields.

Several studies have shown that small amounts of exposure to stressors can bring about repair mechanisms that guard against stressors of greater intensity among animals (Calabrese &
Baldwin, 2002). Inoculation has been shown to affect attitudes as well; by exposing subjects to bits of attitudinal information, subjects have shown to be more resistant to further efforts of persuasion at greater intensities (McGuire, 1964, as cited in Meichenbaum, 2007).

A classic study examining the effects of increased experience in stressful situations upon individuals looked at hormonal and behavioral responses of Norwegian paratrooper trainees (Levine, 1978). Trainees performed multiple jumps from a 10-meter tower. After the first jump for each trainee, cortisol levels were shown to be dramatically increased and fear was high. After the first two jumps, cortisol levels decreased back to basal levels and fear ratings decreased markedly on subsequent jumps.

Similarly, results seen by Kelsey et al. (1999) showed that prior task exposure improved task performance and decreased cardiac reactivity over a delayed-exposure group. While this does not address concerns about physiological stress that would be experienced in certain training exercises or actual combat, these results suggest that psychological stress can be decreased through exposure to similar scenarios and stress levels.

Lazarus and Folkman (1984, as cited in Krohne, 2002) propose that an individual (or group, community, etc.) experiences stress whenever their perception of a situation's demands are a strain or are greater than the resources to respond. This view of stress is similar to that of Martens (1977, as cited in Magill, 2006), which was discussed previously. Stress is neither a characteristic of the environment nor the individual; instead, it is a dynamic relationship between the stressor and the environment. Meichenbaum (2007), who utilizes this proposed view of stress in his formulation of Stress Inoculation Training, sums it up by saying "Like beauty, stress is in large part 'in the eye of the beholder'" (p. 6).
Far from being a cookie-cutter, one-size-fits-all approach to dealing with stress, Meichenbaum (1985) defines his approach as "a generic term referring to a treatment paradigm consisting of a semi structured, clinically sensitive training regimen" (p. 21). Stress Inoculation Training consists of three stages: the conceptualization phase, the skill acquisition and rehearsal phase, and the application phase.

The conceptualization phase focuses on analyzing the stressors to be expected and establishing a relationship between the trainer and client. The second phase, skill acquisition and rehearsal, aims to develop an approach to dealing with stressors by discussing and planning which coping skills should be used. Lastly, the application stage consists of the using of the coping skills that the trainer and client approved. Because Stress Inoculation Training is a fairly general set of guidelines rather than a predetermined plan, this approach could easily be tailored toward preparation for combat situations combining the use of simulation or other methods such as mental imagery, breathing exercises, etc.

In accepting the premise that a person can be more prepared for a stressor by experiencing similar, less intense stressors, we can conclude that realistic combat scenarios would be an appropriate tool in training law enforcement officers. However, it is unknown just how "real" this simulation should be to bring about the best results or if training methods with multiple degrees of realism could be fairly similar.

**Combat Simulation**

For the purposes of combat stress inoculation, high-stress simulation has a significant level of anecdotal evidence to support the notion that extreme realism in training is beneficial. However, little in the way of actual research has been done to show improved weapons
proficiency coming as a result of simulated training or how similar it is to actual combat by measure of performance and stress. Regardless of the lack of research on the topic, enough proof of the efficacy of stressful combat training exists to have influenced an increase in the implementation of it among law enforcement across the country and to even require it by law (Oklahoma v. Tuttle, 1984, 10th Federal Circuit Court).

It is commonly accepted that training, when repeated enough, will eventually become second nature. In the realm of sports, coaches often parrot the phrase "You play how you practice". More than just improving performance in combat, evidence exists that repetitive training has even been able to instill certain values.

In Acts of War, Richard Holmes (1985) gives an example of the French Foreign Legion being trained not to allow their weapons to be taken as a point of honor by hostile tribesmen, regardless of the circumstances. In May 1911, part of the 1st Regiment was killed in an ambush. When found it was realized that two of the soldiers had had the presence of mind to remove and hide their rifle bolts, so as not to let them be found and used by the tribesmen. Similarly, it is reported that a Legionnaire of the 4th Regiment, while being surrounded in hand-to-hand combat and badly wounded, threw his rifle over the heads of the enemy and behind French lines.

Counterintuitive actions such as this are explained by Grossman and Christensen (2008), who point out that with repetitive training, autopilot and reactionary responses can be developed. They also mention that realistic, stressful training should be used as a form of stress inoculation to help officers "stay in the zone". Although frequency of training is outside the scope of this literature review, it is mentioned because the ability to overcome natural reactions, in many cases, can be of the utmost importance in combat situations. Often, the urge to retreat, brought
on by perceptual distortions and the instinct to find a better vantage point, can leave an officer in a poor tactical position. For this reason, even if highly realistic training is proven to be the most beneficial and is implemented, it should still be undertaken frequently.

It has been reported that simulated training for law enforcement has been used since the early 1900s, when Fairbairn of the Shanghai Police Department was asked to determine training methods which would improve an officer's ability to perform in combat and thus, survive (Siddle, 1995). Fairbairn came to the conclusion that qualifications which were based upon shooting at a bull's-eye did not adequately prepare officers for real confrontations. After coming to this conclusion, Fairbairn developed the first known police shooting course that provided realistic situations in 1921, which consisted of officers searching a warehouse and engaging combatants with non-lethal, plastic bullets.

Other forms of simulated combat, or "battle inoculation", have been used in various forms during the World War II era (Holmes, 1985). Holmes reports that by 1943, almost all men in training for the U.S. Army had been put through a course which required them to perform an 80-yard crawl over rough terrain with machine gun fire directly overhead. Similar, or more realistic and dangerous forms of training, were used in various other countries such as by the German SS, who used live ammunition and considered a casualty rate of 5 percent or less during training to be acceptable in order to field experienced soldiers.

As previously mentioned, combat simulation was also implemented in the post-World War II era, after Brigadier General S.L.A. Marshall found a firing rate of 15-20 percent among American riflemen during World War II (Watson, 1978). Determined to improve the firing rate, Marshall recommended that instead of practicing by firing at a bull’s eye, Army riflemen would
be better served to train by shooting realistic, man-shaped silhouettes which provided instant feedback by falling when hit.

According to Watson (1978), such training techniques were able to increase the firing rate among U.S. Army riflemen to approximately 95 percent during the Vietnam War. Watson goes on to report that soldiers who had gone through such training commonly reported that, when encountering an emergency situation, simply carried out the correct drill and completed it before realizing that they were not in a simulation drill.

In more recent years, anecdotal evidence suggests that simulated combat has been an effective tool for training law enforcement officers with the development of new types of non-lethal weapons, such as paintball guns. Grossman and Christensen (2008) report that groups such as the California Highway Patrol, Salt Lake City P.D., Toledo P.D., and others have experienced significant improvements in hit rates in police involved shootings after implementing realistic, simulated training. The authors go on to recall a conversation with a member of the Ohio Peace Officers' Training Academy, in which the trainer reported that after putting one particular police force through simulated combat situations using paintball guns, the police force began getting complaints of being trained too well in the use of handguns.

According to Grossman and Christensen (2008), in the year following the implementation of simulated combat training, officers from the police department were involved in six different shootings; all within departmental policy and in compliance with Tennessee v. Garner (1985), which serves as the legal standard as to what constitutes appropriate use of deadly force by a law enforcement officer. The subjects in all six shootings were killed, which led to some within the police department fearing that officers were being turned into "trained killers".
As noted earlier, little in the way of research related to the use of training techniques has been performed for combat situations. However, with the development of more technology to aid in the training for combat situations, some researchers have started to analyze the efficacy of different simulation techniques. Researchers in Norway, for instance, found that the use of a shooting simulator improved subjects' performance compared to subjects that simply performed skills training. Participants in the treatment group showed a higher rate of shots fired and hits on target (Saus et al., 2006). The results of this study suggest that simulation is an improvement over just skill training but no indication is given as to the optimal level of realism in simulation training. Also, it should be taken into account that testing was performed on a simulator rather than a combat simulation so generalization to real combat requires further research.

Another study, performed by researchers for the Marine Corps, found that "simulators can be effectively used as part of training programs for individual, crew-operated and aviation weapons systems and that the use of simulators supports and enhances the effectiveness and value of live fire training" (Murphy, Farr, & Loviscky, 2007, p. 4). Furthermore, the researchers concluded that simulators improved soldiers' weapon skills which in turn improved their adaptation to live-fire exercises, which is believed to help inoculate trainees against the stresses of operating real weapons.

Burkett, Mullen, and Meliza (2000) also found that live-fire exercises helped to increase weapons competence among soldiers but also noted some disadvantages. In comparing live fire exercises to force-on-force exercises using blank ammunition, the researchers found that each training method offered certain benefits. Force-on-force training was able to provide a more realistic battlefield environment as well as help soldiers cope with the friction of war, practice
field craft, and understand the impact of time and distance factors. On the other hand, there were advantages to live fire training that force-on-force did not provide such as improving confidence, increasing confidence in using weapons, and improving the understanding of weapon safety.

**Paint Bullet Training**

A recently developed technology, known as Simunition®, allows officers to train in realistic situations using modified versions of commonly used service weapons, including such brands as Glock, Beretta, and Smith and Wesson. This technology can allow officers to train in realistic force-on-force situations while still receiving the benefits of live fire training, as discussed in Burkett et al. (2000).

Due to the costs of this form of training, any training that would be possible would be short term and infrequent (McKnight, 2012). Although anecdotal evidence appears to validate this form of training, it is unknown how similar this type of training is to actual combat situations or whether such short term simulations would result in improved weapons performance, as measured by hit ratio.
Chapter Three

Method

Participants

A group of 8 Texarkana-area police officers took part in this study. Participants consisted of officers from two local school districts and one college. The group consisted of 7 males and 1 female with average age of 44.6 (SD 5.85). The average amount of experience as a police officer was 16.5 years (SD 8.3).

Prior to the beginning of the training course, all participating officers signed an informed consent form which apprised them of their right to refuse to allow data to be used in research, description of the study, risks and benefits, as well as their right to withdraw at any time.

The study consisted of a single group, with-in design of four exercises. Participants were tested in groups for static shooting, shooting with running, and simulated combat; shoot-house exercises were performed individually. As a result of department training schedules, exercises were completed through multiple sessions, with simulated combat being performed first, followed by static shooting, shooting with running, and shoot-house drills being completed approximately a month later.

Procedures

Testing consisted of a required Standard Police Handgun Qualification and an Advanced Handgun Training course, as well as a shoot-house exercise which followed the Standard Qualification.
Participant testing began with the Advanced Handgun Training course, which had to be conducted prior to the Standard Qualification due to scheduling issues. The Standard Police Handgun Qualification was performed in later testing sessions which split the 8 participants from the simulated combat testing into two smaller groups.

**Static Shooting**

Standard Qualification testing began with static shooting at a non-moving cardboard silhouette (Figure 2) from a fixed position. Shots were considered a "hit" if the bullet struck within a predetermined area located on the head or upper torso of the silhouette targets.

![Standard NRA B-27 Law Enforcement silhouette target](image)

*Figure 2: Standard NRA B-27 Law Enforcement silhouette target*

To prevent officers from being hit by another officer's ejected casing, the number of officers shooting at one time in the first exercise were limited to four, so as to allow enough space between participants. Also, officers were positioned horizontally to each other so there would be no possibility of a participant being in another participant's shooting lane. All shooting
was done facing a large backstop which was behind all targets. This helped to prevent any injuries from bullets continuing to travel past the targets or ricocheting back towards participants and instructors from anything behind the targets.

Static line shooting followed the order described in Appendix B, as provided by course instructors. Static line shooting included standard, two-handed shooting, magazine changes, and shooting while standing and kneeling. Shooting distances were established at 1, 3, 7, 15, and 25 yards, respectively. Shooting was controlled by the instructor, who provided commands indicating when officers could shoot.

**Run and Shoot**

The second exercise in the Standard Qualification was a run-and-shoot exercise, in which the officers were required to shoot at a non-moving cardboard silhouette (Figure 1) after having to run approximately 50 yards at a moderate pace in order to induce physical stress. Officers also were given less time to perform magazine switches, magazine reloads, and to complete the number of shots from each distance, in order to add further stress. If officers were unable to keep pace with the instructor’s commands, unfired shots were carried over to the next incremental distance. Pairs of 2 to 3 officers participated in this drill at a time due to safety concerns about overcrowding.

Officers followed the same safety precautions and pattern of firing used in static line shooting (Appendix B). Since the same location was used for this drill, a large backstop was present to prevent stray bullets from injuring anyone through over travel or ricochet.
Shoot-house Training

The final exercise performed on Standard Qualifications testing days (although not part of the state-required testing) was a shoot/no-shoot exercise, in which officers participated one at a time. Each officer individually entered the shoot-house, where they were confronted with a series of paper targets which they had to quickly assess as either a threat or non-threat (Figure 3) and react accordingly (Appendix C).

![Figure 3: NRA AT-Q Law Enforcement target used in Shoot-house exercise](image)

Threatening targets were a life-sized paper target which displayed a person wielding a weapon in a threatening manner; non-threats were generally shown holding something non-threatening such as a law enforcement badge or were being held hostage by another threatening target. Potential targets were changed by course instructors after each officer went through, in order to prevent officers from artificially performing better by predicting which potential targets
are threats. As can be seen in Figure 3, targets had an outline of an acceptable area for shot placement, consisting of the head, neck, and upper torso. Shots which did not fall inside this area were considered misses.

To offer an increased level of realism in the exercise and present a greater level of stress, a course instructor shadowed each officer as they progressed through the course. If the officer took too long in assessing a threatening target and acting accordingly, the instructor would fire a gun filled with blank ammunition (non-projectile).

**Simulated Combat Training**

Simulated combat training consisted of officers taking part in simulated combat situations using Simunition® brand low-velocity, non-lethal marking rounds (Figures 4 and 5), which are made specifically for use in modified versions of commonly-used duty weapons in training applications. Each officer used colored marking cartridges, whose colors were unique for each officer, in order to allow performance to be accurately assessed.

*Figure 4: Picture of Simunition® rounds from the side*
For the purposes of this firearms course, training weapons were modified Glock firearms with a blue frame, which made training weapons distinguishable from actual firearms (Figure 6). All officers taking part in this course either carried Glock firearms or a similar handgun while on duty, which helped prevent any issues with unfamiliarity on the part of the officers operating the handgun.

Prior to taking part in this exercise, officers were briefed on safety procedures and equipment by the course instructors. Additionally, firearms and other items that could be used as
weapons (such as pocket knives, keys, etc.) were forbidden from the premises in order to prevent any confusion between training weapons and real weapons or instinctual reactions which may have resulted in injury. To insure that no participant had a firearm, all officers were scanned with a metal detector prior to the course.

All participants were required to wear safety equipment (Figures 7 and 8), including a mask to cover the face and head, throat protector, and tactical vest. Additionally, officers were required to wear long-sleeved shirts, pants, and either tactical boots or tennis shoes.

*Figure 7: Required safety equipment, including mask, throat protector, and tactical vest*
Before beginning, officers were briefed on the situation with which they would be presented, as if being sent by an emergency dispatcher. Upon entering the combat scenarios, officers followed protocol for the scenarios which they were assigned. Varying scenarios, such as hostage or active shooter situations, were presented to each group.

In the different scenarios, officers were presented with armed “suspects,” also carrying modified guns shooting marking cartridges that presented a threat to the officer and/or others. Officers were required to yield their weapons and stop the “threat.”

In keeping with proper training protocol during simulated combat situations, if an officer took too long in reacting or was hit during the course of the simulation, officers were not be stopped by the instructor until they had finished the exercise. The purpose behind this was to train officers to continue to perform, even if wounded, until a threat is impeded. As such,
performance data were still kept in the event that an officer is hit, much like in the shoot-house exercise.

To standardize performance assessments, shots were considered a "hit" if they were located on the upper torso or head on all exercises. Shots which did not strike in those areas, whether they struck another part of the body (or target) or missed the target altogether, were counted as a "miss".

In addition to keeping performance data for each exercise, officers also wore a heart-rate monitor to record stress levels through each training method. Heart-rates were monitored using a wrist-operated heart-rate monitor with a chest strap pulse sensor.

**Treatment of Data**

Hit rate data were analyzed using an arcsine transformation of percentage data and a repeated-measures Analysis of Variance. Using Mauchly’s Criterion, it was determined that sphericity was violated, thus requiring correction via Greenhouse-Geisser.

Heart rate data were analyzed using a repeated-measures Analysis of Variance. Both sets of data were post tested using a Bonferroni correction ($\alpha/6$).

Lastly, a Pearson’s $r$ correlation was performed to assess the relationship between hit rate percentages and heart rate. Hit rate percentage data was transformed using an arcsine transformation.
Chapter Four

Results

The firearms exercises yielded a significant effect on performance $F(1.51, 10.57) = 56.24, p < .0001$ when tested using a repeated measures ANOVA performed on arcsine-transformed hit rate percentages. Mauchly’s test indicated that the sphericity assumption had been violated ($\chi^2 = 19.85, p = .001$), therefore the degrees of freedom were corrected via Greenhouse-Geisser ($\varepsilon = .503$).

Post testing, using a Bonferroni-adjusted alpha level of .0083 (.05/6), indicated that Simulation ($M = 15.69\%$) and Shoot-house ($M = 53.67\%$) exercises were significantly different from all other drills. Static shooting ($M = 97.12\%$) and Run-shoot ($M = 93.37\%$) drills were significantly different from the Simulation and Shoot-house drills, but were not significantly different from each other.

| Table 1: Means and Standard Deviations of Non-transformed hit rates (as a percent) |
|----------------------------------|----------------|----------------|----------------|----------------|
|                                  | Static         | Run/Shoot      | Shoot-house    | Simulation     |
| Mean                             | 97.12          | 93.37          | 53.67          | 15.69          |
| Standard Dev.                    | 3.04           | 5.92           | 18.49          | 23.39          |

The firearms exercises also resulted in a significant effect on heart rates $F(3, 18) = 8.81, p = .0008, \eta_p^2 = .595$, which were also tested using an ANOVA for correlated samples. Post testing, with a Bonferroni-adjusted alpha level of .0083 (.05/6), indicated significant differences
in only two comparisons: Static shooting ($M = 118$) and Shoot-house exercises ($M = 145.28$) and Static shooting and Simulation ($M = 159.8$). The Run-shoot exercise ($M = 139.4$) was not significantly different from any other exercise.

Due to an error with one of the heart rate monitors, results from one test were not obtained for one subject, resulting in that subject's results being excluded from statistical testing for heart rate.

<table>
<thead>
<tr>
<th></th>
<th>Static</th>
<th>Run/Shoot</th>
<th>Shoot-house</th>
<th>Simulation</th>
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<tr>
<td><strong>Mean</strong></td>
<td>118</td>
<td>139.4</td>
<td>145.3</td>
<td>159.85</td>
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<tr>
<td><strong>Standard Dev.</strong></td>
<td>26.15</td>
<td>25.25</td>
<td>27.02</td>
<td>11.63</td>
</tr>
</tbody>
</table>

Finally, a Pearson’s $r$ correlation, performed on arcsine-transformed hit rate percentages and heart rate data, resulted in a significant negative correlation $r(28) = -.4935, p = .0056$. 

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Chapter Five

Discussion, Conclusion, and Recommendations

Discussion

The purpose of this study was to examine the effects which differing stressors, associated with common exercises for handgun training of law enforcement officers, have on performance and heart rate. An advantage of using an observational study was that the exercises and results would be seen in a practical setting, with minimal researcher interference, rather than a clinical setting that is highly controlled by the researcher. Previous research has examined the results of experimental simulated combat training for police officers, although procedures were very controlled and used an unrealistic method for simulation testing (Oudejans, 2008).

Sample size served as a limitation and it could be reasonably expected that some of the variation in data would normalize within groups. Heart rate, in particular, displayed much larger than expected standard deviations. Regardless, a partial eta squared test yields a large effect size of $\eta_p^2 = .595$. Additionally, the finding of a significant negative relationship between hit rate percentages and heart rate ($r = -.4953$, $p = .0056$) further supports a conclusion that, despite the limited sample size, the two variables are related.

The opportunity to shadow the officers in combat simulation exercises offered the researcher insight into the stress, not to mention unpredictability, involved in force-on-force encounters. The effect of the capriciousness of combat situations on performance is evident when comparing the results of such experimental studies to actual statistics collected by law enforcement agencies.
For instance, Oudejans (2008) reported a pre-test hit rate of 68.3% and 61.1% for the control and experimental groups, respectively. In this study, participants were tested in a scenario that resembled an old-west gunfight rather than a likely combat situation.

When we compare these results to the 15% average hit rate reported by the NYPD, it seems apparent that the methods used in this or similar studies, when compared to what commonly occurs in an actual deadly force encounter, accurately reflect deadly force encounters. This begs the question as to whether many commonly used training and qualification methods provide the critical level of stress and accurately model plausible force-on-force scenarios.

Examination of the effects of stress on performance, as it ties into principles such as the inverted-\(U\) hypothesis, would seem to suggest that participants experienced the ideal level of stress in the static shooting and run and shoot exercises. The drills didn’t present an overwhelming level of stress and/or difficulty, yet enough stress was present to result in an average heart rate that is higher than would be expected in a healthy, resting individual along with near-perfect performance.

In reviewing the results of the current study, the pattern shows similarity to other research in that the addition of more stressors decreases performance. Static shooting exercises provided little in the way of stress, which is reflected in the diminished hit ratios in subsequent drills while near perfect scores were average for static shooting, with little variability. Additionally, the heart rates collected were the lowest among the four exercises tested, suggesting that the lesser amount of inherent stress had less of an effect on perceived stress levels.

Judging solely by performance, the run and shoot drills did not provide an adequate
increase in stress, as the hit rates were slightly lower but still remained high with little variability. The amount of physically measureable stress induced in this drill is largely dependent upon the instructor, due to the lack of requirements in running volume and/or intensity that are used to induce stress. Although heart rates measured an average of 20 beats per minute higher, the fact that hit rates remained elevated suggests that either the amount of stress induced was insufficient or the introduction of physical stress cannot adequately replace the psychological stress present in a force-on-force scenario.

Shoot-house exercises proved to be more difficult for the participants despite only a slight increase in the average participant's heart rate. This could be attributable to multiple factors including the application of movement to the drill, having to maneuver through doors and corners, and uncertainty about each potential target. Despite these added limitations, the average hit rate remained slightly above 50 percent, a far cry from real-life data collected on police shootings. Despite the addition of similarities in the shoot-house exercise, one aspect of force-on-force situations is conspicuously absent: the presence of another person shooting back.

The addition of a real opponent presented a much greater strain on participants than the other three exercises which were observed. Participants were not simply required to apply combat tactics and active assessment against one or more two-dimensional cutouts but rather, active targets that presented a threat. In lower stress exercises, a stimulus-response relationship (Osgood, 1949) which is comparable to real combat seemingly goes unfulfilled due to a lack of elements similar to those that exist within actual combat situations. For instance, there are no decision-making prompts, which require an officer to decide whether force is needed. This could be a significant issue for officers placed in similar situations, such as was seen in *Tuttle v.*
The disparity seen as a result of this addition is apparent: an average hit rate of 15.7% and a jump in heart rate to 159.86 beats per minute. Although many of the skills required were essentially the same as those used in the shoot-house exercise, the added dynamic of interaction with others (both potential targets and officers) seems to be significant. Participants were also presented with the challenge of targets that move and shoot back, elements that are not present in any of the other drills and presented them with a high level of psychological stress.

One aspect of force-on-force scenarios which presents a hardship for research, at least when employing an observatory method, is the absence of uniformity between each exercise. By not having a standardized scenario for each exercise, the current study or similar research could possibly be open to critique for reliability issues. However, it could be argued that the advantages of such methods outweigh the disadvantages.

Primarily, it should be noted that real-life situations are anything but controlled, which begs the question why training (or testing) should be highly controlled. As Coker (2004) notes, “A skilled performer can not only execute an action proficiently but can do so under a variety of conditions” (p. 182). This belief is expressed with a specific application to handgun proficiency by Morrison and Vila (1998), who state that “Being ‘handgun qualified’ should mean being able to perform competently during unpredictable armed confrontations arising out of routine activities involving close-range exchanges of gunfire...” (p. 529).

As we know, the goal of these training exercises is to prepare officers for the potential of dynamic, chaotic force-encounter in any situation that they may face, and not a controlled,
unrealistic force-on-force scenario. Therefore, it makes little sense to present officers with a controlled force encounter in training exercises or testing. This suggestion is supported by research in the area of motor learning, which concludes that variable practice techniques may not result in better performance initially but have greater influence on learning and long-term skill retention (Coker, 2004).

More than simply relating to motor patterns governing proficiency in combat situations, there is research suggesting that training at higher levels of arousal is superior when the expected performance conditions also involve high levels of arousal (Movahedi, Sheikh, Fazlolah, Hemayattalab & Ashayeri, 2007). Taken along with studies suggesting that exposure to a task lowers both physiological and psychological measurements of fear-induced stress in subsequent exposures (Levine, 1978; Kelsey et al., 1999), the apparent conclusion seems to be that preparation should utilize similar psychological elements as well as physical elements. The practical implications for firearms training are significant, considering the vast difference that exists between the stress levels involved in standard training and those associated with combat simulations.

A particular aspect that should be considered for training methodologies, in light of the wide disparity between the results seen in simulated combat and the other drills, is that there are no required alterations in training once an officer has reached a certain level of proficiency on less difficult exercises (simulated combat and shoot-house exercises are not requirements). Given the fact that participants of the current research averaged 97% and 93% hit rates on static shooting and run and shoot exercises, respectively, it would seem that at the very least, training requirements would shift towards a greater proportion of training time occurring in higher-stress
exercises.

Although it typically would not be feasible to employ such techniques frequently for training, Oudejans (2008) did find that the use of three one-hour training sessions in higher-stress scenarios improved performance among those trained in higher stress exercises over a two-week period. This would seem to indicate that an extensive amount of training is not needed to yield positive results, although a minimum amount of necessary training time or frequency has not yet been established.

Finally, based on the results of this study, it is unclear as to whether current qualification methods are even valid. If it is possible to qualify as competent to carry and use a handgun by passing a test such as the Run and Shoot range exercise, it would seem that the officer has not truly been tested sufficiently for their ability to operate a handgun adequately in a combat situation. As can be seen in the average heart rates, the Run and Shoot and Shoot-house exercises did not result in a greatly different maximum heart-rate level while the actual performance results were very different. One further potential issue with the use of Run and Shoot drills for handgun qualifications is the lack of standard guidelines as to what even constitutes a sufficient amount of stress.

Conclusion

In summation, the purpose of this study was to observe if differences exist between firearms training methods used by law enforcement officers in measures of performance and stress level. To make this comparison, a group of police officers were observed while performing four different firearms training exercises of increasing levels of similarity to real combat situations.
Significant differences were found between exercises in both performance and heart rate, showing that training which is more similar to actual force-on-force situations resulted in decreased performance and increased heart rate levels. Based on these findings, it can be determined that there are significant differences between less-realistic firearms exercises, with some level of stress introduced, and exercises that attempt to simulate combat situations. As a result of significant differences being found in both performance and heart rate, further research should be performed to examine training methods and potential revision of training requirements.

**Future Directions for Research**

Due to the current findings, it is the opinion of the researcher that further study along this vein should continue to explore the effects of highly realistic simulation training protocols as well as the residual effects of such training, the effects of handgun training frequency variations, and potential application methods for combat simulation in standard handgun qualification tests. Additionally, due to the costs related with combat simulation training, such as the equipment, specialized ammunition and requisite man-hours, further research could examine the effectiveness of alternative forms of simulation such as the use of laser-equipped training firearms and virtual reality firearms simulators.


Appendix A

Texarkana I.S.D. Police Department
4241 Summerhill Road  Texarkana, Texas 75503
903/792-4658 tigerwatch@txkisd.net

May 31, 2012

To whom it may concern,

The Texarkana I. S. D. Police Department Training section has agreed to assist John Thomason in his research project to measure observable stress indicators and the effect of induced stress on officer firearm proficiency.

This will involve several different scenarios ranging from a static line qualification to simunition force on force training.

Sincerely,

Raymond Calhoun
Training Sergeant
July 11, 2012

MEMORANDUM

TO: John Thomasson
    Dean Gorman

FROM: Ro Windwalker
      IRB Coordinator

RE: New Protocol Approval

IRB Protocol #: 12-06-750

Protocol Title: An Analysis of Firearms Training Performance among Active Law Enforcement Officers

Review Type: ☑ EXEMPT ☐ EXPEDITED ☐ FULL IRB

Approved Project Period: Start Date: 07/11/2012 Expiration Date: 07/10/2013

Your protocol has been approved by the IRB. Protocols are approved for a maximum period of one year. If you wish to continue the project past the approved project period (see above), you must submit a request, using the form Continuing Review for IRB Approved Projects, prior to the expiration date. This form is available from the IRB Coordinator or on the Research Compliance website (http://vpreuark.edu/210.php). As a courtesy, you will be sent a reminder two months in advance of that date. However, failure to receive a reminder does not negate your obligation to make the request in sufficient time for review and approval. Federal regulations prohibit retroactive approval of continuation. Failure to receive approval to continue the project prior to the expiration date will result in Termination of the protocol approval. The IRB Coordinator can give you guidance on submission times.

This protocol has been approved for 15 participants. If you wish to make any modifications in the approved protocol, including enrolling more than this number, you must seek approval prior to implementing those changes. All modifications should be requested in writing (email is acceptable) and must provide sufficient detail to assess the impact of the change.

If you have questions or need any assistance from the IRB, please contact me at 210 Administration Building, 5-2208, or irb@uark.edu.
Appendix C

Informed Consent Form

Title: An Analysis of Firearms Training Performance among Active Law Enforcement Officers

Investigator: John Thomasson
Dept. of Kinesiology- CEHP
University of Arkansas

Compliance Contact Person:
XXXX
IRB Coordinator
Office of Research Compliance

Description: The present study seeks to observe the performance levels of active law enforcement officers during training exercises which present increased degrees of similarity to combat scenarios. While taking part in the present Advanced Handgun Training course, performance levels and heart rate will be measured. The following page will ask you a few demographic questions as well as inquiries about firearms training. During the firearms training course, the researcher will record your performance levels and monitor stress via a small heart-rate monitor.

Benefits and Risks: The benefit of the study will be the identification of handgun proficiency and stress levels among active police officers in commonly-used training exercises which incorporate various levels of stress. This would provide a quantitative basis for further research into training methods for law enforcement, which would allow for improved efficacy of training methods.

Officers taking part in the advanced handgun training course will be exposed to risks typically associated with handgun training courses. For this reason, all officers will participate in a classroom session dealing with safety procedures and proper handgun use prior to participation in any exercise, regardless of previous training, firearms experience, etc. This session, along with all training exercises, will be taught and supervised by firearms instructors which are certified by the State of Texas.

In the first exercise, officers will be shooting a handgun at a static target from a fixed position. In order to prevent officers from being hit by another officer's ejected casing, the number of officers shooting at one time will be limited to four so as to allow enough space between participants. Also, officers will be positioned horizontal to each other so there will be no possibility of a participant being in another participant's shooting lane.

In the second exercise, officers will shoot a handgun at a static target from multiple positions, which they must move to. Although the officers' paths would not cross over
each others' own paths or shooting lanes, further precaution will be taken by limiting the number of participants at one time even further, to two. Additionally, all officers will take the same path in their respective lane so participants will be horizontal to each other during live fire, rather than in the line of fire.

In the third exercise, officers will be shooting a handgun while moving through shoot house. Due to close quarters, only one officer will be allowed to take part in the exercise at a time. One instructor, familiar with the layout of the shoot house, will follow directly behind each officer as they participate in the drill. By following directly behind, the instructor will be safely outside the line of fire.

The final exercise will consist of placing officers in simulated combat situations in which they'll be firing modified, non-lethal marking cartridges from a modified duty weapon. In order to prevent any accident due to confusion from the high degree of similarity between these modified training weapons and actual handguns, training weapons are all blue. Additionally, real handguns will be forbidden from the premises at the time of training. Although marking cartridges are non-lethal, contact with the eyes, throat, or bare skin could result in injury. All participants in these simulated scenarios will be required to wear a mask which covers the entire head, a throat protector, tactical vest, and long sleeve shirts, pants, and boots. Officers will be required to wear long sleeves, pants, and boots, while course instructors will provide all other safety equipment for the exercise.

The most common risk involves hearing damage resulting from exposure to high levels of noise due to the discharge of a firearm(s). In order to prevent hearing damage, protection will be required for all participants, either participating or waiting within close proximity, in the form of earmuffs or ear plugs. Eye protection will also be required in all drills for participants in order to prevent injury to the eyes from a casing ejected from an officer's handgun. Officers not taking part in a drill and outside a reasonable proximity will not be required to wear eye protection. All drills using live fire will be performed in environments free of debris in order to prevent ricochets from occurring.

**Voluntary Participation:** Your participation in this research is voluntary. You will receive state required training credits by taking part in this training course, even if you do not consent to the use of your performance and stress data for this study.

**Confidentiality:** The Informed Consent form, as part of the research packets, will be passed out prior to the beginning of the Advanced Handgun Training course along with classroom materials used during Day 1. Research packets will be divided into either ACCEPT or DECLINE groups based on the Informed Consent form. The ACCEPT group will be separated and each participant will be assigned a unique number that will be written on their demographic page from the research packet and their performance sheets. Once all data has been collected, the list linking your name and your code will be destroyed. Your name will only be listed on this consent document and will not be connected to your results in our records in any way.

All information, including Informed Consent forms, demographic information, and performance data, will be stored in a locked safe at the researcher's residence and data will be stored on a password-protected computer.
Right to Withdraw: You are free to change your mind at any point during the training course if you do not want your performance used as part of the research data. Even if you change your mind, you can still complete the training course and receive training credit. If you decide you do not want to participate in the training course and withdraw from the present study, any training credit for the course will be determined by the instructors and/or governing law enforcement agency; not the researcher. If, at some point during the course, you decide that you do not want your data used, please contact the researcher at xxxx@uark.edu.

Informed Consent: I, ____________________________, have read the description of the current study as well as the methods used, benefits and risks associated with the study, practices to ensure confidentiality, and the statement outlining the right to withdraw from the study at any time. Additionally, each item has been satisfactorily explained to me and I have had all of my questions about the study answered. With my signature below, I am freely agreeing to participate in this study after fully reading this agreement.

☐ Yes, I AGREE to allow the information from this study to be used for research on firearms performance and stress.

☐ No, I DO NOT AGREE to allow the information from this study to be used for research on firearms performance and stress.

______________________________________________________  __________
Printed Name and Signature                                  Date
Appendix D

TCLEOSE

Pistol Qualification Proficiency Course

1 Yard - 6 Rnds. - Anchor Point - Two Rnds. Per Command - From Holster

1 Yard - 6 Rnds. - Anchor Point - Six Rnds. On Command - From Holster

3 Yards - 6 Rnds. - One Hand - Six Rnds. Strong Hand, on Command - From Holster

3 Yards - 6 Rnds. - One Hand - Six Rnds. Weak Hand, on Command - From Holster

7 Yards - 6 Rnds. - Two Hands - Two Rnds. Per Command - From Holster

7 Yards - 12 Rnds. - Two Hands - Twelve Rnds. With a Mandatory Reload - From Holster (24 seconds)

15 Yards - 6 Rnds. - Two Hands - Six Rnds. On Command - From Holster (30 seconds)

25 Yards - 2 Rnds. - Two Hands - Two Rnds. On Command Standing or Kneeling - From Holster
Appendix E

Tactical Response Course

Targets

Start

Target

10 Rounds Ammunition
2 Magazines (No more than 6 rnds each)
Timer at Entry
Hit Hostile 10pts
Hit Friendly -15pts
Hit Hostage -15pts

Max. 100pts.
+seconds under 90 seconds

Loading Area