The Effectiveness of Use of Force Simulation Training
Final Report

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Executive summary

Use of force situations in the law enforcement context occur frequently in Canada and Canadian courts regularly scrutinize the decisions made by police officers in such encounters and the use of force training that the officers receive. This highlights the need for police agencies to provide adequate and suitable training to their officers and to have access to a body of empirical research that generally supports the training being provided. From the perspective of the police agency, this research should ideally demonstrate that the existing training program (1) effectively imparts the skills that police officers require to deal appropriately with use of force situations and (2) teaches skills that are transferable to naturalistic settings.

Many Canadian police agencies have recently incorporated use of force simulators into their training programs. Indeed, as of 2003, at least 32 police agencies across Canada had access to a use of force simulator and at least 13,000 Canadian police officers were being trained on these simulators annually. This number continues to grow. Unlike earlier use of force instructional methods, such as range shooting, simulators are designed to provide more realistic training and to cover a broader range of use of force options. This latter approach accepts that mastering specific skills is a crucial component of any training regime, but the ability to apply those skills appropriately under stressful (i.e., sub-optimal) conditions is viewed as equally critical.

In order for use of force simulation training to be successful, it must encompass several key principles empirically demonstrated to underlie effective training. These are components that relate to practice issues, retraining needs, information feedback, and degree of fidelity. However, as currently implemented by Canadian police agencies, it appears that use of force simulation training likely falls short in many of these key areas. For example, based on a recent survey conducted by the Canadian Police College (2003), it would appear that the amount of instructional time provided to police officers on simulators is far too short to be of benefit. In addition, training sessions are not ordered or spaced appropriately, retraining needs are not effectively met, and instructor feedback is insufficient in terms of both quality and quantity.

However, use of force simulators can theoretically provide effective training to police officers. In fact, simulators offer several advantages over other pedagogical options. For example, simulator training allows for many more practice trials than would occur ordinarily and the training can be individually tailored to meet instructional purposes. Furthermore, the trainee is afforded the opportunity to commit errors that in the real world would result in fatal consequences. The potential for simulation training in this area is supported by research from a variety of domains, including law enforcement, the military, and aviation. Indeed, empirical studies consistently demonstrate that simulation training is an effective means of teaching individuals a broad range of motor and cognitive skills.

More specifically, research from the law enforcement domain indicates that use of force simulators can serve as effective instructional devices, regardless of the simulator used or type of officer in training. In fact, simulator training often appears to be more effective than

alternative approaches. Subjectively, participants have provided consistent positive feedback regarding simulator training and have viewed the experience as extremely beneficial to improving their critical decision-making skills. Objectively, simulation training has been demonstrated to increase the number of preventative actions taken by police officers, enhance shooting accuracy, reduce the number of shots fired to achieve an objective, increase the degree to which police officers use cover, and decrease the number of unjustified shootings.

In sum, based on this literature review, it appears that simulation training can be a useful component of an overall use of force instructional program for officers in Canadian police agencies. However, for use of force simulation training to reach its full potential, several important changes to the current training regime must be implemented. The following changes, each based on sound empirical research, appear to be most critical. These suggested modifications will increase the likelihood that police officers render appropriate decisions in use of force situations as they occur on the street. In addition, they will provide officers with the ability to fully explain and justify these decisions to the courts thereby reducing the risk of personal liability findings. Such changes will also decrease the probability that police agencies will be viewed as negligent by the courts in their training of police officers.

1. Training time should be increased and a cost-benefit analysis conducted to determine the optimal training time for desired performance gains, while maintaining training-related costs at a reasonable level.

2. Open simulation practice should be implemented for trainees who have already received a degree of instructor supervised training.

3. A greater number of scenarios of a given type (e.g., domestic disputes) should be presented until the trainee masters appropriate use of force responses in a specific context. Only at this time should other scenarios be introduced.

4. Trainees should be allowed to master basic responses (e.g., motor skills) before additional difficulties are introduced (e.g., parallel performance of motor and cognitive skills).

5. Simulator training sessions should ideally be spaced over a number of days rather than condensing an equal number of training hours on the simulator into a single session.

6. Re-training sessions should be scheduled approximately midway between the period of skill non-use (these requirements may vary depending upon the type of officer in question).

7. Instructor feedback time should be increased during initial training sessions, but gradually reduced as the trainee progresses (i.e., from a continuous to an interval schedule).

8. Instructor feedback should be complemented by the trainee's self-assessment, either through group discussion or individual reflection in order to improve long-term training retention.

1.0 Introduction

Use of force training has been an integral component of police training programs for more than a century. With the gradual escalation in both frequency and severity of use of force encounters in North America, police agencies began to place even more importance on the quality of training provided to their officers. With this increased emphasis on use of force training came new and innovative instructional approaches. Perhaps the most innovative approach currently included in the training arsenal of Canadian police agencies is use of force simulation training. Modern computerized use of force simulators expose police officers to highly realistic and interactive scenarios whereby they can learn appropriate responses using the full range of use of force options available. These simulators have allowed use of force training to move beyond the point of simply mastering specific skills. The focus now is on teaching police officers the appropriate application of these skills under field-compatible conditions.

While the concept of use of force simulation training may be intuitively appealing, there has been sparse empirical research conducted to date to examine its effectiveness. Furthermore, the investigations that do exist are scattered across numerous published and unpublished sources, many of which are difficult to locate and access. This report unites, for the first time, research findings that relate to the effectiveness of use of force simulation training. Some of this research was conducted in the law enforcement domain and, therefore, it relates directly to this issue. Other research was performed in military and aviation contexts and relates to use of force training in a more indirect manner. However, these bodies of research considered together, in addition to general psychological findings relevant to the underlying principles of effective training, will serve to address the issue of whether simulators can assist in successfully improving use of force decision-making in the law enforcement context.

Exploring the issue of simulation training effectiveness is important for several reasons, beyond the fact that numerous Canadian police agencies are using this training approach. First, few police officers will go through their career without encountering complex use of force scenarios. Indeed, recent statistics indicate that use of force situations occur with great frequency. Therefore, it is imperative for both the safety of police personnel and the public that police officers receive the training required to render sound use of force decisions. Second, police officers will frequently be summoned to court for the purpose of justifying their decisions with regard to a use of force encounter. Participating in a high-quality use of force training program should enable these officers to provide testimony in a more convincing and effective manner. Third, the courts have, on occasion, found police agencies negligent for providing insufficient use of force training to their officers. Relying on training programs that are evidence-driven will reduce the likelihood of such occurrences in the future.

Including the present introduction, this report is divided into eight sections. The second section deals with the importance of examining the effectiveness of use of force simulation training. The third section reviews the various methods that have been employed over time to train police officers in use of force decision-making. The fourth section reviews the general psychological literature pertaining to the underlying principles of effective simulation training. The fifth section reviews all existing simulation studies from the law enforcement domain. The sixth section reviews a select, but representative, sample of simulation studies from the military domain. The seventh section examines the implications and limitations of this review. Finally, the eighth section presents several recommendations for training and research that will ensure use of force simulators are used more effectively in the future. Note that several appendices are also provided at the end of this report, which summarize (1) recent court cases dealing with use of force decisions and training standards and (2) the major research findings from simulation studies.

2.0 Why worry about simulation training effectiveness?

The decision to use force in the line of duty can be the most life altering decision with which a police officer may ever be confronted. This split-second judgement may mean the difference between life and death for an officer, an offender, or a bystander. Regardless of whether or not the force applied is of lethal form, the implications associated with the use of any level of force by a law enforcement officer can be enormous. As a result, it is vital that police agencies provide suitable use of force training to their officers. The fact that numerous agencies across Canada have decided to integrate computerized simulators into their mainstream use of force training programs (CPC, 2003) is certainly justification enough to examine the effectiveness of these simulators as training devices. However, studying the effectiveness of use of force simulation training is also important for the following reasons:

1. Use of force decisions are made frequently by police officers in Canada. Thus, it is necessary to ensure that these officers are participating in suitable training programs that will enable them to render such decisions effectively.

2. Increasingly, courts are requiring police officers to justify their use of force decisions. Therefore, it is important to provide these officers with training that will enhance their ability to deliver such testimony in a convincing manner.

3. Courts are increasingly questioning the use of force instruction being imparted by police agencies. In order to avoid liability rulings, these agencies must uphold training standards of the highest quality.

2.1 The frequency of use of force decisions

While it appears to be the case that use of force situations arise less frequently in Canada than in the U.S., it is difficult to estimate the exact frequency at which these occur. This is particularly true for situations requiring non-lethal force. While the U.S. makes detailed use of force statistics publicly available, such is not the case in Canada. Indeed, our repeated attempts to obtain current, detailed Canadian statistics regarding the frequency of use of force decisions were ultimately fruitless. Individuals from a number of police forces claimed that, while these records are kept, they could not be provided for our research purposes. In our search for Canadian use of force statistics, the only up-to-date information that we obtained was located in a web-based document, posted by the Toronto Police Service (1998). Written by a committee formed by the Toronto Police Service, the report examined whether alternatives to deadly force could be employed in certain situations, without compromising police officer safety.

Within this document, the Toronto Police Service presents pertinent statistics on the use of force by police officers in Canada. In terms of fatal and non-fatal shootings, findings clearly reveal that the frequency of such incidences varies across Canadian cities (see Table 2.1). For example, from 1987 to 1997 there were no recorded fatal or non-fatal shootings in

Regina, Saskatchewan. This contrasts dramatically with the situation in Montreal, Quebec where, during the same time period, police officers were responsible for 18 fatal shootings and 48 non-fatal shootings. Likewise, the circumstances surrounding use of force incidents appears to vary dramatically. For example, in Toronto, Ontario, there was a range of situational precursors to the 52 shootings that transpired in this 10-year span. In decreasing order, the situations that led up to the shootings in Toronto were: drug investigations or arrests (11), robberies (11), interactions with mentally ill individuals (8), traffic violations (7), break and enter offences (4), domestic disputes (2), crimes against persons (2), and other criminal offences (7).[1]

Table 2.1. Fatal and non-fatal shootings in several Canadian cities from 1987 to 1997. (Source: Toronto Police Service, 1998)

City	Population (1996)	Service strength	Fatal	Non-fatal
Vancouver	522,400	1,065	8	8
Edmonton	648,700	1,080	0	9
Calgary	783,200	1,150	1	3
Regina	185,800	296	0	1
Saskatoon	194,200	290	0	0
Winnipeg	640,100	1,135	0	7
Toronto	2,450,000	4,750	19	33
Montreal	1,811,500	4,120	18	48
Halifax	114,600	390	4	1

Unfortunately, the statistics provided in this 1998 report are limited to serious use of force situations. Therefore, the frequency with which less serious use of force situations occur in Canada is unknown (e.g., use of physical restraint, chemical spray, police dogs, etc.). Nevertheless, given the statistics reported by other countries, one can safely state that non-lethal force is applied much more frequently than lethal force.[2] Thus, given the results in

[1] These statistics are important because, as discussed in Section 3.0, they provide some indication as to the types of simulated scenarios that should be used to train Canadian police officers in use of force decision-making.

[2] The general consensus in the examined literature is that frequency of force is inversely related to degree of force, with less serious use of force options being used much more frequently than more serious use of force options. For example, Pate and Fridell (1993) collected data from 1,111 U.S. police agencies to determine the degree to which various types of force was applied by police officers in their interactions with members of the public during a one year period. Based on their results, it is clear that less serious force

Table 2.1, coupled with the fact that non-lethal force situations likely occur with far greater frequency than lethal force scenarios, it is apparent that Canadian officers must render use of force decisions on a fairly regular basis throughout their policing career. Therefore, as a safety measure for both officers and members of the general public, it is critical to ensure that law enforcement officers are participating in training programs that will provide them with the necessary skills to engage in effective use of force decision-making.

2.2 Explaining use of force decisions

In Canada, police officers are granted the right to use force to protect the general public and themselves (Walma & West, 2002). More specifically, Section 25 of the Canadian Criminal Code states that, "Every one who is required by law to do anything in the administration of enforcement of the law…is, if he acts on reasonable grounds, justified in doing what he is required or authorized to do and in using as much force as is necessary for that purpose". Despite this statutory protection, any time a police officer uses force when dealing with a member of the general public, there is a significant probability that the officer will be required to explain and justify his decisions before a court of law. Indeed, the criminal and civil cases that are summarized at the end of this report (see Appendix A) represent a fairly limited but representative sample of court cases from the past decade. These were selected from literally hundreds of similar cases that arose during the same time period.

If a police officer applies force without reasonable grounds, or if the force used is in excess of what was required to suppress a potentially volatile situation, courts will often determine that the force used by the police officer was inappropriate. In such cases, the officer can be found guilty for charges ranging from assault and battery to breaches of Charter rights. Consequently, it is important for active police personnel to receive adequate use of force instruction. In addition to potentially saving lives, if high-quality training is effectively implemented in the field, it will also provide individual law enforcement officers with the ability to understand, recall, and effectively defend their use of force decisions. The well-trained police officer will understand the situational factors preceding his use of force judgements and why he chose to act in a certain manner. In the context of a court of law, police officers will also be better equipped to justify their decisions as they relate to training experience. In brief, appropriate use of force training will reduce the likelihood of personal liability rulings by the courts.[3]

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options were used more frequently. Reflecting the number of reported incidents where force was used per 1,000 officers during 1991, the reported rates include: handcuffs (490.0), bodily force (272.20), chemical spray (36.20), batons (36.00), dog attacks (6.50), electrical devices (5.40), vehicle rammings (1.00), and shooting (0.90).

[3] As an example, consider the case of MacPhee v. The Ottawa Police Services Board et al. (2003). Responding to a call over his radio, one of the Defendants, Constable Bernier, arrived at an address where he had been informed that the Plaintiff had drawn a knife in a nearby store and had waved it about in a threatening manner. Bernier was told that the Plaintiff then fled to a vehicle in the parking lot. Believing the plaintiff was potentially dangerous, Bernier decided to arrest him. Bernier positioned his cruiser so as to box in the

2.3 Defending use of force training programs

There are frequent circumstances in which the Plaintiff has established that force was used by the police and in turn, the defending officer has convincingly argued that agency policy was followed. In such cases, the onus often falls on the officer's superiors, his agency, or the municipality to provide evidence that the use of force was not a product of negligence on their part (Daane & Hendricks, 1991). In other words, in court, "The burden of the force decisions made by line officers rests not only with them, but with those who train, supervise, and administrate" (O'Linn, 1992 p. 54). Again, as the cases summarized in Appendix A indicate, it is not uncommon for such issues to be raised in Canadian courts and, on occasion, police agencies have been found liable for providing inadequate or improper use of force training to their police officers. In fact, several examples exist in which Canadian courts have ruled that a police agency's use of force training program or policy contributed directly to the injuries suffered by a Plaintiff and, as such, these agencies have been required to pay damages.

Thus, even if a police officer's actions in a use of force situation are not deemed inappropriate or excessive, the issue of possible negligence can still be raised by a Plaintiff in relation to the use of force policies and training practices by which police officers are to abide. As argued by O'Linn (1992), where the need for police training is obvious but the training either does not occur or is provided such that errors in judgment will likely be committed in the field, police agencies will likely be found liable. Therefore, it is crucial

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Plaintiff's vehicle, exited his vehicle with his pistol drawn, and informed the Plaintiff he was under arrest. Bernier then instructed the man to step out of the vehicle with his hands in the air. The Plaintiff failed to comply with these directions, even after they were repeated. At this time, another Defendant, Constable Gagnon, arrived at the scene. Bernier then pulled the driver's side window open and Gagnon delivered a shot of pepper spray into the vehicle, at which time the Plaintiff was forcefully handcuffed. Gagnon retrieved a jackknife from the Plaintiff's vehicle with the blade still open. Among the allegations made by the Plaintiff was that the police officers used excessive force in his arrest. The Defendant, Bernier, was required to defend his use of force decisions by describing and justifying his actions at the scene in question. During the hearing, Bernier expressed his belief that he acted reasonably in response to the situation. For example, Bernier claimed that boxing the Plaintiff in with his cruiser and approaching the Plaintiff with his pistol drawn was "…consistent with [his] use of force training in dealing with an armed individual who has the potential to employ lethal force" (paragraph 14). In response to the fact that the Plaintiff did not exit his vehicle when instructed to do so, Bernier also stated, "I was still unable to arrest the Plaintiff and he continued to pose a threat of lethal force to me" (paragraph, 14). Finally, when discussing the point at which he handcuffed the Plaintiff, Bernier argued that "Following standard arrest procedure dealing with an uncooperative individual, I physically directed the Plaintiff face down on the ground and placed handcuffs on him behind his back" (paragraph, 14). In ruling on the case, the judge found that throughout the incident, the officers' actions were both reasonable and justified. The case was dismissed.

for agencies to develop and implement comprehensive, high quality use of force training programs that are evidence-based and empirically defensible. Such training programs will not only result in innocent lives being spared but, potentially, police agencies can also save vast amounts of capital by adopting a proactive role in the prevention of legal suits.[4] These issues are particularly important in today's policing environment, where serious use of force situations appear to be on the rise and policing budgets remain extremely limited.

[4] For example, consider the case of Berntt v. The City of Vancouver et al. (1997). On the evening of June 14th, 1994 a riot erupted in Vancouver following the Stanley Cup playoffs. As a part of the Emergency Response Team, Constable David Hancock was called to the scene to assist with crowd control. The Plaintiff was a participant in the riot, and was shot by Hancock with an Arwen (first in the back and then in the side of the head, which resulted in serious injuries). The Defendant, Hancock, was accused by the Plaintiff of firing his weapon unnecessarily, failing to follow the appropriate police procedures, failing to handle the weapon in a safe manner, failing to consider all the reasonable safe alternatives, and failing to maintain a reasonable standard of care by using a level of force that was grossly excessive. In addition, the Plaintiff argued that the shot fired by Hancock in the direction of the Plaintiff's head must have been either a product of intention or "…lack of experience and a paucity of training of the weapon's use, and a lack of supervision…" (paragraph 5). Thus, claims were also made against Hancock's superiors, alleging negligence in a number of respects. According to the Plaintiff, because the Vancouver Police Department did not adequately train Hancock, placing him at the scene of a riot with a potentially lethal weapon was negligent. However, the Plaintiff was unable to present an adequate argument to sustain questions regarding the training that Hancock received. The court was satisfied that Hancock was competent to use the Arwen based on the details regarding the training sessions attended by the officer as well as his evaluation scores.

3.0 Use of force training methods

Despite the scant amount of published literature on use of force training, it is clear that there has been a gradual shift towards integrating what were once disjointed training methods into more cohesive instructional programs. While earlier training methods focused on teaching isolated elements on the use of force continuum (e.g., firearm use) under optimal (i.e., non-stressful) conditions, recent training programs are designed to provide more realistic instruction that covers a broader range of use of force options. Modern use of force training approaches accept that mastering specific skills is a crucial component of any training regime, but the ability to apply those learned skills appropriately under realistic conditions is viewed as equally critical (Stock, Borum, & Baltzley, 1998). The following section outlines briefly some of the major use of force training methods that have been adopted by law enforcement agencies. Particular attention is paid to recent pedagogical innovations focusing primarily on use of force simulators.

3.1 Early use of force training methods

3.1.1 Target practice

Historically, a large part of use of force training consisted of target practice. Police officers would stand before stationary bull's-eye-targets to practice shooting accuracy (Arnspiger & Bowers, 1996). Presumably, it was believed that officers could readily and effectively translate skills acquired on the training range to dynamic scenarios encountered on real-life city streets. Recognising this probably was not going to be the case, police forces gradually adopted silhouette targets in an attempt to enhance the realism of their training (Morgan, 1991). However, the overall instructional approach remained largely the same. It was not until the U.S. Federal Bureau of Investigation (FBI) introduced their Practical Pistol Course in the 1930s that firearms training changed to a significant degree. In this course, police officers were trained to shoot their firearm accurately at silhouette targets from a variety of distances and firing positions (e.g., kneeling, standing, running, etc.) (Skillen & Mason, 1977).

3.1.2 Defensive tactics classes

In addition to firearms training, police officers would traditionally take part in other use of force training classes as well. These supplementary lessons were intended to teach, under equally favourable conditions, other techniques from the use of force continuum. For example, defensive tactics classes would teach police officers a repertoire of empty hand techniques to assist in controlling uncooperative suspects (Arnspiger & Bowers, 1996). The emphasis in these sessions was typically on the mechanics of the technique (i.e., demonstrating and then rehearsing skills in a controlled fashion) rather than on teaching police officers when and how to apply the techniques in naturalistic settings (Borum, 1993). Additional classes would be offered to train officers to perform other important tasks, such as the appropriate use of batons and effective handcuffing procedures, for use with resistant suspects.

3.1.3 Awareness videos and lectures

"Awareness" videos or lectures have also played a central role in use of force training. These materials expose police officers to simulated use of force situations in which actors make either appropriate or inappropriate use of force decisions. Theoretically, trainees are expected to process this information and convert it into skills that can be used effectively in the field. In addition to scenario-based sessions, videos and lectures are also employed to teach police officers about other issues related to use of force decision-making, such as the legal foundations upon which force can be applied or how they should present evidence in court about their decisions. While such audio-visual resources are still commonly employed for many of the same purposes, there is a growing appreciation that the abstract knowledge resulting from their use is far less likely to positively influence police behaviour compared to experientially derived knowledge (Artwohl, 2002).

3.2 More recent use of force training methods

The primary difficulty with early use of force training methods is that police officers were being taught isolated skills from the use of force continuum under conditions that failed to approximate the types of situations police officers encounter (Binder, Scharf, & Galvin, 1982). This is problematic because it is easier to apply skills when the conditions under which they are learned and applied are similar (Christina, 1996). In other words, "…target shooting skills acquired in a distraction-free indoor range and practiced at a relaxed pace may not generalize well to an actual armed encounter because the conditions (internal and external) are dramatically different" (Stock et al., p. 30, 1998). An appreciation of this problem led to the development of more realistic training programs over the past 30 to 40 years (Morrison & Vila, 1998). These newly devised training regimes include the methods discussed above, which are meant to result in a mastery of specific use of force options. However, such programs also include methods designed to teach the critical decision-making skills that will allow police officers to implement those options effectively in the field (Morgan, 1991). Equally important, there are now attempts to teach police officers to articulate the reasoning behind their use of force decisions. Hence, officers are provided the skills and knowledge necessary to write accurate reports and, if required, to provide clear and thorough testimony in courts of law in justification of their actions (O'Linn, 1992).

3.2.1 Hogan's alley courses

One of the first modern use of force training methods was the Hogan's Alley course, developed by the FBI (Justice and Safety Center; JSC, 2002). Hogan's Alley was designed to resemble a fully developed urban environment that could be used to train law enforcement officers to make use of force decisions in realistic situations. The development of the program was based on the premise that, while any comprehensive use of force training effort must include extensive practice of individual skills, training must also transcend the firing range, the gymnasium, and the lecture hall to incorporate real-to-life, dynamic scenarios (Stock et al., 1998). With Hogan's Alley, this level of realism came in the form of scenarios, which included pop-up targets that represented "good guys" or "bad guys". The trainee would be required to move through the mock community, having to make appropriate, split-second, shoot/don't shoot decisions (Boyd, 1992).

3.2.2 Role-playing

While the use of Hogan's Alley courses marked a significant step towards more effective use of force training by including an important decision component, pop-up targets restricted the unpredictability of the encounters. In order to increase the dynamic nature of training scenarios and encourage realistic responses from trainees, role-playing became a common way of training police officers to make appropriate use of force decisions (e.g., Rossiter & MacLennan, 2003). Either in Hogan's Alley environments or, more commonly, in gymnasium settings, police officers donned in protective gear stage various simulated use of force situations to which their fellow officers are expected to respond in a very realistic fashion using the full range of force options. Recent developments in training ammunition (i.e., Simunition) provide even greater flexibility when using role-plays to train for deadly force encounters. In addition, role-playing is now often conducted under the sub-optimal conditions frequently encountered in the field (e.g., low lighting, multiple suspects, bystanders present, etc.) (Morgan, 1991).

3.3 Use of force simulators

The development of use of force simulators represents the most recent training approach for use of force decision-making. Becoming popular in the law enforcement domain during the 1980s and 90s, these simulators started off as simple systems that projected motion pictures of use of force situations onto paper screens (Federal Law Enforcement Training Center Staff; FLETC, 1986). The trainee, armed with an air-powered rifle, would practice use of force decision-making by shooting at the image. The report from the gun would automatically freeze the action on the screen so that the trainee's accuracy and judgement could be evaluated. While these early systems had certain advantages over the role-playing approach (e.g., valuable manpower was not wasted by requiring police officers to play both suspect and officer), the technological limitations of the time detracted from the quality of training. Not only were the projected scenarios silent, small, and fuzzy, they were also not interactive like role-plays were. In addition, the firing screen had to be continually patched or replaced due to the holes made by the air-powered firearm.

Technological advances quickly allowed use of force simulators to become more effective training tools. The quality of the projected images increased and multiple projectors were now employed to provide a primitive branching option; that is, by turning projector lamps on and off at appropriate times, instructors could create alternate versions of the same scenario (FLETC, 1986). Service revolvers that shot plastic bullets gradually replaced the air rifles previously used and methods for evaluation became increasingly sophisticated. By the early 1980s, use of force simulators could provide immediate on-screen feedback related to shooting accuracy scores and they could critique the trainee if he failed to shoot when appropriate (i.e., the scenario could automatically rewind to demonstrate to the trainee the point at which he should have fired). In addition, simulators allowed the option to print hard-copy summaries of evaluation scores so that the instructor and trainee could discuss performance issues.

3.3.1 The firearms training system

Modern day use of force simulators are manufactured by a number of different companies. However, the focus here will be on an off-the-shelf unit manufactured by Firearms Training Systems (FATS), Inc. since FATS appears to be the major simulator supplier to Canadian police agencies at present (Canadian Police College; CPC, 2003).[5] As with other modern use of force simulators, FATS features a life-size screen that allows high quality images to be projected from a ceiling-mounted video projector. Hundreds of scenarios currently exist, each relating to a realistic use of force situation that may be encountered by police officers. These include, for example, alley chases, domestic disputes, and school shootings.[6] Custom-made videos can also be constructed by police forces using the FATS authoring station, which includes a camera, VCR, monitor, and editing equipment. However, the cost (and time) required for developing custom videos can be prohibitive (Seymour, Stahl, Levine, & Smith, 1994).

Compared to earlier use of force simulators, FATS training is more realistic because officers have access to a range of lethal and non-lethal weapons, including infrared-light emitting firearms, batons, and chemical sprays. FATS compatible firearms have traditionally been connected to carbon dioxide (CO_2) containers to provide them with realistic recoil action. Recently, however, FATS has introduced their line of BlueFire™ weapons, which allows for wireless training. As with the non-wireless weapons range, these weapons are weighted and balanced to feel like loaded firearms and have added features, such as instructor controlled weapon malfunctions (FATS, 2003). In addition to the range of weapons available, realism is emphasized in FATS training by requiring that trainees treat the scenarios as veritable situations, using verbal commands and taking cover

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[5] A recent survey conducted by the CPC examined how simulator systems were being used by the Canadian police community (CPC, 2003). Questionnaires were distributed to 69 police agencies of which 61 responded. Of these 61 agencies, 32 had access to a simulator, with an additional 10 agencies reporting that they planned to start using a simulator in the next year. While ICAT was the most common simulator used by the police at the time the survey was conducted, this simulator was recently purchased by FATS, thus eliminating it from the market. The survey estimates that approximately 13,000 Canadian police officers received some training on simulators in the 12 month period preceding the survey, though the report indicates that this is a gross underestimate since only agencies with 100 or more officers were sampled. Various findings from this survey will be discussed throughout this report, particularly in the next section dealing with the underlying principles of simulation training.

[6] FATS can also be used simply for firing range practice with a variety of wireless and non-wireless weapons. Marksmanship training is available in one, two, or four-lane configurations. As part of this training, FATS also enables weather effects (and other conditions) to be simulated (FATS, 2003).

as appropriate. Artificial trees, fences, and mailboxes are often placed in the simulation training room to enhance authenticity.

Compared to earlier scenarios, FATS scenarios are also much more realistic. In large part, this is due to the use of seamless branching technology, which can either be computer or instructor controlled. Computer controlled branching responds to the trainee's infrared-light emitting weapons (e.g., firearms, batons, and chemical spray). Essentially, the trainee's action or inaction automatically lowers or raises the level of threat presented on the video without interrupting the action. This provides immediate feedback as to the consequences of the trainee's decision, which acts as an invaluable training tool. Instructor controlled branching can override the pre-set computer programmed branching alternatives in order to modify the outcome of a scenario on the basis of the trainee's actions. Instructor controlled branching is carried out from a compact trainer's console that houses the video equipment, a computer, and a printer. This unit also allows the instructor to control other factors such as the lighting and weather conditions of a given scenario. In addition, an extra element of realism can be introduced to the training through an instructor controlled shoot-back cannon, which fires .68 calibre foam balls at the trainee.[7]

For feedback purposes, FATS can be equipped with a LookBack™ option, which replays the actions of the trainee using a "picture in picture" format (FATS, 2003). A monitoring system is also available for observation from another room and microphones can be used to provide instructions during training and to record instructor and trainee verbalisations during testing. In addition, after the training session is complete, the simulator can provide a printed summary of the trainee's performance. This summary contains a range of information. For example, if the trainee fired his weapon during the scenario, the output would specify the number of shots fired, the accuracy of the shots, and whether any innocent people were harmed. If a scenario was presented in which it was necessary for an officer to shoot a suspect, but the trainee failed to emit this response in due time, the output would indicate such an error and state that the officer may have sustained a fatal injury. Likewise, if the trainee used a level of force beyond what was required, the system would indicate that an inappropriate judgement was rendered.

The simulator feedback indicates to the trainee where mistakes were made so that one's performance can improve as necessary. However, feedback from the use of force instructor is also very important. The instructor can provide detailed comments to the trainee about his performance independent of the simulator's output. More specifically, "The action of the trainee creates 'markers' that are then assessed [by the instructor], according to pre-determined standards of performance" (Seymour et al., p. 267, 1994). Such markers pertain

[7] Although features such as the shoot-back cannon are intuitively appealing, it may be difficult to use these features within the training context itself. For example, during the course of writing this report, anecdotal evidence was provided by Canadian use of force instructors that the shoot-back cannon, while often available, was rarely used. The reason for this was simple. Because the instructors had to observe the trainee throughout the training session and control the branching component of the scenarios, they were unable to simultaneously aim and fire the shoot-back cannon at appropriate times.

specifically to the accuracy of force applied and whether the trainee's response represented an appropriate or inappropriate judgement. The instructor can clarify to the trainee where and why certain actions were correct or erroneous. The trainee can then be exposed to additional scenarios to further refine his use of force decision-making. Moreover, the instructor can discuss the legal ramifications of the trainee's decisions and any other issue of concern.

4.0 Underlying principles of simulation training

The following section outlines several key principles empirically demonstrated to underlie effective training with respect to a variety of motor and cognitive skills. After each principle is discussed, an evaluation of whether each criterion applies to use of force simulation training is rendered, both from a theoretical standpoint and with reference to the technology's present state of use in the Canadian law enforcement domain. A summary of this discussion is presented at the end of this section, in Table 4.1.

4.1 Practice

It has been demonstrated that learning in general is more effective in contexts where the student is an active participant rather than a passive observer (James et al., 2002; Tailby & Haslam, 2003). Military research has found that, while students typically retain only 50% of instructional content based on simple handouts and visual aids, engaging trainees in realistic practice of required skills has the potential to increase retention rates to 90% (California Assembly Concurrent Resolution 58 Study Committee, 1991). Furthermore, there is consensus in the literature that long-term retention of tasks is improved by increasing the amount of practice in the original learning environment (Bjork, 1994; Hurlock & Montague, 1982; Tremblay, Welsh, & Elliott, 2001). In other words, repeatedly performing components of a task should theoretically lead to complete skill acquisition, refinement, and retention (Rogers, 1969).

As applied to use of force scenarios, it is critical that police training not only optimize retention rates for individual skills, but also permit practice in the co-ordination of multiple skill sets. For instance, one must learn to accurately manipulate weaponry while concurrently surveying one's environment for cues to moderate appropriate levels of force. When several tasks must be performed simultaneously, it is recommended that part-task training (i.e., practice of individual skills) be alternated with whole-task training (i.e., practice of multiple skills concurrently) (Means, Salas, Crandall, Jacobs, 1993). While both forms of rehearsal are integral, it has been demonstrated that incorporating whole-task training into training programs facilitates the transfer of skills from the learning context to the natural environment by enabling the student to form stronger relationships between each component of the wider task (Detweiler, 1988).

4.1.1 Procedural skills versus cognitive skills

Much of the training provided in law enforcement involves the acquisition of procedural knowledge (i.e., knowledge of the steps required to properly execute a given task) (Eichenbaum, 2003; FATS, 2003). For instance, students must gain proficiency in shooting stance, breath control, trigger control, sight alignment, and various weapon handling procedures (FATS, 2003). With adequate amounts of practice, the learner will generally achieve mastery of such tasks. The mastery criterion is typically attained when error commission is minimised (Means et al., 1993). Training beyond this point leads to automaticity of performance such that a given response becomes unconscious, rapid, and effortless. This occurs because, with practice beyond what is considered mastery, performance is no longer dependent upon one's limited short-term memory resources (Schneider & Shiffrin, 1977). Note that the specific quantity of practice required for automating a task is a function of multiple factors involving the learner, the instructor, and the nature of the task itself (Arthur, Tubre, Paul, & Edens, 2003; Bebko et al., 2003; Druckman & Bjork, 1991). With repeated trials, an officer may come to master weapon assembly such that the task becomes a relatively unconscious process - what an individual may term "second nature". It is only possible to achieve automatic processing with respect to a response that is consistent from trial to trial, irrespective of variations in environmental stimuli (Schneider & Shiffrin, 1977). Accordingly, an officer would perform the same steps when assembling a weapon regardless of situational variants. Use of force decision-making, in contrast, is highly dependent upon a large number of situation-specific variables (Canadian Association of Chiefs of Police; CACP, 2000). As shall be discussed, automatic processing of such tasks is not necessarily feasible or desirable.

In terms of procedural skills, why should one wish to train beyond the point of mastery to attain automaticity in performance? As mentioned, coupled with the execution of the aforementioned procedural tasks, police officers are simultaneously required to employ complex decision-making strategies when in the field (Geber, 1990). When evaluating the necessity to apply a given degree of force, one must invariably consider an array of situational factors. Any one of these may alter one's selected course of action as dictated by the use of force continuum (CACP, 2000). Such complex judgements, which require analyses of different conglomerations of variables from one situation to the next, involve a second form of cognitive activity termed controlled processing (Druckman & Bjork, 1991; Schneider & Shiffrin, 1977). Controlled processing consists of a serial exploration of each situational variable within the individual's attention scope. Contrary to automatic responses, controlled searches take place in one's limited short-term or working memory space. Given the complexity of scenarios with which officers are frequently presented, there is great benefit in cultivating automaticity of invariant procedural tasks wherever possible in order to reserve cognitive resources for more complex decision-making tasks (Eysenck & Keane, 2002). For instance, if an officer is struggling with the manipulation of his weaponry, it is unlikely he will have the cognitive capacity remaining to render complex judgements regarding use of force decisions, or even have the capability required to attend to all relevant stimuli. Therefore, the individual may base a momentous decision upon simple heuristics (i.e., learned strategies or rules of thumb likely to produce a given outcome). A heavy reliance upon heuristics at the expense of ignoring potentially significant situational variables tends to result in lower decision accuracy, and may produce detrimental consequences in life-or-death scenarios (Sommer, 1996).

As discussed with respect to part-task/whole-task integration, simulation training is advantageous in that it provides the opportunity for repeated practice of several tasks jointly, as would be the case in naturalistic settings. Specifically, simulators are beneficial for use of force decision-making, because they permit multiple practice trials in the parallel performance of motor and cognitive skills (Arnspiger & Bowers, 1996; Wehrenbert, 1986). Many of the alternative methods of training discussed in Section 3.0 allow only the opportunity to practice motor skills in isolation (e.g. target practice) or to gain the basic theoretical knowledge underlying decision-making ability (e.g., classroom instruction). In contrast, simulated learning environments are ideal in their capacity to provide the simultaneous practice of several automated tasks in conjunction with complex decision-making strategies requiring controlled processing (Druckman & Bjork, 1991).

4.1.2 Distribution of practice

While overall amount of practice is positively correlated with level of learning and performance (Hauptmann & Karni, 2002), the distribution of a fixed amount of practice time is also a significant consideration in long-term training effectiveness (Dempster & Farris, 1990). Within the context of the training program itself, massed practice has been determined to lead to superior performance when compared to spaced practice on both motor and cognitive skills (Corrington, 1997; Druckman & Bjork, 1991; Moss, 1996). However, with respect to long-term learning outcomes, distributing practice sessions over time (e.g., over the span of several days) ameliorates retention of performance for delayed tasks (Baddeley & Longman, 1978; Cahill & Toppino, 1993). These results are consistent with the finding that the transfer and consolidation of new information from short-term to long-term memory is a neuro-chemical process that is time-dependent (Cahill & Alkire, 2003). Therefore, the optimization of the long-term effectiveness for officer training programs would be most successfully accomplished through the spacing of practice sessions over a number of days rather than condensing an equal number of hours into a single session.

4.1.3 Order and number of training scenarios

The transfer of knowledge from training to genuine settings is maximized with a greater variety of scenarios within a given contextual category (Homa & Cultice, 1984). For both motor and cognitive tasks, it has been suggested that the more constrained and invariant the simulation practice, the more inflexible a student's post-training performance will be (Winn, 2002). Thus, raising the number of training situations of a given type (e.g., domestic dispute scenarios) allows increased opportunity for the learner to acquire the most appropriate rules of transfer for application to natural settings. In behavioural terms, variations in presented scenarios allow for the development of stimulus generalization and discrimination (Martin & Pear, 1999). Stimulus generalization refers to one's ability to respond similarly to a variety of situational cues that resemble one another. Stimulus discrimination, on the other hand, refers to the learner's ability to emit a given response in the presence of a given stimulus but to inhibit the same response in the context of another stimulus. Given a bank robbery scenario, for example, an officer would be expected to discharge his weapon if the immediate area were clear and the perpetrator suddenly pointed a gun towards him. However, if the bank robber were clutching a small child, this latter stimulus (i.e., the child) should serve as an inhibitory cue, precluding the officer from discharging his weapon.

In use of force training, the caveat is that both the variability and complexity of training scenarios should be increased gradually, with the learner mastering appropriate responses within each situation type before novel, more complex contingencies are introduced

(Teague, 1998). For instance, it would be preferable for the learner to master basic skills in a relatively straightforward domestic dispute incident before introducing a drastic complication such as having the man unexpectedly take his wife and child hostage. In a related vein, while amount of practice is positively correlated with performance quality (Rogers, 1969), simply allowing the learner to perform a large number of trials without executing correct responses is demonstrated to be an ineffective training method (Ashy, Landin, & Lee, 1988). The key to successful instruction is particular attention to the number of correctly executed actions by the trainee. Again, only once the learner masters an appropriate response of a given type should the trainer proceed to introduce drastic variations to the training scenario (Christina, 1996).

4.1.4 Practice issues: Do they apply in theory and practice?

From a theoretical standpoint, use of force simulator systems have the capacity to deal with all of these practice-related issues. As previously mentioned, simulated learning environments are ideal in their capacity to provide the simultaneous practice of several automated tasks in conjunction with complex decision-making strategies requiring controlled processing. In addition, practice time can be as long, and as distributed, as required and trainees can be presented with literally hundreds of scenarios depicting a range of potential use of force situations including drug investigations, robbery situations, domestic disputes, and suspect apprehensions (FATS, 2003). Importantly, the range of scenarios that is available for use are representative of those typically encountered in the law enforcement context. For example, according to Toronto-based statistics, over the period ranging from 1987 to 1997, many of the scenarios just mentioned, including robbery situations, drug investigations, and suspect apprehensions, represented the largest proportion of situations to which officers were responding when lethal force options were used (Toronto Police Service, 1998).

In terms of the current application of simulator training in Canadian law enforcement, 90% of police forces that were recently surveyed about their use of simulators indicated that the scenarios provided by the manufacturer were appropriate and representative of those typically encountered in Canadian contexts (CPC, 2003). However, approximately the same proportion of respondents considered the simulation training time to be insufficient. It is also clear that police officers are not being exposed to an adequate range of scenarios. For instance, according to the CPC (2003), officers currently participate in an average of four simulated scenarios per year. Two of these scenarios are typically employed for practice, while the remaining two are presented for evaluative purposes. Furthermore, scenarios are often only five seconds in duration, and when combined with debriefing, the average officer may receive a total of only five minutes of simulation practice per year. Given these stringent constraints on both training time and range of scenarios, it is unlikely that mastery of appropriate responses in situations of increasing complexity is currently being incorporated into law enforcement simulation training in Canada. Furthermore, the minimal training time precludes a consideration of optimal practice distribution. Thus, there is clearly a discrepancy between what is theoretically feasible and what is currently being implemented in use of force simulator training. Ultimately, this gap may result in inadequate preparation for the complexities police officers encounter in use of force situations.

4.2 Retraining needs

Even once tasks have been trained and mastered, one generally requires periodic post-training intervention for knowledge maintenance (Druckman & Bjork, 1991). The process of forgetting entails a decline in recall of information or skill as a function of time (Baker, 1999; Slamecka, 1985). There are discrepancies in the literature regarding the specific shape of this memory decay function. In studies examining knowledge retention, it has typically been found that forgetting increases most rapidly in the time period immediately following training and then diminishes as the skill-related retention or non-use period increases (Bahrick, 1979). Bahrick (1979) recommends that initial retraining sessions be administered at intervals approximately equal to the expected period of retention (i.e., scheduled between anticipated occasions of actual skill or knowledge application).

In contrast, other investigations requiring the integration of multiple procedural skills report a more pronounced decline in recall as time progresses (O'Hara, 1990; Ruffner, Wick, & Bickley, 1984). For instance, a simulation-based study on the enhancement of watch-standing skills for marine cadets (O'Hara, 1990), and another on the training of helicopter flight skills (Ruffner et al., 1984), both suggest that the most substantial decay in learning occurs between six and nine months post-training. It should be noted that these results reflect a period of non-utilisation of skill spanning one year after the initial training session. However, it was also found that even 30 minutes of refresher training at approximately six months following the initial program significantly mitigated declines in performance (O'Hara, 1990). There is consensus that post-training interventions are necessary for skill maintenance (Druckman & Bjork, 1991). However, further research is required to examine the specific decay characteristics of skills acquired during police use of force simulation training in order to determine optimal scheduling of refresher training sessions.

4.2.1 Retraining of novices versus experts

There is evidence to suggest that the practice requirements of novices (i.e., new trainees) differ from those of experts (i.e., retrainees) (Druckman & Bjork, 1991). Some argue that it may be adequate, and indeed cost-effective, to successively increase post-training intervals, since most cognitive links related to a given task are formed during the original learning sessions (Bjork, 1994; Bouton, 2000). While the training requirements for novices are initially stringent, refresher-training needs may be reduced with time and level of expertise. Yet, others have proposed that beyond initial training, mere cueing through written or oral methods are adequate to prompt and maintain adequate recall and task performance (e.g., discussion of scenarios in a classroom-type setting) (Druckman & Bjork, 1991). The relative effectiveness of such post-training methods versus periodic simulator retraining is a research question open to potential exploration.

4.2.2 Retraining issues: Do they apply in theory and practice?

With the hundreds of scenarios now available, simulation systems are theoretically conducive to accommodating various retraining requirements. All of the Canadian police agencies that currently have access to simulators employ them for this purpose, with refresher training typically scheduled once annually or less (CPC, 2003). However, if it is indeed the case that, given a period of skill non-use, the most significant decay in learning occurs between six and nine months post-training (O'Hara, 1990), refresher training scheduled for over a year after initial instruction may well be inadequate. In addition, while 70% of the police agencies described above report using simulators primarily to train/retrain specialized officers (e.g., tactical team members), less than 50% claim to use the device for remedial instruction (CPC, 2003). Training one to become proficient in one's area of expertise while providing periodic retraining is obviously essential. However, administering training/retraining predominantly to those exposed to use of force scenarios on a frequent basis (e.g., tactical team members) may not be the most effective use of resources. This is because it is those who go through extensive periods of skill non-use who are most apt to benefit from frequent refresher training to mitigate against potential skill decay (O'Hara, 1990). Moreover, since most cognitive links are formed during initial task training, novices, and those experiencing difficulty in certain skill areas, may benefit from more extensive time with the simulator. These individuals should also be prioritised for retraining so they can adequately confront use of force scenarios when required.

4.3 Feedback

4.3.1 Intrinsic feedback

Dually rooted in motivation and learning theory, feedback is regarded as an essential factor in the acquisition and retention of desired response patterns (Rushall & Siedentop, 1972; Schroth, 1995). Information feedback is broadly defined as information about the discrepancy between a given response and a prescribed standard of performance. As illustrated in Figure 4.1, feedback resulting from an initial response provides:

1. A frame of reference for the quality of one's current performance.

2. An impetus for the modification of one's current performance.

3. A stimulus prompting a subsequent response that is expected to be a closer approximation of the desired behaviour.

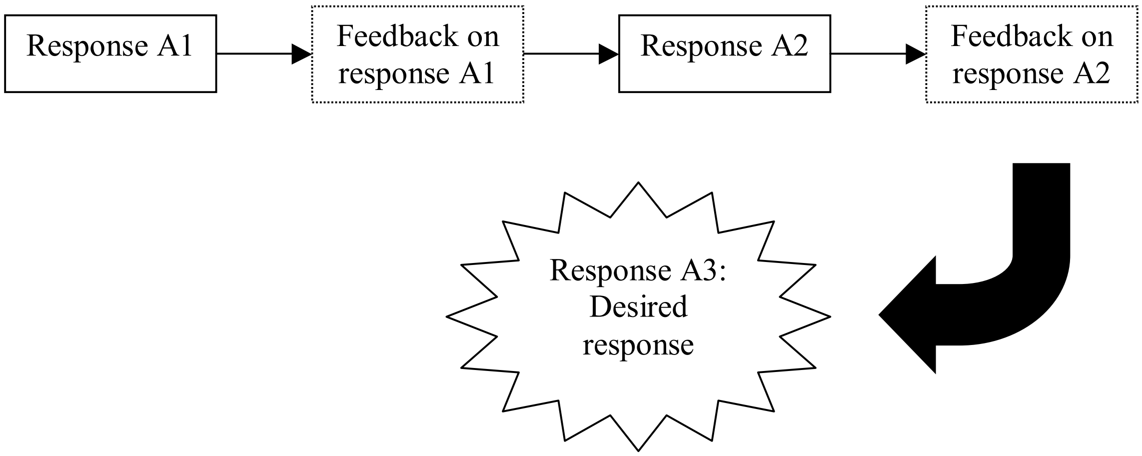

Figure 4.1. A simple feedback-response chain.

According to Holding (1965), there are two primary types of information feedback. The first is intrinsic and refers to an inherent component of a task itself. This form of feedback is supplied to the learner via a change in the environment following a given response. For complex decision-making tasks involving the potential use of force, there are typically multiple sources of intrinsic feedback to which one must be attuned in order to regulate one's behaviour accordingly. In a bank robbery scenario, for instance, an officer at the scene must evaluate several situational variables serving as feedback cues in order to select an optimal level of force. For example, if an employed tactic increases the level of agitation of the perpetrator, the officer may wish to use this information feedback cue to adjust his strategy. In addition, the interaction between officer and perpetrator does not occur in isolation but rather, amidst a complex environment. As such, the officer must also gauge his behaviour in response to that of bystanders and other relevant situational factors. Thus, as illustrated in Figure 4.2, the relationship between feedback and behaviour in complex scenarios is not linear but rather, forms a matrix of causal feedback loops, embedded in which are components of uncertainty, competing goals, and high stakes (Spector, Christensen, Sioutine, & McCormack, 2001).

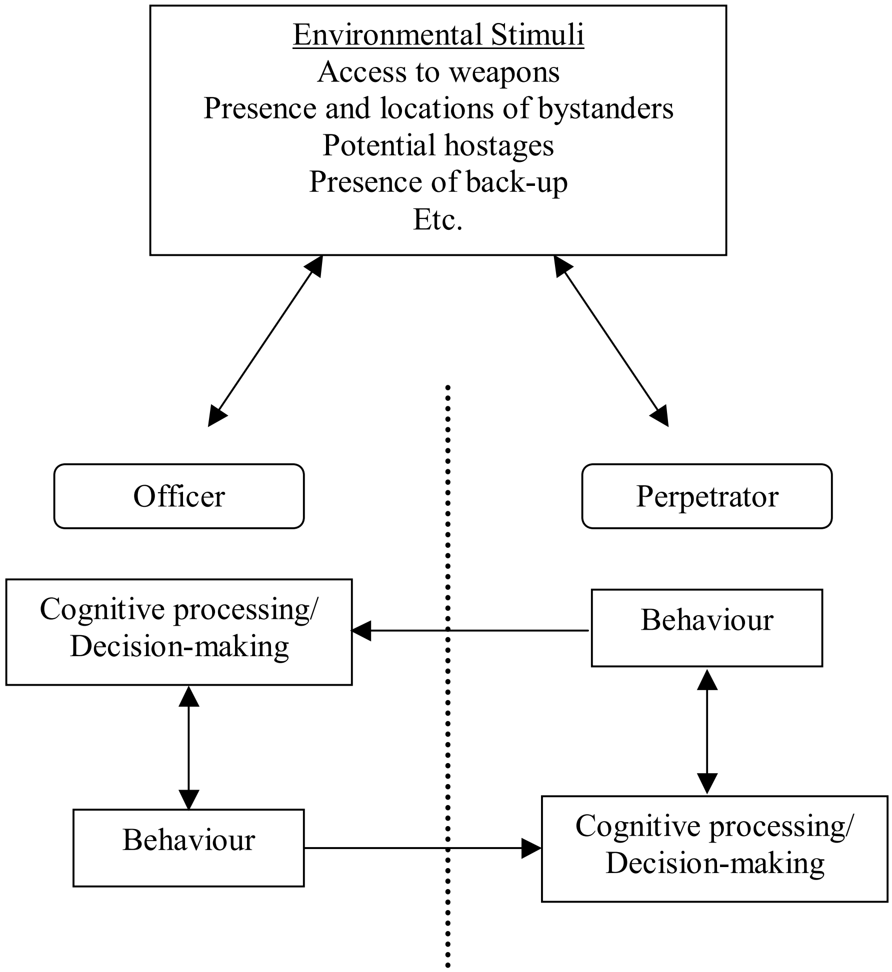

Figure 4.2. Illustration of a causal feedback loop in a bank robbery scenario.

4.3.2 Augmented feedback

The second form of feedback is termed augmented and refers to information that is not inherent in a given task. Primarily a pedagogical tool, augmented feedback is typically provided by an instructor in training contexts (Druckman & Bjork, 1991). While the role of intrinsic feedback in training and real-world settings is indispensable to performance proficiency, the application of augmented feedback is not as clearly outlined (Rushall & Siedentop, 1972). As argued by Holding (1965), the difficulty of supplying the learner with artificial performance knowledge is that the beneficial effects of this feedback on training performance may not translate to naturalistic settings in which the individual must rely solely on intrinsic feedback cues. In addition, the learner may become overly dependent upon instructor feedback and fail to establish the necessary cognitive links required for consolidating proper stimulus-response patterns. Thus, effective augmented feedback must have the ability to signal one's attention to intrinsic cues in order to maintain high performance levels once the training program is terminated and the augmented feedback is removed.

Particular implications in police use of force simulator training concern the quality of instructor feedback. While it is valuable for instructors to highlight trainees' errors in performance and decision-making, it is imperative that this feedback fosters an understanding of the relationships between responses and situational variables of which the scenario is comprised. It has been suggested that instructor feedback may be complemented with a student's self-assessment, either through discussion or individual reflection in order to improve long-term performance quality (Dobson et al., 2001; Washington Crime News Services, 1991). There is evidence indicating that verbal information generated by students in response to instructor cues or feedback is better consolidated than information that is simply conveyed from instructor to learner (Slamecka & Graf, 1978). Above all, it is vital that the student understand the reasons behind the decisions and actions he is being trained to perform and not simply learn these as a product of rote memorization (Benjamin & Bjork, 2000; Farr, 1978).

4.3.3 Scheduling of augmented feedback

It is universally accepted that regardless of mode of delivery, feedback in general is most effective when presented in an immediate and systematic fashion (Hodge, 1998). While augmented feedback is an important component of most training programs (Thorndike, 1927; Winstein & Schmidt, 1990), recent evidence suggests there may not exist a direct positive correlation between degree of augmented feedback and quality of performance over time. Several studies in both the verbal and motor domain have revealed that decreasing the frequency of instructor feedback produces poorer performance during the initial training period (Druckman & Bjork, 1991). However, individuals having received augmented feedback on an interval schedule (e.g., every fifth trial) or a thinned schedule (e.g., gradual and incremental decrease in feedback until its eventual elimination) performed significantly better on post-training measures than those who received continuous instructor feedback (e.g., after each trial). Ultimately, the goal in police use of force training is to foster skills that are both enduring and transferable to real-world settings (Geber, 1990). Therefore, while instructor feedback is an essential tool, it is preferable to gradually reduce such feedback over the course of training such that the student is able to construct his own mental representations of the task, which in turn are more aptly transferable to naturalistic environments.

4.3.4. Feedback issues: Do they apply in theory and practice?

Simulators employed as training devices for police officers in the use of force domain are equipped to provide intrinsic feedback. As discussed in Section 3.0, incorporated into the technology is a branching feature, where projected onto a screen are actors programmed to respond in accordance with the trainee's selected course of action (FATS, 2003). Hence, the officer in training is provided immediate audio-visual feedback regarding the congruity and aptness of his decisions given the situational variables in question. In addition, use of force simulators provide tactile feedback through weapon recoil and shoot-back capacity

(FATS, 2003). The majority of these intrinsic feedback cues are currently integrated into the simulation training employed by Canadian police agencies (CPC, 2003).

Supplementing simulator-provided feedback with augmented feedback is theoretically feasible and evidence suggests that this is done in practice. For example, in the recent CPC survey, all police services in the sample that use simulator training reported that the performance of trainees on the simulator is critiqued by an instructor after each presented scenario (CPC, 2003). However, it is important to mention that 25% of these police agencies also indicated that the time allotted for feedback was insufficient. It is reasonable to assume that given limited feedback time, mutual discussion of one's performance with an instructor would be even more restricted. Moreover, as indicated previously, information stemming from personal communication with Canadian use of force instructors strongly suggests that that it is difficult to control the simulator's branching feature in conjunction with features such as the shoot-back cannon, all while attempting to focus one's attention upon the trainee's performance. Thus, even if the time allotted for post-scenario feedback was sufficient, questions are also raised as to the quality of the feedback given the instructor's divided attention. It has been argued that inadequate feedback (in terms of quality or quantity) results in an incomplete learning experience. More specifically, inappropriate responses on the trainee's part may potentially remain uncorrected and proper responses may not be reinforced.

4.4 Fidelity

4.4.1 Physiological fidelity

Physiological fidelity refers to the capacity of the training situation to produce somatic reactions in the trainee reflecting those produced in target situations (i.e., the natural environment). In genuine use of force scenarios, an officer is required to render complex decisions and engage in intricate responses under conditions of time pressure, high stakes, and stress-induced physical discomfort (Boyd, 1992). There is evidence to suggest that decision-making is substandard when these circumstances are present in extreme form (Cumming & Harris, 2001; Reason, 1988; Rothstein, 1986). In order to optimize performance, it is beneficial to train potential officers under analogous degrees of pressure and intensity (Means et al., 1993).

4.4.2 Physical and psychological fidelity

As far back as the eighteenth century, it has been argued that the most effective education emanates from the student's interaction with his natural surroundings (Rousseau, 1762/1933). The development of simulator training in the twentieth century is an attempt to mirror or replicate the authenticity of one's natural learning environment (Winn, 2002). Physical fidelity refers primarily to the degree of realism associated with the mechanical aspects and material structure of the training context (e.g., realistic props, replicated weapon recoil, shoot-back effects, etc.). In contrast, psychological fidelity refers specifically to the degree of perceived behavioural equivalence between the training scenario and the target situation (Matheny, 1978). The latter is essentially a measure of the degree to which the training situation can be generalized to real-world settings. All these principles are interrelated in the sense that greater physical fidelity typically results in heightened physiological and psychological fidelity (Erwin, 1978).

It has been demonstrated empirically that decision-making and procedural tasks are most effectively transferred to real-world settings when training contexts psychologically and physically conform to the environments in which these responses are naturally to occur (Christina, 1996; Helsen & Starkes, 1999). Gick and Holyoak (1987) further argue that the greater the number of perceived similarities between the training and transfer tasks, the more likely the occurrence of positive skill transfer. Such perceived similarities have been found to act as prompts for the learner in the natural environment when explicit instructor cues are absent. In effect, several military studies have demonstrated that flight and combat skills are most effectively imparted when training environments simulate natural environments (Boyd, 1992).

Despite the promising training results of high-fidelity simulators (Bernstein & Gonzales, 1971; Boyd, 1992; Dobson et al., 2001), it should be noted that a few studies have demonstrated that, in certain instances, ridged adherence to realism in training contexts is unnecessary or even counterproductive (Moreno & Mayer, 2004). For instance, in a military study pertaining to the fidelity of flight simulators, it was found that while visual displays benefited performance, increasing simulation fidelity through the inclusion of platform motion had no impact upon training effectiveness (Eddowes, 1978). In a similar study, Eddowes (1978) found that the performance of inexperienced pilots was actually impaired by the addition of platform motion. However, it should be highlighted that these studies failed to incorporate post-training measures of performance within the target situation. Such measures are important in order to assess the ultimate effectiveness of the program, as it has been suggested that increased fidelity may actually impair performance within the training context itself (Druckman & Bjork, 1991). This occurs because high-fidelity simulators designed to mirror naturalistic environments typically include additional situational variants that produce contextual interference (e.g., bystanders, trees, phone booths, etc.) (Magill & Hall, 1990). Incorporating contextual variety initially necessitates the application of greater cognitive processing resources – there are simply more stimuli, some relevant and others superfluous, to which one could potentially attend. Nonetheless, it has also been demonstrated that, while contextual interference places greater initial cognitive demands upon the trainee, it promotes improved long-term retention and task transfer (Battig, 1979; Magill & Hall, 1990). Ultimately, introducing contextual variety as would be encountered in naturalistic settings leads to more elaborate encoding and fosters stimulus generalization. When an officer finds himself in an actual use of force decision-making scenario, one would expect that variations from the original training context would not preclude him from exercising sound judgement in the situation at hand.[8]

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[8] Furthermore, it bears mentioning that the skills required of pilots in Eddowes' aforementioned study (1978) were procedural responses, which could for the most part, become automated with sufficient practice. The circumstances are quite different with respect to police use of force decision-making. Only a relatively small fraction of an officer's responses should be automated since the resolution of such scenarios relies

4.4.3 Fidelity issues: Do they apply in theory and practice?

High-fidelity simulators such as FATS prompt physiological reactions in learners similar to those produced in the natural environment, such as shortness of breath and increased heart-rate (Boyd, 1992). In addition, simulators devised for use of force decision-making are explicitly equipped with features that convey a high level of physical fidelity. For instance, FATS provides highly realistic visual, auditory, and tactile cues. To reiterate, these include a life-size screen upon which are projected representative scenarios featuring veritable actors, as well as authentic weapon recoil and shoot-back capability (FATS, 2003). The physical fidelity of the system is further enhanced by the strategic placement of props in the training room such as brick walls, trees, and mailboxes. Such realistic physical features in addition to the genuine physiological reactions prompted by the simulator translate to an equally high degree of psychological fidelity. In other words, trainees tend to perceive a high level of equivalence between the training environment and the corresponding real-life scenario.

Survey research suggests that, in its current state of use in Canada, scenarios presented for use of force training are perceived by 84% of police agencies to be realistic depictions of genuine situations. However, the following questions remain: To what degree must training contexts emulate real-life settings in order to be effective? To what extent are additional "naturalistic" features redundant, producing diminishing returns? Furthermore, what is the relative contribution of fidelity over other essential components of training, namely the quality and quantity of practice and feedback? These are research questions that have yet to be answered adequately (Harris, 1978; Moreno & Mayer, 2004).

4.5 Overview of advantages of use of force simulation training

In summary, learning in simulated environments offers several advantages over both training in real-world contexts or through observation. From a purely logistic standpoint, simulator training allows many more practice trials than would occur ordinarily (Means et al., 1993). Simulation-based learning environments also allow for a compression of situational dynamics that may naturally unfold over appreciably longer time intervals (Spector et al., 2001). For instance, actual hostage-type scenarios may take place over the span of several days (Taylor, 2002), included in which are situational factors unrelated to a police officer's decision-making role (e.g., sleep requirements). Simulation training enables the omission of such extraneous factors. Additionally, using high-fidelity simulators as training devices is valuable from a safety perspective. A learner is afforded the commission of misguided actions, which in real-world contexts, would result in fatal consequences to oneself or others (Geber, 1990). Furthermore, the delivery of feedback and presentation of subsequent scenarios can be individually tailored to meet instructional purposes. However, as illustrated in Table 4.1, for these advantages to be realised, the existing gap between

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heavily upon complex cognitive strategising (Scharr, 2001). Given the potential significance of any situational variant to the outcome of this decision-making process, the simulator's capacity for high physical and psychological fidelity in a large number of contexts is arguably indispensable.

what is theoretically possible with use of force simulators and what is currently practiced must be eliminated.

Table 4.1. A summary of the underlying principles of effective use of force simulation training and whether they are met in theory and practice.

Training principle	Met in theory?	Met in practice?
Practice		
• Procedural skills	Yes	Yes
• Cognitive skills	Yes	Yes
• Spaced distribution of practice	Yes	No
• Appropriate order of training scenarios	Yes	No
• Adequate number of training scenarios	Yes	No
Retraining needs		
• Novices	Yes	Limited
• Experts	Yes	Limited
Information feedback		
• Intrinsic	Yes	Yes
• Augmented	Yes	Limited
• Scheduling of augmented feedback	Yes	No
Fidelity		
• Physiological	Yes	Yes
• Physical	Yes	Yes
• Psychological	Yes	Yes

5.0 A review of law enforcement simulation studies

The increased use of simulation-based training in law enforcement has greatly altered the instructional regime of officers. Use of force simulators now enable realistic enactments of complex scenarios involving mobile targets and access to a range of weapons (FATS, 2003; JSC, 2002; Scharr, 2001). The majority of literature in this area has focused primarily upon simulator use in the study of factors that influence use of force decision-making (Barton, Vrij, & Bull, 2000; Doerner, 1991; Doerner & Ho, 1994). Despite the widespread use of simulator systems in policing (CPC, 2003), empirical documentation of simulator training effectiveness in the law enforcement domain is scarce. Indeed, an exhaustive literature search has led to the discovery of just four studies directly relevant to the topic (Boyd, 1992; Helsen & Starkes, 1999; JSC, 2002; Scharr, 2001). While these four studies will be discussed in detail in this section of the report, and summarised in Appendix B, an additional overview of relevant military research on simulation training effectiveness will subsequently be presented.

5.1 Boyd (1992)

Boyd's (1992) doctoral research represents the first attempt to determine the effectiveness of interactive video-based simulation as a component of law enforcement training. The goal in her study was to assess the trainee's perceived value of simulation technology as a pedagogical tool for use of force decision-making relative to alternative training methodologies, such as range shooting, instructor expertise, classroom activities, and simple handouts. Participants comprised 207 California peace officers, primarily consisting of active officers and deputies. The training program spanned approximately four months and each of the required courses included a simulation training component on the ICAT simulator. The compulsory courses offered were Officer Safety and Field Tactics (80 hours), Survival Shooting (40 hours), Basic Special Team Training and Tactics (40 hours), Plainclothes Officer Survival (40 hours), and Advanced Special Team Training and Tactics (40 hours).

At the conclusion of each course, participants were administered the 33-item Training Effectiveness Questionnaire (Boyd, 1992). This measure was intended to assess training background, motivation for enrolling in the above training program, and subjective ratings of effectiveness of the interactive video system as an instructional device. The majority of items on the questionnaire used either ranking or Likert scaling, with additional space allotted for elaboration. Based on participants' past instructional experiences, ICAT training was perceived to be the most effective program component. As illustrated in Table 5.1, simulation training was ranked as one of the top three training components by a total of 88.4% of respondents. In addition, officers perceived themselves to be more adequately prepared to engage in use of force decision-making as a direct result of training with the interactive video system. Approximately 90% of respondents either strongly agreed or agreed that, as a result of training with ICAT, they felt better equipped to effectively conduct use of force decision-making. Thus, the use of simulators as instructional tools was perceived by participants to be an integral component of police training.

Table 5.1. Effectiveness ranking of training components in terms of their ability to facilitate use of force decision-making. (Source: Boyd, 1992)

	Rank 1		Rank 2		Rank 3		Total
Training component	%	n	%	n	%	n	%
Interactive video	41.1	85	27.0	56	20.3	42	88.4
Range shooting	34.2	71	41.5	86	9.2	19	84.9
Instructor expertise	22.2	37	17.9	37	40.1	83	80.2
Classroom activities	1.0	2	9.2	19	25.1	52	35.3
Simple handouts	1.4	3	4.3	9	5.3	11	11.0

5.2 Helsen and Starkes (1999)

The study conducted by Helsen and Starkes (1999) represents the first published attempt to evaluate the effectiveness of simulation training for police officers in potential use of force situations. Ultimately, the goal was to assess the ability of video-based simulators to improve the complex decision-making skills required in such precarious situations. The sample comprised 24 police officers ranging from 19 to 24 years of age. Prior to the investigation, each participant had acquired 80 hours of training on policing fundamentals, although their shooting experience was limited. All officers were administered a pre-training test based on the nature of their responses to sample slide and video simulations involving potential use of force interventions (this provided a baseline measure of performance). Participants were then randomly assigned to one of four experimental groups as follows, with each group containing one female and five male officers:

1. Classic training: Focus on shooting precision with stationary pop-up targets.

2. Decision training with slides: Focus on use of force decision-making with sequentially presented slides based on a representative sample of law enforcement scenarios (e.g., apprehending suspects).

3. Decision training with video: Focus on use of force decision-making with acted out motion picture simulation at authentic locations (e.g., parking lots) based on the same scenarios selected in 2.

4. Combination of slide and video training.

In preparation for the study, four representative scenarios were acted out by veritable police officers. A camera was placed on a moveable dolly track so as to enable filming from the perspective of one of the participating officers. These images were then presented to participants in Groups 2-4, in slide and/or video format, as life-size projections upon a white screen. Following a briefing regarding the nature of a given scenario, the participant was to interact with the projected figures in an attempt to first diffuse or de-escalate the situation. Ultimately, officers were required to employ a timely shooting or non-shooting response as deemed appropriate. Each individual received 10 hours of training in total. This included two hours of theoretical instruction (content unspecified) and eight hours of practical training in use of force decision-making, either with simulations or stationary targets as specified by their designated group. After each officer's performance during training, feedback was provided by the instructor based on the retrospective decision tree illustrated in Figure 5.1, followed by discussion among trainees. Four weeks after the end of the training program, participants were administered a final post-test to assess changes in responses to simulated incidents in both slide and video format.

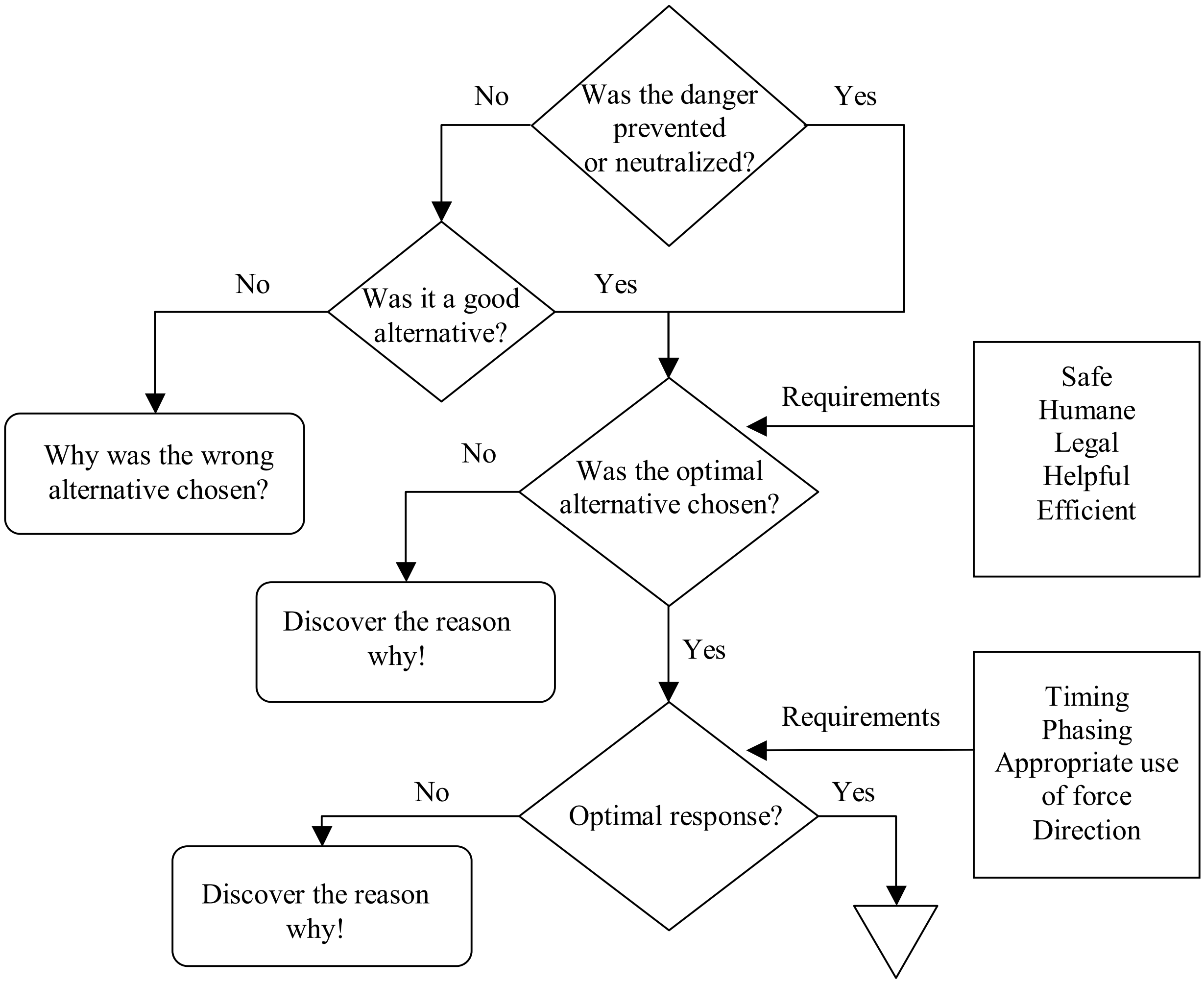

Figure 5.1. Decision tree for the retrospective evaluation of decision-making following a simulation. (Source: Helsen & Starkes, 1999)

A video recording of each subject's performance was assessed by expert police officers through an itemized evaluation protocol. Participants were rated on indices related to the quality of their use of force decision-making skills. These included the number of preventative actions in which the officer engaged to de-escalate the situation, as well as the number of shots fired either before or after the pre-determined legal window. Participants were also evaluated on shooting performance (i.e., accuracy) as measured by the number of hits upon the intended target. Finally, ongoing cognitive processes during performance were measured by tracking both number and length of visual fixations - the authors argue for the importance of efficient visual tracking of stimuli in their order of relevance (e.g., fixations moving from the suspect's head, to their hands, to their torso respectively). According to Helsen and Starkes (1999), both accurate and rapid visual processing is fundamental to: (1) the expedient identification of the suspect, and (2) the assessment of potential weapon possession.

In the pre-training test, all participants demonstrated approximately equal performance in terms of the average number of preventative actions attempted (M = 10 actions). As illustrated in Figure 5.2, post-test simulations involving either slides or video indicated that video-based simulation training yielded the greatest increase in number of preventative actions.[9] In fact, this group engaged in an average of 60 preventative actions on video post-test, representing a 600 percent improvement. Slide training and slide + video training also significantly increased the number of preventative actions in which participants engaged during slide and video post-tests. However, the difference between the latter two groups was marginal. As predicted, classic training produced only minimal improvement from pre-test results, with less than 20 preventative actions performed on average during slide and video post-tests.

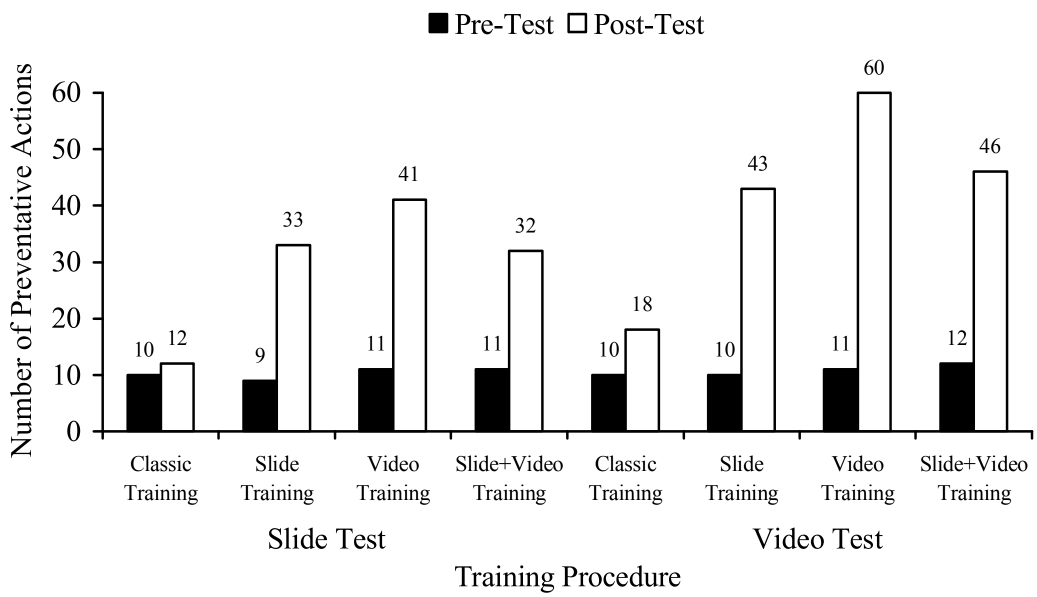

Figure 5.2. Pre- and post-test results of the number of preventative actions performed by each training group under slide and video testing conditions. (Source: Helsen & Starkes, 1999)

Overall, analysis of ongoing cognitive processes indicated that visual fixations for the video-training group were more rapid and greater in number when compared to the other three groups. As previously discussed, given the time constraints imposed upon one's actions in video scenarios, as with veritable live incidents, efficient visual tracking of pertinent stimuli is a fundamental prerequisite to sound decision-making (Helsen & Starkes, 1999).

[9] The design of this experiment makes it possible to determine whether particular training procedures have cross-transfer performance effects. The fact that video-based training yielded large positive training effects in both post-test environments (i.e., slide and video) suggests that video-based training may generalise to other contexts as well, including, perhaps, settings outside the laboratory.

Contrary to the dramatic increase in the number of preventative actions related to video simulation training, no significant improvement was demonstrated with regards to shooting accuracy. This conclusion held for all groups. Overall, of the 202 potential shooting responses across groups, only 56% were hits. In fact, both pre- and post-test results were poorer for video simulations (pre-test 47%, post-test 54%) than for slides (pre-test 58%, post-test 71%). The authors argue that, because participants' original academy training did not emphasise the shooting of moving targets and experimental training time was limited, this particular skill may have remained underdeveloped.

With respect to complex decision-making in a law enforcement context, this investigation lends empirical support for the use of simulators as training devices. The results suggest that the high fidelity with which video-based scenarios can be presented facilitates the acquisition and expansion of an adaptive behavioural repertoire for dealing with the precarious situations typically encountered in police work. Retrospectively, participants themselves reported that the simulation training and associated feedback served to heighten confidence in their ability to aptly respond to such critical scenarios.

5.3 Scharr (2001)

In a subsequent published investigation, Scharr (2001) attempted to assess the effectiveness of FATS, as described in Section 3.0. More specifically, the study sought to rate the system's capacity to increase one's mental preparedness and perceived ability to effectively resolve potentially violent incidents. Participants consisted of 36 probation officers. Of these individuals, 27 were veterans and each completed one hour on the FATS simulator. The remaining nine participants were recently hired officers and trained for one and a half hours on the simulator. Prior to these training sessions, participants briefly reviewed rudimentary firearms skills such as target acquisition, barrel location, and trigger pull.

Officers were instructed that, in the forthcoming training scenarios, they should attempt to use an appropriate level of force as specified by the use of force continuum. In addition, they were encouraged to administer suitable verbal commands, and to use cover and concealment as alternatives when deemed appropriate. As discussed previously, the branching feature on the FATS simulator permits situational outcomes that are dependent upon the verbal and physical responses of the trainee. A variety of scenarios were presented to participants, ranging from a confrontation with an intoxicated man to a domestic dispute incident. Immediately after each scenario, feedback was provided via an instructor and discussion was generated. More specifically, officers were required to justify their actions and consider alternative response options.

As a subjective evaluation tool for training effectiveness, each participant was asked to complete a post-training questionnaire. Officers responded to a series of items regarding changes in perceptions and attitudes towards use of force as a result of training. Ratings were also provided concerning overall training effectiveness. Each question was rated on a five-point Likert scale, ranging from "1=to a very little extent" to "5=to a very great extent". For clarification purposes, it was requested that officers complement their numerical ratings with written feedback where required.

Results indicate that 86% of participants believed that the simulation training had a positive influence on their ability to employ effective decision-making skills in critical incidents. Globally, both numerical and written responses suggested that the FATS simulation training reinforced awareness of the ambiguity and hence, the complexity, of use of force decision-making. In addition, officers reported a gained appreciation of effective communication skills, as well as the importance of being prepared for such scenarios through continued training. In sum, findings were "overwhelmingly positive", with 97% of officers reporting that overall training was effective at least to "a great extent" (Scharr, 2001).

5.4 Justice and Safety Center (2002)

The JSC (2002), located at Eastern Kentucky University, recently conducted the most comprehensive examination yet of use of force simulation effectiveness when they investigated the PRISim simulator as a mobile training device for law enforcement officers. Participants had an average of 12 years experience and consisted of 181 patrol officers across Kentucky, Texas, and Washington. All subjects participated in three training sessions (henceforth identified as Time 1, 2, and 3), each lasting approximately one hour. Prior to training, participants completed a series of exercises involving shooting at both stationary and mobile objects. In order to maintain experimental control, JSC researchers attempted to select nine different scenarios of approximately equal complexity for training purposes with the PRISim simulator. Situations ranged from routine incidents (e.g., a domestic dispute) to infrequent occurrences (e.g., a school shooting). Furthermore, each of the three training sessions consisted of one "no-shoot" (where lethal force was unjustified) and two "shoot" (where lethal force was justified) scenarios.

Participants were first administered a pre-training questionnaire comprised of items pertaining to individual backgrounds and experiences. Objective assessment of training effectiveness was determined through measures of performance across all three sessions. One's performance in each session was rated by an experienced firearms instructor according to the following criteria:

1. Accuracy: Percentage of rounds that hit the intended target, number shots fired, etc.

2. Tactics: Proper identification of suspect, use of cover, etc.

3. Judgement: Appropriate use of force.

4. Safety: Proper indexing of trigger, keeping weapon operational, etc.

Positive responses were rated dichotomously as 1 if present or 0 if absent. These refer to contextually appropriate or necessary behaviours such as proper drawing of a weapon and correct verbalisation. Negative responses were rated as -1 if present and 0 if absent. These are contextually inappropriate or damaging responses, including shooting innocent persons, unjustified shootings, turning on firing line with a loaded weapon, and the like. Finally, participants completed a post-training oral interview in which they discussed their performance and attitudes towards the PRISim simulator.

5.4.1 Accuracy

Objective measures of performance suggest that the PRISim system is beneficial in fostering the acquisition and enhancement of several indices of use of force decision-making and related motor skills. For example, as illustrated in Figure 5.3, the most pronounced increase in shooting accuracy occurred between Time 1 and Time 2 (i.e., an increase of 31.6%), with skills being maintained from Time 2 to Time 3.

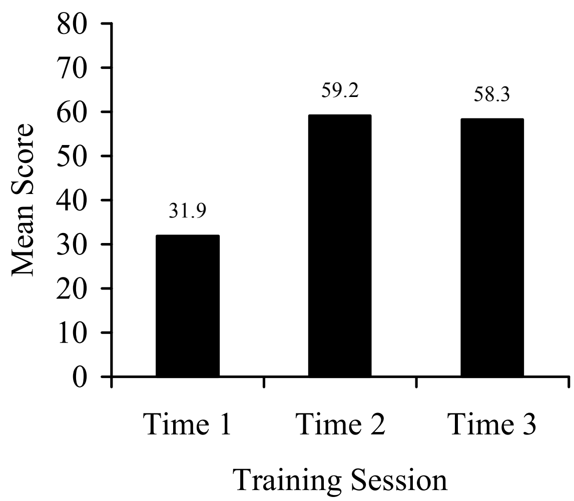

Figure 5.3. Mean score on "accuracy of shot" index across training sessions. (Source: JSC, 2002)

Another accuracy-related issue is number of shots fired. It is argued that officers should fire the minimal number of shots necessary for a given scenario such as to preclude the use of excessive force and the needless endangerment of lives (JSC, 2002). Within each training session, the number of shots fired generally declined. At Time 1, the number of rounds fired decreased by a factor of over 50% as one progressed from Scenario 1 to Scenario 3 of that particular session (3.5 shots for Scenario 1; 1.6 shots for Scenario 3). For Time 2, there was also a significant decrease in rounds from Scenario 1 (3.7 shots) to Scenario 3 (2.0 shots). However, Time 3 failed to reveal the same magnitude of decrease, with 3.7 shots fired in Scenario 1 but 3.2 shots fired in Scenario 3. Overall, the results actually suggest an increase in shots fired from Time 1 to Time 3 (919 to 1249 shots fired, respectively). To explain this finding, the authors argue that Scenario 3 of Time 3 may have been qualitatively different than the other training scenarios. This particular situation involved a highly intense school shooting featuring crying children and bleeding victims. The authors suggest that the inordinately heightened emotional arousal produced as a result may have accounted for the increased rounds fired, as confirmed by post-training interviews.

5.4.2 Tactics

In terms of tactics employed by officers, findings suggest that simulation training with PRISim was effective in fostering effective use of cover. As illustrated in Figure 5.4, significant learning occurred from Time 1 to Time 2, and this learning was sustained from Time 2 to Time 3. However, no significant effect was produced with respect to appropriate identification (i.e., as a law enforcement officer) or verbalisation across the training sessions.

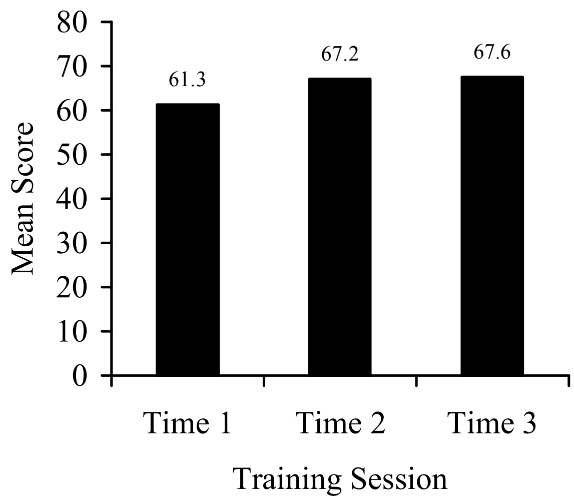

Figure 5.4. Mean score on "use of cover" index across training sessions. (Source: JSC, 2002)

5.4.3 Judgement

Regarding use of force judgement, a marked improvement was observed across all three training sessions in terms of whether or not officers discharged their weapons without justification. As depicted in Figure 5.5, such errors of commission decreased as a function of simulation training. However, when evaluated specifically on appropriate drawing of a weapon (i.e., drawing the weapon at an appropriate point in time), officers actually performed worse at Time 2 and Time 3 compared to Time 1 (M_{Time1}=14.0, M_{Time2}=7.9, M_{Time3}=10.9). As the researchers failed to specify whether these responses occurred primarily before or after the appropriate time frame, further investigation is required to explore potential factors related to this finding.

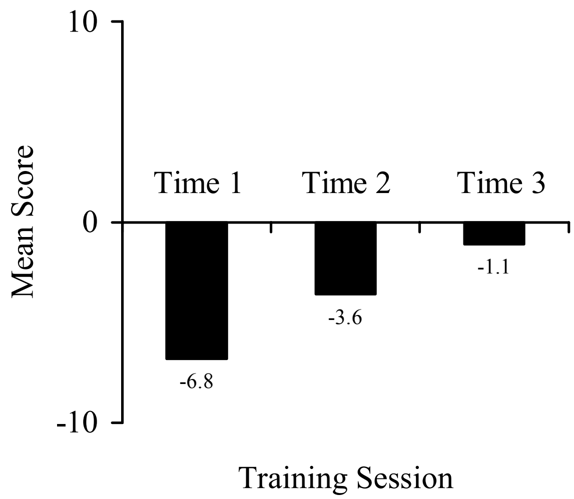

Figure 5.5. Mean score on the "shoot without justification" index across training sessions. (Source: JSC, 2002)

As observed in Figure 5.6, judgement scores related to unintentional shooting or endangerment of innocent persons improved significantly between Time 1 and Time 2. However, this improvement was not sustained at Time 3. Again, the authors attributed this decline to the inadvertently higher complexity and increased number of victims and bystanders associated with the school shooting (i.e., Scenario 3, Time 3).

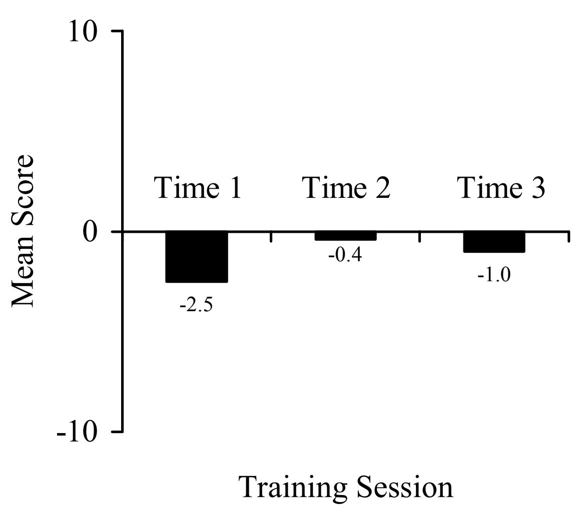

Figure 5.6. Mean score on the "shoot at innocent persons" index across training sessions. (Source: JSC, 2002)

5.4.4 Safety

With regards to the safety criterion, training decreased participants' tendency to point their weapon outside the firing line (i.e., in an unsafe direction). Although not statistically significant, this improvement was evident from Time 1 to Time 2, and was maintained at Time 3 (M_{Time1}=-0.9, M_{Time2}=-0.4, M_{Time3}=-0.4). Moreover, errors regarding one's failure to de-cock a weapon appeared to decrease consistently throughout training, albeit this improvement was also not statistically significant (M_{Time1}=-2.0, M_{Time2}=-1.3, M_{Time3}=-1.1). Finally, average scores on measures of proper indexing (i.e., keeping one's finger outside the trigger guard until the decision to shoot has been made) were relatively stable from Time 1 to Time 2 but then decreased at Time 3 (M_{Time1}=54.4, M_{Time2}=56.9, M_{Time3}=40.0). Once again, the qualitative difference in scenarios at Time 3 was offered as a potential explanation.

In sum, the results of this investigation indicate that training with the PRISim simulator was most promising in the improvement of the following: shooting accuracy, effective use of cover, avoidance of unintentional shootings, and ensuring that shooting is justified. Overall, the greatest skill increases were observed between Time 1 and Time 2, suggesting that the greatest magnitude of learning occurred during the initial stages of training. While the gain observed at Time 2 was maintained at Time 3, no further improvement was incurred. However, given that the scenarios across training periods were not counterbalanced (i.e., they were not varied in order across subjects), one cannot discount the possibility that the results observed at Time 3 were simply a function of the scenarios selected for that particular training session (i.e., greater level of difficulty, etc.). Furthermore, due to the absence of baseline measures, it was impossible to determine the amount of learning that occurred at Time 1. Future research is warranted in order to address these various issues.

From a subjective perspective, participants' attitudes towards the PRISim simulator system were highly favourable, as revealed through post-training interviews. In addition to conveying their appreciation for the high realism of the scenarios and mobility of the system, 96% of officers indicated that, as a result of the training, they felt better prepared to deal with future lethal force incidents.

6.0 A review of military simulation studies

The following is a review of military-based inquiries into the effectiveness of simulator training for various skills related to combat missions. These studies are presented in order to supplement the investigations in the law enforcement domain. This review is useful, since many of the required skills and fundamental training principles for military personnel closely mirror that of police officers (Pleban, Matthews, Salter, & Eakin, 2002). Military operations consistently require problem solving, strategising, and decision-making in conflict-ridden scenarios. As with policing, complex cognitive tasks must be integrated with motor skills such as weapon manipulation. Moreover, the military frequently employs simulation training for the acquisition and enhancement of both decision-making and motor skills (Endsley et al., 2000; Pleban et al., 2002). Four representative military studies will be discussed in detail in this section (and summarised in Appendix C). A number of simulation studies from the aviation and navigation domain have also been summarised in Appendix D.

6.1 White, Carson, and Wilbourn (1991)

White et al. (1991) investigated the effectiveness of an M-16 rifle simulator in training marksmanship skills versus the conventional method of live-fire training. Furthermore, this study examined the importance of fidelity-related simulation features such as weapon recoil capacity and auditory feedback. The authors also considered length of practice time with the simulator and participants' previous experience with weapons as potential factors related to training effectiveness.

Participants were 247 men and women registered in a 30-day Security Specialist training course for the U.S. Air Force Security Police. Prior to the investigation, all subjects received three days of instruction pertaining to M-16 rifle safety, maintenance, and nomenclature. Participants were also required to complete a brief questionnaire to assess previous experience with weapons. Of the total number of trainees, 80 were then assigned to a control group and scheduled to receive 30 minutes of live-fire training. This session included practice of sight alignment, target shooting, and other marksmanship fundamentals. The remaining 167 participants were further divided into eight simulation training groups.

Provided by FATS, the M-16 rifle simulator employed in the present study consisted of four firing lanes, each equipped with a large screen upon which life-size scenarios could be projected. Each of the eight experimental groups received a different configuration of the following system features:

1. Presence or absence of weapon recoil capability through a CO_2 gas system.

2. Presence or absence of noise report through a speaker system (i.e., auditory feedback following weapon discharge).

3. Allotted practice time (i.e., 10 or 20 minutes).

Logistic constraints precluded a 30 minute training session with the simulator (i.e., the live-fire training time for individuals in the control group). Participants receiving simulator training were required to shoot at a 9.5 in. x 40 in. kneeling target with a bull's-eye-type centre ring from various distances. The accuracy of marksmanship skills was evaluated according to the total number of hits on the projected target.

Overall, there were no significant differences in shooting accuracy scores between the control group and the average scores of the eight simulation training groups. However, when analysis was confined to participants with minimal experience, the average number of target hits was consistently higher for those having received simulation versus live-fire training. The simulator configuration in which both recoil and auditory feedback were present yielded the highest accuracy scores. These scores were not significantly different from the condition in which neither feature was present. However, the simultaneous inclusion of both training features produced superior results to groups having only one of the two features in place. The authors argue that the consistent experience of both recoil and auditory feedback, either in their presence or absence, represents a greater degree of realism than presenting one of these simulator capabilities without the other. Furthermore, no significant differences in accuracy were found with respect to length of simulator training (10 versus 20 minutes). Due to the minimal range of practice time, further research is required to determine whether the latter finding can be replicated or generalized to longer training periods.

Overall, this investigation lends qualified support for the effectiveness of simulator training with respect to the acquisition of marksmanship skills, with training being most beneficial to those with minimal weapon experience.

6.2 McAnulty (1992)

Sponsored by the U.S. Army Research Institute, McAnulty (1992) sought to evaluate the training effectiveness of the AH-1 Flight and Weapons Simulator (FWS) in sustaining and enhancing crew gunnery skills in the AH-1F helicopter. A secondary objective was to assess the effect of manipulating training time with the FWS on subsequent performance with aircraft weapon systems. Participants included 20 aviators from several U.S. Army units. An initial pre-test was administered in which each individual was required to complete a questionnaire pertaining to flight experience and knowledge of the AH-1 weapon systems. In order to obtain an objective baseline measure of gunnery skills, all aviators participated in a live-fire pre-training test. Since all individuals received similarly high scores on the pre-tests, random assignment was used to divide participants into three training groups:

1. Control group (4 participants): These aviators were instructed to continue their live-fire training regime. However, they were restricted from conducting any gunnery practice in the simulator.

2. Experimental group – monthly training (8 participants): These individuals were instructed to continue their training schedule but were precluded from conducting

gunnery practice in the AH-1 aircraft while flying to their designated crew stations (i.e., no live-fire training). They received a total of 15 monthly FWS training sessions, each ranging from 75 to 120 minutes in length.

3. Experimental group – quarterly training (8 participants): These aviators were exposed to the same experimental conditions as those defined for Group 2. However, they received training on a quarterly basis, for a total of six sessions.

The live-fire training in which the control group participated took place in an AH-1 aircraft. The AH-1 is a single engine, two-bladed helicopter equipped with three weapon systems. The crew member could select type of warhead, quantity of ammunition discharged, and rate of firing. The primary weapon system on the AH-1 is the tube-launched, optically-sighted, wire-guided missile. The training range was approximately 5000 m long and comprised a series of pop-up targets. Weapon engagements for each range exercise were scored by personnel stationed in the range high tower according to the following weighted criteria:

1. Engagement time (15%): Time from target presentation until engagement completion.

2. Exposure time (25%): Portion of the engagement time in which the AH-1 aircraft was visible to the enemy.

3. Target effect (60%): Effect of the fired ammunition upon the target (i.e., whether or not the target was fatally hit or whether the hit was close enough to incapacitate the target).

As mentioned above, the simulator employed by participants in the experimental groups (Groups 2 and 3) was the FWS. Intended to replicate the AH-1 aircraft, the FWS features pilot and co-pilot/gunner cockpits, both mounted on separate motion platforms but operating in integrated mode for the purpose of this study. The instructor/operator station was located behind the crew cockpits. Multicoloured laser beams projected images upon the front and side windows of the simulator. Computer-generated imagery replicated target and weapon effects. Either fixed or moving computer targets were presented, at which point trainees were required to hold a given altitude while aiming a weapon of choice (i.e., missile, gun, or rocket) towards the target engagement point. When a firearm system was discharged, the trainee was provided with visual, auditory, and kinaesthetic weapon feedback effects (e.g., weapon recoil).

The simulation training encompassed eight tactical scenarios and one firing range scenario. Enemy threats were only included in the tactical scenarios and, consequently, these required the flight crew to maintain a low profile while travelling between target points to evade the opposition's radar. Four of the tactical scenarios and the firing range scenario were day deployments and the remaining four were dusk deployments. Other environmental conditions such as temperature and visibility were held constant across scenarios.

Six senior aviation officers served as instructors and air traffic controllers for the simulation training groups (Groups 2 and 3). Upon participants' arrival at the simulation training facility, each received a mission briefing and tactical map. The aviator was then assigned to his respective crew station in the simulator, either assuming the position of navigating pilot or co-pilot/gunner. These positions were alternated across missions. Participants were given 30 minutes to an hour to plan each mission. During engagements at the various designated battle positions, the investigator tracked computer-generated performance information related to engagement time, number of hits, number of misses, average miss distance, and the like. Minimum standards of successful performance were established prior to the investigation. After mission completion, the instructor and investigator provided performance feedback regarding each trainee's performance. If time permitted, paired aviators switched crew stations and repeated portions of the mission that were identified as most problematic. Finally, participants were asked to complete a debriefing form regarding actions performed during the flight mission.

All aviators from both experimental and control groups were required to participate in a final post-training live-fire test 15 months after the pre-training exercise in order to evaluate the relative effectiveness of the simulation training in building and maintaining gunnery skills. Participants were scored on a point system, representing a weighted average of engagement time, exposure time, and target effect.

Results indicate that the accuracy of gunnery skills for the simulator training groups significantly improved between pre- and post-tests, while that of the control group declined. Whereas participants receiving simulation training increased their accuracy by an average of 12 points, the control group's performance declined by approximately the same amount. While the most pronounced improvement was reported between the quarterly training group and the control group, there were no statistically significant differences in effectiveness between quarterly and monthly FWS training. Both experimental groups also required fewer runs and less ammunition to successfully complete their missions. However, the FWS was most beneficial in increasing the accuracy rather than the speed of gunnery skills. While low sample sizes raise certain doubts as to the extent of result generalizability, these preliminary findings suggest that the FWS is moderately effective in sustaining AH-1 gunnery skills and fostering a more efficient utilisation of range time and ammunition. Thus, the authors concluded that simulation training may be a useful adjunct to live-fire training.

6.3 Krebs, McCarley, and Bryant (1999)

When executing air-to-ground attacks, military pilots must synchronously estimate target location and assume a defensive stance against enemy threat, all while maintaining navigational awareness. These concurrently performed perceptual and procedural tasks are cognitively taxing, thus rendering accurate target acquisition extremely difficult (Bryant, 1998). While aviators typically prepare for such bombing missions solely through maps and aerial photographs (Krebs et al., 1999), the present authors sought to evaluate the effectiveness of mission rehearsal simulations on target acquisition.

Participants were 21 male aviators, recruited from the Navy and Marine Corps in California. Subjects were divided into three equal groups through random assignment as follows:

1. Standard briefing (control group): As per the typical method of briefing, participants were provided a written description of the mission, daylight photos of the target, and a navigational map of the target area along with estimated detection range.

2. Visible-light mission rehearsal format: In addition to the standard mission preparation provided to the control group, this second group also viewed both static and dynamic aerial imagery (i.e., still photographs and motion-picture footage of target area). The dynamic simulations were presented at both two-thirds and full aircraft velocity.

3. Visible-light + infrared mission rehearsal format: Simulations were presented in both visible and long-wave infrared wavebands. The visible-light dynamic images were presented concurrently with static narrow field-of-view infrared images at equal ranges. This enabled one to compare the two and confirm that targets visible in the simulated visible images would also be visible in the infrared images. Note that subjects in this group were also provided with the standard mission preparation materials (e.g., maps, etc.).

For both experimental groups (Groups 2 and 3), simulations were presented on high-resolution monitors that matched the dimensions of the aircraft display screen. Seven video simulations, each differing in duration, were presented in random order to aviators in these two groups. The selected scenarios were representative of typical air-to-ground missions and included targets such as boats and tanks. Following respective briefing sessions, participants were allowed further study time to review the mission-related materials. Performance on target acquisition, in terms of accuracy and speed of recognition for the seven sequences, was subsequently assessed for each participant through simulated video presentations (aerial perspective). Each scenario began with the target beyond visual range, eventually entering into the aviator's field of view. The participant was asked to signal his acquisition of the intended target and indicate its perceived location upon the monitor. The accuracy of the individual's response was gauged and the simulation paused at the corresponding video frame number. For each task, the aviator was provided instructional feedback by the investigator on response accuracy. The time elapsed between stated target recognition and over-fly was measured, with larger values indicative of early identification and superior performance. An error was recorded if the subject failed to identify the target stimulus, or mistakenly identified a given stimulus as the mission target.

As presented in Table 6.1, aviators in the two simulation training groups engaged in earlier target recognition than participants briefed in standard format. In addition, the control group committed significantly more errors than those in either of the two experimental training groups. While the visible-light + infrared mission rehearsal group's performance was slightly superior than the visible-light mission rehearsal group on speed of target recognition, the reverse trend occurred with respect to error rates. However, these differences between experimental groups did not reach statistical significance. The authors counter the potential argument that greater rehearsal time may have accounted for the improved performance of both experimental groups over the control group. Across the three groups, none of the participants actually used the fully allotted time for mission preparation prior to the presentation of test simulations. Thus, Krebs et al. (1999) maintain it is unlikely that those aviators briefed in standard format received insufficient rehearsal time. Overall, results indicate that preparing aviators for missions with either of the two simulation formats in addition to the standard briefing may promote earlier target acquisition and greater accuracy in target identification.

Table 6.1. Mean target recognition time and error rates (and standard deviations) for control and experimental groups. (Source: Krebs et al., 1999)

	Target recognition time (sec.)		Error rate (%)	
Group	M	SD	M	SD
Standard briefing	41.68	3.60	8.16	2.89
Visible-light	49.90	2.17	4.08	2.63
Visible-light + infrared	53.89	3.17	6.12	2.89

6.4 Pleban, Matthiews, Salter, and Eakin (2002)

Finally, the objective of this next investigation was to evaluate the effectiveness of an individual combat simulator for the training of military unit leaders on sound decision-making skills. The first group of participants consisted of seven inexperienced platoon leaders, with an approximate average age of 24. These were lieutenants having recently completed the Infantry Officer Basic Course (i.e., required initial training). Thus, none had actually served as platoon leaders in the field. The second group was composed of seven experienced captains, with an average age of 28. The training scenarios involved role-playing by retired military personnel acting as confederates and assuming the positions of squad leader, company commander, and platoon sergeant. In preparation for the experiment, these role-players rehearsed four different combat scenarios.

Each participant (i.e., platoon leader) was given a 30 minute pre-training introductory session, namely to gain a degree of familiarity and comfort with navigation through the virtual environment. The combat simulator consisted of four full-immersion enclosures with a built-in projection screen. The participant manipulated his position via a thumb switch located on an M-4 rifle, through which he was able to regulate both direction and speed. Immediately following this introduction, the participating platoon leader read profiles of each role-player, being the commander, sergeant, and squad leader. Next, he was briefed on a particular scenario and allowed 15 minutes to develop a mission plan. Each platoon leader participated in the four 25 minute scenarios over the course of a single day.

As an objective measure of decision-making skills, researchers and senior military personnel identified critical decision points for each scenario in advance. Failure of participants to engage in appropriate responses at a given decision point was recorded and time stamped by the investigator (e.g., failure to provide instructions to squads, etc.). These errors of omission were then aggregated and converted to a percentage based on the total number of possible incidents of inaction, to produce a total score reflective of decision-making proficiency. Note that no errors of commission were recorded (e.g., firing weapon at an innocent person).

Although there were no objective pre- or post-training measures of program effectiveness, within the training period itself, both experienced and inexperienced platoon leaders tended to make fewer decision errors with each successive trial. On average, there was a slight tendency for the experienced group to make fewer errors than the inexperienced group, but this difference was not statistically significant. Overall, the consistent performance improvement of participants throughout the program lends support for the effectiveness of simulator training in the enhancement of decision-making skills. In addition, participants provided a subjective evaluation of training effectiveness via self-report. Results of this questionnaire indicated that 86% of subjects believed their decision-making skills improved as a result of training. Furthermore, 93% expressed their desire to have simulation included within their regular training regime. According to platoon leaders, a feature of the combat simulator found particularly valuable from a learning perspective was the provision of immediate, intrinsic feedback (e.g., visible increase in number of casualties from lack of appropriate action). In sum, simulation training was demonstrated to be a beneficial tool for the enhancement of complex decision-making skills related to combat.

7.0 Implications and limitations of the review

The research reviewed in this report reveals much about the effectiveness of use of force simulation training in Canada, both in terms of its current state of application by police agencies and its theoretical potential. However, due to the extremely small number of empirical studies that have examined the effectiveness of use of force simulators in the law enforcement context, only limited conclusions can be drawn at present. Indeed, rather than providing explicit answers with regards to the effectiveness of use of force simulation training, many of the reviewed studies have raised important questions that remain to be addressed through future research. In this section, we will discuss the various implications and limitations of the present report.

7.1 Canadian use of force statistics

Prior to discussing the various implications and limitations associated with this review of simulation-based training, a related issue bears mentioning. While there are ample and accessible American statistics pertaining to police use of force, analogous Canadian data is scarce at best. For the present report, an exhaustive search of existing literature and web-based sources was conducted. In addition, personal contacts from several law enforcement agencies were questioned on the subject of statistics related to police use of lethal and non-lethal force. However, as we discussed in Section 2.0, this extensive pursuit only yielded one web-based document recently posted by the Toronto Police Service (1998). Although we have been informed through personal communication that use of force frequency data is indeed collected by various police agencies, our concerted efforts to obtain these statistics were clearly unsuccessful. The availability of such data is important if we are to rationalize expending financial resources on research and instructional programs related to simulation-based training in police use of force decision-making. In other words, it is difficult to justify conducting research to determine the effectiveness of simulation training if we have not yet objectively quantified the need to impose such training in the first place.

7.2 Defending use of force training programs

The literature suggests that, theoretically, use of force simulation training can serve as a successful adjunct to an officer's instructional regime. However, as currently implemented by police agencies, use of force training via simulators is unlikely to be effective in honing relevant decision-making skills (CPC, 2003). There is a notable scarcity of available documentation regarding the implementation of current use of force simulation training in Canada. However, the research that does exist (e.g., CPC, 2003) indicates that police agencies will likely have difficulty convincing Canadian courts that this particular training component achieves the objective of teaching police officers effective use of force decision-making in the field. The reasons for this claim are discussed extensively elsewhere in this section and include issues pertaining to insufficient training time and instructor feedback. In order to address these matters, changes must be implemented to use of force simulation training or, alternatively, compensatory modifications must be made to other components of an agency's use of force instructional program. However, it will initially be important to conduct a more thorough assessment of the exact manner in which use of force simulators are currently employed by Canadian police agencies. In turn, this will enable one to determine the specific modifications required for improving the quality of simulation training. (Note: While the CPC (2003) survey did examine at this issue, this was not the primary purpose of that report.)

7.3 Individual simulator systems

Regardless of methodology and simulator employed, each featured study concluded that simulation training was effective, if only to a certain degree. While specific tasks required of participants varied across and within occupational domains (i.e., law enforcement, military, or aviation), the common function of the simulation training was to hone cognitive and/or procedural skills within high-stake scenarios. Given the relatively favourable results achieved irrespective of simulator system, it is possible that the critical factors related to training effectiveness are inherent in certain underlying principles of simulation training in general, and not in any one particular system's technology. Future research in the area of policing may potentially consider a cross-comparison of various simulators in their ability to improve decision-making in use of force scenarios. Furthermore, it may be worthwhile to identify simulator features most significantly related to training effectiveness in specific skill areas.

7.4 Measures of effectiveness

While simulation training was consistently determined to be effective to a certain extent in the studies cited, it should be noted that each study differed in its operational definition of effectiveness. The primary definitional variation across studies resides in the objective/subjective dichotomy. Most investigations included a subjective measure of effectiveness, seeking to assess participants' perceptions of various training components. In these cases, the vast majority of participants across studies provided positive feedback, deeming simulation training to be extremely beneficial. Within both the law enforcement and military domains, students perceived the experience gained through simulated scenarios to be integral in improving their critical decision-making skills (e.g., Pleban et al., 2002; Scharr, 2001).

In contrast, objective measures of effectiveness pertain specifically to a quantifiable improvement of given capacities. Helsen and Starkes (1999) and JSC (2002) were the only two investigative teams in the area of law enforcement to include objective performance measures. The former considered shooting accuracy and number of preventative actions employed in each scenario, while the latter also examined effective use of cover, avoidance of unintentional shooting, and assurance of justified shooting. Certain military studies also evaluated post-training performance on various combat and flight tasks, ranging from enemy target exposure time to number of hits upon target (e.g., McAnulty, 1992; White et al., 1991).

It is arguable that subjective and objective measures of effectiveness are both required in the evaluation of simulator training, neither being sufficient in its own right. While officers have demonstrated a subjective preference for simulation training over alternative methods such as role-playing and classroom instruction (Boyd, 1992), there has yet to be an objective evaluation contrasting the relative effectiveness of different training methods intended to instil the same skill set. Although such quantifiable measures are necessary to gauge veritable improvement, the relevance of subjective evaluations should not be discounted. Indeed, in other areas of research, a student's positive perception of his instructional regime is a valuable prerequisite in sustaining learning motivation, preventing program attrition, and encouraging high achievement (Davis et al., 2003; Kuhlemeier, Van Den Bergh, & Melse, 1996).

Regardless of the manner in which one defines effectiveness, there remain severe limitations across the investigations presented. Namely, a sound research methodology would dictate the imperative inclusion of a measure intended to indicate transfer of skill to the natural environment. While performance post-tests were administered by certain investigative teams (e.g., Helsen & Starkes, 1999), these evaluations still assessed one's skill improvement within the simulated environment. In other words, they failed to address the extent to which proficiency developed via simulation training translates to performance in real-world contexts. Such measures of transfer are invariably required in the ultimate evaluation of training effectiveness. As mentioned previously, the cognitive demands produced by the sheer novelty of a task may impair one's performance during the instructional period itself (Druckman & Bjork, 1991; Magill & Hall, 1990). Accordingly, it may be the case that sufficient training produces greater transfer performance gains than have actually been observed to date. On the other hand, it is also conceivable that skills acquired through simulation training do not generalize as readily to naturalistic settings. Future research is clearly required to address this issue.

7.5 Length of training

One must consider the possibility that the promising conclusions drawn with respect to simulation training effectiveness may simply be a product of the extensive practice time afforded with the systems in the reviewed studies. In the domain of law enforcement, for example, participants in experimental groups received between one to eight hours of practical simulation training in use of force decision-making (e.g., JSC, 2002; Helsen & Starkes, 1999; Scharr, 2001). As per the current training regime in Canada, officers participate in an average of four simulated use of force scenarios per year, two of which are included for evaluative purposes. This translates to approximately five minutes of simulation training per annum (CPC, 2003). Thus, it is unlikely that these stringent limits placed on police use of force simulation training, in terms of both range of scenarios and ultimate time of exposure, would result in any significant improvement in either decision-making or procedural skills. It is therefore advisable that cost-benefit investigations be conducted to determine the optimal practice time required for desired performance gains, while simultaneously maintaining training-related costs at a reasonable level.

One of the most salient conclusions emanating from this review is that practice time allotted for simulation training is sorely lacking. It is not our suggestion that simulation-based training alone can or should replace an instructor. However, once basic skills have been imparted and verified for accuracy via an instructor, simulators can potentially assist in providing more practice trials than would ordinarily be feasible (Means et al., 1993). In the context of police use of force training, it might be worthwhile to consider the possibility of implementing an “open-simulation-practice” concept for officers who have already received a degree of instructor supervised training. Such an approach has been adopted by certain police agencies in the U.S. and it would offer an opportunity for increased practice time for Canadian police officers without having to expend financial resources on additional trainers and supervision.

7.6 Training of different skill domains

A related question that remains to be addressed adequately is the relative degree to which simulation training is capable of improving cognitive/decision-making skills versus procedural/motor skills. It was generally revealed that simulation training led to an increase in decision-making effectiveness, either by improving the number of preventative actions in which one engaged (Helsen & Starkes, 1999) or by encouraging the performance of justified shooting responses and effective use of cover (JSC, 2002). The investigations that focused primarily on cultivating motor skills related to simulated flight or combat proficiency also yielded significant performance improvement when experimental groups were compared to respective control groups (Dennis & Harris, 1998; McAnulty, 1992). However, discrepancies occurred when tasks required the integration of both cognitive and motor skills. For instance, Helsen and Starkes (1999) discovered that, contrary to the impressive increase of preventative actions resulting from video simulation training, no improvement was observed with respect to shooting accuracy. The authors rationalized their findings by arguing that (1) shooting of moveable targets had not been emphasized adequately in original academy training and (2) experimental training time for this task was limited. This raises the issue that perhaps such motors tasks should first be honed separately to encourage performance automaticity (i.e., via simulated practice with *moving* targets), only after which point should they be performed in parallel with complex decision-making in simulated use of force scenarios. Such a proposition is compatible with research indicating that simple tasks should be mastered before graduating to more complex tasks (Christina, 1996). Perhaps high-fidelity simulators, as currently employed in law enforcement, are best suited to train parallel skill integration rather than any one individual skill component.

7.7 Fidelity requirements

In a related vein, the following questions arise: To what extent should fidelity be observed in a simulator system? In other words, to what degree must training contexts emulate real-life settings in order to be effective? It is possible that the answer is dependent upon the skill set in question. For instance, increasing simulation fidelity through the inclusion of platform motion had no impact upon military flight skills (Eddowes, 1978). However, the tasks featured in this investigation were strictly procedural in nature, as are the steps required in discharging a weapon. It is conceivable that high-fidelity, while not necessarily integral to the development of motor skills, is indeed required when attempting to transfer the performance of procedural tasks to a high-stress environment. Such is the case observed in critical use of force scenarios commonly encountered by police officers. Druckman and

Bjork (1991) have intimated that performance in general is subject to impairment in high-stress situations. Thus, genuine physiological reactions prompted by the realistic features of simulators such as FATS are conducive to practising the integrative performance of cognitive and motor tasks in an environment similar to that encountered in naturalistic settings. Future researchers may wish to explore the relative effectiveness of different degrees of fidelity in simulated use of force scenarios. Moreover, it may also be beneficial to examine the relative contribution of system fidelity over other essential components of training, namely quality and quantity of practice and instructor feedback (Harris, 1978; Moreno & Mayer, 2004).

7.8 Sample issues

Samples sizes varied widely across the studies we reviewed, ranging from 14 (Pleban et al., 2002) to 207 participants (Boyd, 1992). Irrespective of such deviations, results generally indicated some degree of training effectiveness. While sample size can potentially affect the reliability of results for individual studies, and the degree to which these may be generalized to a larger population, it appears to have not precluded the attainment of statistically significant results concerning program effectiveness. The most noteworthy sample-related issues in this case are not so much in the size of the sample itself but rather in its composition. In the present review, each investigation conducted in the area of law enforcement featured different sample characteristics. Across studies, participants ranged from experienced police officers (Boyd, 1992; JSC, 2002), to probation officers (Scharr, 2001), to relatively novice police recruits (Helsen & Starkes, 1999). Future research may wish to address whether certain training programs (or elements thereof) impact distinct groups of individuals differently. In practice, it would of course be advisable to tailor the simulated scenarios to be representative of the situations typically encountered by each of the above groups.

A matter of greater concern, however, is the absence of baseline measures and potential lack of sample uniformity *within* each investigation. Save for Helsen and Starkes (1992), no other research team in the law enforcement domain administered baseline measures of performance to trainees. Baseline or pre-training data is required as a standard to which post-training measures are compared in order to quantify program effectiveness. While Scharr (2001) administered various objective measures of program effectiveness, the absence of baseline data rendered it impossible to determine the amount of learning that occurred between pre-training and the evaluation conducted at Time 1.

Baseline measures are required not only to quantify true performance improvement but also to ensure the uniformity of one's sample. For instance, Boyd (1992) specified only that her participants included 207 California peace officers, primarily consisting of active officers and deputies. Presumably, these individuals differed in age, experience on their respective forces, area of specialization, previous experience with simulator training, and the like. Any of the aforementioned variables could theoretically interact with the training itself to influence program effectiveness. Hence, it is imperative that such variables be included or at least controlled for in future investigations.

A related issue concerns the differential impact of simulated use of force training on experienced versus inexperienced officers. Recall that White et al. (1991) revealed no significant differences in shooting accuracy scores between the control group and the aggregated scores of the eight simulation training groups. However, when analysis was confined to participants with minimal experience, evaluative marksmanship scores were consistently higher for those in the simulation versus the live-fire group. Thus, the simulation training in this case was determined to be more effective for the inexperienced group than for the experienced group. This finding prompts several interesting questions, namely whether a ceiling effect for learning exists as a function of training time and experience. It was unclear in this particular investigation whether veterans had received significantly more simulation-based training than novices prior to the study or if the difference in performance was simply due to the former group's relatively greater amount of overall experience on the force. This issue requires further elucidation.

The "ceiling effect hypothesis" appears to be consistent with the finding that the greatest quantity of learning in general tends to occur in early training sessions (Bjork, 1994). It appears to be further substantiated by the research conducted by JSC (2002). Recall that while the gain in skill observed at Time 2 was maintained at Time 3, no further improvement was noted. However, as suggested by the authors, given that the scenarios across training periods were not counterbalanced, one cannot discount the possibility that results observed at Time 3 were simply a function of the scenarios selected for that particular training session (e.g., greater level of difficulty, etc.). Hence, it is important that future research address the question of whether there does indeed exist a ceiling effect in the first place. If so, once this plateau is reached, it may be necessary to consider refining the training program by increasing the level of difficulty or modifying its objectives.

Once all training goals are successfully met, refresher training should be considered for skill maintenance. Again, due to the limited amount of research conducted thus far, additional investigation is required to determine the optimal scheduling of refresher training for use of force decision-making as related to the guidelines proposed by Bahrick (1979). As the scheduling of refresher training appears to be dependent upon period of skill non-use (Bahrick, 1979; Druckman & Bjork, 1991), it may be the case that optimal scheduling will vary according to the individual officer's exposure to such critical scenarios. In addition, given that cognitive links related to a particular task are formed during the original learning sessions (Bjork, 1994; Bouton, 2000), it may be possible to administer less intensive training in refresher sessions, or potentially rely on alternative oral and written prompts. Nonetheless, the relative effectiveness of these methods over simulation training should be further explored prior to implementation.

7.9 Instructor role

All the investigations reviewed for the purpose of this report were cryptic with regards to the instructor's specific role within respective training programs. Generally, it was simply stated whether or not an instructor was present to provide performance feedback (e.g., Helsen & Starkes, 1999; McAnulty, 1992). Anecdotally, instructors involved in police use of force simulation training have expressed a view whereby they perceive their expertise as playing a primary role in the pedagogical process. In other words, they consider the simulator as simply a tool or vehicle that aids in conveying their own knowledge. Given that 25% of police officers surveyed by the CPC indicated that time allotted for performance feedback was insufficient (CPC, 2003), it is difficult to assume that instructors are even provided the opportunity to assume a significant function in use of force simulation training as currently practiced in Canada. Future research may wish to explore issues related more explicitly to instructor role in veritable police training contexts such as instructional style and length of augmented feedback time. In addition, it may be worthwhile to address the relative contribution of augmented feedback versus components more intrinsic to the simulator itself (i.e., intrinsic feedback, etc.).

7.10 Other potential uses for simulation training

Simulation training may be employed in lieu of live rehearsal or alternative instructional methods in any high-stake scenario that requires (1) the co-ordinated performance of procedural tasks and/or (2) the integration of motor and decision-making skills. Simulators have been used for training in police use of force decision-making (e.g., Boyd, 1992), aviation instruction (e.g., Dennis & Harris, 1998), military combat (e.g., McAnulty, 1992), and medical emergency response (e.g., Agazio, 2002). However, there likely remain unexplored venues for the application of this form of technology in the policing context. For instance, one prospective use that we are currently exploring is in area of child street-proofing. While there exist publications and programs designed to instruct and educate both parents and children in this capacity (Royal Canadian Mounted Police; RCMP, 2004), simulation training might assist children in identifying precarious situations and exhibiting proper reactions to these.

8.0 Recommendations

Based on our review of the research literature dealing with simulation training, a number of recommendations can now be made. We believe that many of these recommendations, if adopted, could have an immediate and direct impact on the effectiveness of use of force simulation training for Canadian police officers. Other recommendations deal more specifically with how research in this area should be conducted to ensure that the results of future studies are both more meaningful for the police community and more generalizable to the real world. These recommendations will also likely have an impact on the effectiveness of use of force training, though this impact will probably be felt over the longer term.

8.1 Recommendations for training

For use of force simulation training to reach its full potential, several important changes to the current training regime must be implemented. The following issues, each based on sound empirical research, appear to be most critical:

1. Increase training time and conduct a cost-benefit analysis to determine the optimal training time for desired performance gains, while maintaining training-related costs at a reasonable level.

2. Implement open simulation practice for officers who have already received a degree of instructor supervised training.

3. Present a greater number of scenarios of a given type (e.g., domestic disputes) until the trainee masters appropriate use of force responses in a specific context. Only at this time should other scenarios be introduced.

4. Allow trainees to master basic responses (e.g., motor skills) before introducing additional difficulties (e.g., parallel performance of motor and cognitive skills).

5. Space simulator training sessions over a number of days rather than condensing an equal number of training hours on the simulator into a single session.

6. Schedule re-training sessions approximately midway between the period of skill non-use (these requirements may vary depending upon the type of officer in question).

7. Increase instructor feedback during initial training sessions, but gradually reduce this feedback as the trainee progresses (i.e., from a continuous to an interval schedule).

8. Complement instructor feedback with the trainee's self-assessment, either through group discussion or individual reflection in order to improve long-term training retention.

8.2 Recommendations for research

In addition to evaluating each of above proposed changes to use of force simulation training on an ongoing basis, the following research questions/issues should be considered in the future:

1. Provide greater accessibility to Canadian police use of force statistics (e.g., frequency data).
2. Compare different use of force simulator systems in terms of their ability to improve decision-making in use of force scenarios.
3. Identify simulator features most significantly related to training effectiveness in specific skill areas.
4. Include both objective and subjective measures of effectiveness in the evaluation of simulation training.
5. Include measures to evaluate the extent to which proficiency developed via use of force simulation training translates to performance in the natural environment.
6. Explore the possibility of ceiling effects in training and, if ceiling effects exist, examine whether modifying difficulty level and/or the training objectives allows the trainee to move beyond this plateau.
7. Examine how simple visual or verbal prompts compare to additional simulator time for the purpose of refresher training.
8. Examine the relative effectiveness of different degrees of system fidelity.
9. Examine the relative contribution of system fidelity over other essential components of training (e.g., quality and quantity of practice).
10. Include baseline or pre-training data as a standard to which post-training measures can be compared.
11. Include potentially confounding subject variables (e.g., age, experience, specialization, etc.) in future investigations.
12. Examine other ways that use of force simulators could be used in the policing context (e.g. for child street proofing).

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10.0 Appendices

Appendix A. Summary of court cases.

Case	Description	Charges	Decision
Allarie v. The City of Victoria (1993)	PO uses wooden baton to assist in the arrest of the plaintiff who was drunk, angry, resistant, and posing a threat to others. Accidental blow to the plaintiff's head causes permanent brain damage.	• Use of excessive force • Negligence in obtaining immediate medial assistance	• All charges dismissed
Chritopherson v. District of Sannich and The City of Victoria (1994)	POs arrest the plaintiff for being intoxicated in public. POs use physical force and pepper spray to control her on numerous occasions. The plaintiff was drunk, angry, resistant, and causing harm to herself.	• Unlawful arrest and detention • Use of excessive force	• All charges dismissed
Nault et al. v. Tremblay (1995)	PO arrests plaintiff A for impaired driving and forcefully restrains plaintiff B who interferes with the arrest. PO hits plaintiff A on the head with a flashlight multiple times after he kicks a window out of the police cruiser.	• Use of excessive force	• All charges dismissed
Carpenter v. The City of Vancouver et al. (1995)	PO releases police dog and uses physical force (a kick to the chest) to arrest the plaintiff who was attempting to steal from a car. Plaintiff attempts to flee from the dog and suffers numerous injuries.	• Use of excessive force • Negligence • Breach of duty	• PO did use excessive force • Plaintiff 50% at fault for injuries • PO 50% at fault for injuries • Judgement of $20,000 in damages
Berntt v. The City of Vancouver et al. (1997)	PO shoots the plaintiff twice with an Arwen anti-riot weapon during a riot. Second shot causes serious head injuries.	• Negligence in use of Arwen • Assault and battery • PD negligent in Arwen training	• PO negligent in use of Arwen • PO committed assault and battery • PD not negligent in Arwen training • Plaintiff 75% at fault for injuries • PO 25% at fault for injuries

Appendix A. Continued.

Case	Description	Charges	Decision
Neville v. Owen et al. (1998)	POs smash the windshield of the plaintiff's vehicle with a baseball bat and physically remove the resistant plaintiff from his vehicle after he sped away from what turned out to be an undercover drug bust (POs believed plaintiff was a drug dealer). The plaintiff suffered a broken rib.	• Assault and battery	• All charges dismissed
Irving et al. v. Clemens et al. (1999)	POs use physical force to arrest the plaintiffs, who were verbally aggressive and resistant, for being drunk in a public place and causing a disturbance. As a result, one plaintiff has her arm broken.	• Use of excessive force • False arrest and imprisonment	• All charges dismissed
Glover v. Magark (1999)	PO shoots the plaintiff in the chest causing serious injuries when executing a warrant to search the plaintiff's residence for drugs. PO mistook a television remote control in the plaintiff's hand for a gun.	• Assault • Negligence and wilful misconduct • Breach of duty • Breach of Charter rights	• All charges dismissed
Francis v. The City of Maramichi (2000)	PO uses physical force and pepper spray to control and arrest the verbally aggressive and resistant plaintiff who was involved in an altercation at a hockey game.	• Assault and battery • False arrest • Breach of Charter rights	• All charges dismissed
Anderson v. Smith et al. (2000)	PO arrests the plaintiff for wilful obstruction of a PO and resisting a PO. In the process, PO uses pepper spray on the plaintiff and his dogs.	• Assault • Negligence and gross negligence • Malicious and wilful misconduct	• All charges dismissed

Appendix A. Continued.

Case	Description	Charges	Decision
Mohamed v. The City of Vancouver et al. (2001)	PO releases police dog to pursue the fleeing plaintiff who was a suspected robber. The plaintiff broke his leg climbing over a wall and the dog bit him on the arm.	• Use of excessive force • Negligence in use of police dog • PD negligent in police dog training	• All charges dismissed
Khan v. The City of Vancouver (2001)	PO forcefully pulls the non-compliant plaintiff out of his car for failing to stop for a PO. PO continues to use physical force (a knee to the rib cage) while walking the plaintiff to the sidewalk.	• Assault	• All charges dismissed • Defendant to pay court costs ($2,500)
Bolianatz v. The Edmonton Police Service et al. (2002)	PO kicks the plaintiff in the groin in order to control and arrest him for a physical fight he was having with another man.	• Assault	• All charges dismissed
Vlad v. The Edmonton Police Service et al. (2002)	PO stops the plaintiff's vehicle for going through a red light and uses 3-4 open handed head stuns in an attempt to handcuff the plaintiff who was resisting the PO.	• Unlawful arrest • Use of excessive force • Breach of Charter rights	• All charges dismissed
McLean v. Seisel et al. (2002)	PO discharges tear gas at short range into a locked bathroom in an attempt to extract the mentally ill plaintiff who had stopped taking her medication. The plaintiff had earlier threatened her neighbours with a knife. The shot causes serious damage to the plaintiff's eye resulting in blindness.	• Negligence • Use of excessive force	• PO negligent in use of tear gas gun • PO did use excessive force • Plaintiff 50% at fault for injuries • PO 50% at fault for injuries • Judgement of $67,500 in damages

Appendix A. Continued.

Case	Description	Charges	Decision
Ernst v. Quinonez et al. (2003)	POs forcefully arrest and imprison the plaintiff who was an innocent passenger in a car being driven in a way that endangered a PO's life.	• Assault • False arrest and imprisonment • Breach of Charter rights	• POs committed assault • POs committed false arrest and imprisonment • Judgement of $38,300 in damages
MacPhee v. The Ottawa Police Services Board et al. (2003)	Based on statements by witnesses that the plaintiff had drawn a knife in a store, PO uses physical force and pepper spray to remove the uncooperative plaintiff from his car and arrest him.	• Unlawful arrest • Use of excessive force • Negligence	• Summary judgement granted to the defendants
Stevens v. The Toronto Police Services Board et al. (2003)	POs use knee strikes to handcuff and arrest the fleeing plaintiff for possession of controlled substance for the purposes of trafficking (and other related offences).	• Assault and battery • False arrest and imprisonment • Malicious prosecution • Negligent investigation	• All charges dismissed
Robinow v. The City of Vancouver et al. (2003)	PO releases police dog to pursue the fleeing plaintiff who was suspected in a car theft. The police dog bit the plaintiff on the arm causing serious injuries.	• Assault and battery	• All charges dismissed

Appendix B. Summary of law enforcement simulation studies.

	Boyd (1992)	Helsen & Starkes (1999)	Scharr (2001)	JSC (2002)
Simulator	• ICAT	• Unspecified simulator	• FATS	• PRISim
Sample	• N=207 peace officers	• N=24 police officers	• N=36 probation officers	• N=181 police officers
Description of study	• All participants received same training • Officers required to assess relative effectiveness of simulation training versus other training methods	• Pre and post-tests on 4 training groups: - Classic training - Slide training - Video training - Slide + video training	• All participants trained with FATS on a variety of scenarios	• All participants given: - Pre-training questionnaire - 3 training sessions - Post-training interview
Practice time	• ICAT: unspecified • Total program: 240 hours over 4 months	• Simulator: 8 hours • Theory: 2 hours	• FATS: - Veterans: 1 hour - Novices: 1.5 hours	PRISim: 3 one hour sessions
Feedback	• Unspecified	• Intrinsic feedback • Augmented feedback • Discussion among trainees	• Intrinsic feedback • Augmented feedback • Discussion	• Augmented feedback • Discussion via interview
Measure of effectiveness	• Post-test questionnaire to assess perceptions of simulator effectiveness relative to other training methods	• Objective measures of: - Shooting accuracy - Preventative actions taken - Cognitive processes • Post-test interview with subjects	• Post-test questionnaire administered to assess subjects': - Perceived ability and confidence after training - Perceived overall training effectiveness in improving decision-making skills	• Evaluation of: - Shooting accuracy - Tactics - Judgment - Safety - Post-training interview with subjects to discuss attitude towards simulator

Appendix B. Continued.

	Boyd (1992)	Helsen & Starkes (1999)	Scharr (2001)	JSC (2002)
Results	• ≈ 90% of subjects ranked simulation training as one of the top three training methods (compared to methods like range firing, etc.) • ≈ 90% of subjects felt better prepared for use of force decision-making as a result of their simulation training	• Video simulation training improved number of preventative actions taken by 600% and led to more efficient visual tracking • Shooting accuracy did not improve	• 97% of officers reported that training was effective at least "to a great extent" • 86% of officers felt better prepared for use of force decision-making	• Simulator enhanced: - Shooting accuracy - Effective use of cover - Avoidance of shots fired unintentionally - Justified shootings • 96% of subjects felt better prepared to deal with lethal force incidents after training
Simulator effective?	• Yes	• Limited	• Yes	• Yes

Appendix C. Summary of military simulation studies.

	White, Carson, & Wilbourn (1991)	McAnulty (1992)	Krebs, McCarley, & Bryant (1999)	Pleban, Matthiews, Salter, & Eakin (2002)
Simulator	• M-16 rifle simulator	• AH-1 Flight and Weapons Simulator (FWS)	• Visible-light simulations • Visible-light + infrared simulations	• Individual Combat Simulator
Sample	• N=247 Air Force Security Police trainees	• N=20 aviators from several U.S. Army units	• N=21 aviators from Navy and Marine Corps	• N=14 male platoon officers (7 experienced, 7 inexperienced)
Description of study	• Control group: Live-fire training for marksmanship skills • 8 experimental groups: Each received simulation training under different configuration of the system	• 3 Groups: - Control group: Live-fire training only - FWS training on monthly basis - FWS training on quarterly basis	• 3 Groups: - Control group: Standard briefing for mission through maps, photos, written descriptions, etc. - Visible light mission rehearsal (also given static and dynamic aerial imagery) - Visible light + infrared mission rehearsal (also given static and dynamic aerial imagery)	• Each subject was given a pre-training introductory session with simulator then participated in four simulated scenarios
Practice time	• 10-30 minutes	• Monthly training group: 15 monthly sessions ranging from 75-120 minutes each • Quarterly training group: Six sessions, ranging from 75-120 minutes each	• Briefing session of unspecified duration • Study time of 15 minutes • Exposure to seven scenarios, each with a duration of 1-2 minutes	• 30 minute pre-training session with simulator • 15 minutes to develop mission plan • Exposure to four 25 minute scenarios

Appendix C. Continued.

	White, Carson, & Wilbourn (1991)	McAnulty (1992)	Krebs, McCarley, & Bryant (1999)	Pleban, Matthiews, Salter, & Eakin (2002)
Feedback	• Unspecified	• Intrinsic feedback • Augmented feedback	• Augmented feedback	• Intrinsic feedback
Measure of effectiveness	• Shooting accuracy (i.e., number of hits)	• Engagement time • Exposure time • Target effect (i.e., was target suppressed?)	• Target acquisition (i.e., accuracy and speed)	• Considered errors of omission as a measure of decision-making skills • Post-training evaluation by participants on training effectiveness in improving decision-making skills
Results	• No significant difference in shooting accuracy scores b/w control group and average score of eight simulation training groups • When analysis confined to subjects with minimal experience, higher levels of shooting accuracy found for simulation over live-fire training	• Gunnery skills improved for simulator training group b/w pre- and post-test (declined for control group) • No significant differences in performance between monthly and quarterly training • Simulation training led to more efficient utilization of range time and ammunition	• Simulation training in either format was superior to standard briefing in promoting earlier target acquisition and greater accuracy in target identification • Only marginal differences between two simulation formats	• Simulation training improved decision-making skills from trials 1-4 • 86% of subjects believed their decision-making skills had improved as a result of training
Simulator effective?	• Limited	• Yes	• Yes	• Yes

Appendix D. Summary of aviation and navigation simulation studies.

	Holman (1979)	O'Hara (1990)	Dennis & Harris (1998)
Simulator	• CH-47 Flight Simulator	• Full-mission real-time ship-handling simulator	• Desktop Simulator (DTS)
Sample	• N=59 student pilots	• N=16 senior cadets from U.S. Merchant Marine Academy - All subjects were desk officer trainees - All subjects had spent a year aboard a merchant vessel - No subject had previous experience with ship-handling simulators	• N = 21 student pilots - No subject had previous flight experience
Description of study	• Control group: - Trained to proficiency in aircraft • Experimental group: - Trained to proficiency on 32 flight tasks in flight simulator	• Pre-test of watch-standing skills • Program only group: - Pre-test (week 1) - Training (weeks 2-9) - Post-test (week 10) - Retention test (week 47) • Refresher training group: - Same as above with added refresher training	• 3 groups: - No simulation training - Controls: Allowed full use of primary flight controls on simulation software - Keys: Allowed use of computer cursor and function keys to control flight path of aircraft

Appendix D. Continued.

	Holman (1979)	O'Hara (1990)	Dennis & Harris (1998)
Practice time	• Unspecified	• 8 weeks, 3 sessions per week - 1 day/wk on classroom instruction - 2 days/wk on simulator training (each scenario ≈ 20 min.) • Refresher training group: - Also received 30 min. of simulation practice 6 months following program completion	• 1 hour on DTS
Feedback	• Unspecified	• Intrinsic feedback • Augmented feedback • Classroom discussion	• Augmented feedback • Debriefing
Measure of effectiveness	• Performance on training tasks (e.g., hovering) between experimental and control groups	• Evaluation of watch-standing skill components (e.g., navigation, collision avoidance, etc.) • Comparison of pre- and post-test measures of training effectiveness • Comparison of retention performance b/w program only and refresher training group	• Use of a 5-point scale to assess: - Performance in straight and level flight - Performance in sustaining a turn - Performance when exiting a turn

Appendix D. Continued.

	Holman (1979)	O'Hara (1990)	Dennis & Harris (1998)
Results	• Simulator effective for training of all tasks except those involving extensive ground referencing, night operations, and terrain flight (possibly due to task difficulty or limited training time)	• Significant improvement of watch-standing skills b/w pre- and post-test for both groups • Skills declined over 9-month retention interval (program only group) • Refresher training generally effective in minimising skill loss	• Use of DTS resulted in improved performance relative to control group (result held irrespective of simulation format)
Simulator effective?	• Limited	• Yes	• Yes