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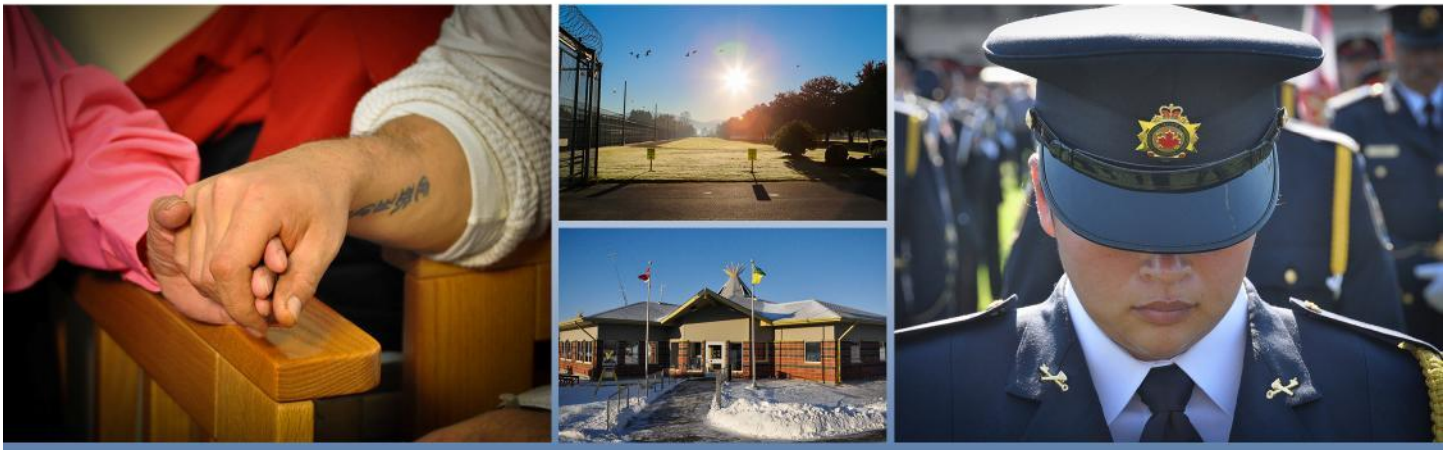

RESEARCH REPORT

The Impact of Simulated Firearms Training on Correctional Officer Firearms Requalification

2020 Nº R-433

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The Impact of Simulated Firearms Training on Correctional Officer Firearms Requalification

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January 2020

Acknowledgements

We would like to thank Learning and Development staff including Sylvain Mongrain, Julia Crosier and Shevaun Corey for their support of this project. This work would not have been possible without Angela Davie who coordinated data collection and sharing, and provided invaluable knowledge and expertise at each stage of the process. Thank you to all of the staff at the Correctional Service of Canada Training Academy who assisted in implementation and data collection, in particular Albert Boucher and Jason Seems. We would also like to acknowledge Gregory Krätzig for consulting on the design of the study and providing valuable feedback on the draft report. Thank you to Research Branch staff including Andrew Harris and Sara Johnson for their foundational contributions to this project, Laavanyan Selvendren for assistance with data entry, as well as Dena Derkzen for her support throughout the project.

Executive Summary

Key words: *simulated firearms, training, technology, weapons, correctional personnel*.

The Correctional Service of Canada (CSC) has piloted simulated 9mm firearms training for Correctional Officer (CO) recruits. Unlike live fire training involving ammunition, this innovative training method entails the use of laser-based technology in a simulated environment. The use of simulated firearms has been utilized in various military and law enforcement settings for its associated safety, efficiency, and cost-savings. However, research examining the effectiveness of this technology concerning firearms skill acquisition and retention remains limited.

This report represents the second phase of research examining the effectiveness of simulated firearms training in a correctional setting. Using a between-subjects design, this study draws comparisons between CO recruits trained using simulated firearms (n = 76) and those trained primarily using live fire (n = 80). In the first phase of the study, outcomes related to theoretical understanding, safety and handling, as well as accuracy were compared between groups at initial qualification. While it was found that CO recruits trained in the simulated environment had significantly lower scores on accuracy at the initial qualification, the overall findings were promising as no significant differences emerged in pass/fail rates.

Extending beyond examining the effectiveness of simulated firearms training on performance during qualification, the purpose of the current study was to examine the long-term effects of simulated firearms training in regards to skill retention. More specifically, this phase of research sought to determine how the type of training received impacts the requalification performance of COs one-year post training. Performance over time from initial qualification to requalification were examined, alongside group comparisons between COs trained with simulated firearms and those trained using primarily live fire. Outcomes included both evaluation scores and overall pass/fail rates for theoretical understanding, safety and handling, as well as accuracy.

Overall, there were no differences in requalification pass/fail rates between COs trained in a simulated environment and COs who received primarily live firearms training. In comparison to COs who received primarily live fire training, those trained using simulated firearms demonstrated higher scores on the Skills Checklist evaluation of the safety and handling component. No differences were found between the two groups for the Course of Fire evaluation of safety and handling or for the evaluation of theoretical understanding. While COs trained in the simulated environment demonstrated lower scores on accuracy during the initial qualification, there was no difference in accuracy performance at requalification between those trained with simulated firearms and those trained using live fire. In general, COs tended to show higher performance at requalification on all evaluation measures, regardless of training modality.

Viewed collectively, the results from this study suggest that simulated firearms training is associated with long-term retention benefits, as demonstrated by performance at requalification one-year post training. While this study highlights the relevance of simulated firearms as an effective alternative to training involving live fire, future research should explore the optimal use of simulated environments and the advancement of innovative technologies in correctional training environments.

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Introduction

The use of simulated technologies has increasingly been integrated in various training environments, including law enforcement, military and medical settings. Extending the use of simulated technologies to a correctional environment, the Correctional Service of Canada (CSC) recently piloted the use of simulated firearms for the 9mm training of Correctional Officer (CO) recruits. Across the globe, military and law enforcement agencies have implemented simulated firearms as a part of their marksmanship training to both reduce costs and enhance practice (Hawthorne, Wollert, Burnett, & Erdmier, 2011). Within Canada, both the Royal Canadian Mounted Police (RCMP) and the Canadian Armed Forces have piloted simulated firearms training (Band, Dragotta, & Sizemore, 2016; Grant, 2013; Krätzig, 2014; Krätzig, Parker & Hyde, 2011). Despite the increased use of simulated firearms in both Canada and other jurisdictions, the use of this technology remains largely understudied, particularly within a correctional setting. This report represents the second phase of research on CSC's simulated firearms training pilot and aims to expand current understanding on the use of this technology within a correctional setting, as well as add to the growing body of literature examining the use of simulation for firearms training in other domains. The first phase explored the impact of simulated training on 9mm pistol skill acquisition and transfer by examining CO recruits' initial qualification while at the National Training Academy (Hanby & Selvendren, 2018). Extending beyond this, the purpose of the current study is to consider the long-term effects of simulated firearms training on skill retention.

Skill retention may be defined as the maintenance of an acquired skill over a period of time (Adams, 1987; Arthur, Bennett, Stanush, & Mcnelly, 1998). Within the literature, there is general agreement that psychomotor skills have the tendency of decaying overtime (Adams, 1987; Adams, Webb, Angel, & Bryant, 2003; Arthur et al., 1998). Alongside other use of force skills commonly used in correctional and law enforcement settings, firearms skills have been identified as being susceptible to perishability, particularly with infrequent use (Angel et al., 2012; Arthur et al., 1998; Centre for Organizational Research And Development, 2010; Gallo, Collyer, & Gallagher, 2008; Morrison, 2003). As outlined by Angel and colleagues (2012), several factors may influence skill retention, such as opportunities to practice (Ginzberg & Dar-

El, 2000), overlearning (Krätzig, 2016), or the availability of refresher training (Wells & Hagman, 1989). Despite this, the literature has largely overlooked how training modality, such as the use of simulated training environments, may subsequently influence skill retention.

Within CSC, CO recruits undergo a Correctional Training Program (CTP) at the National Training Academy. The CTP provides recruits with opportunities to acquire and practice fundamental competencies, equipping them to work with different offender populations and institutions, as well as to manage a variety of operational situations. As part of the training, CO recruits learn how to handle, manipulate and use firearms. The previous 9mm pistol firearms training component of the CTP involved CO recruits trained using 75% live fire and 25% simulated firearms training. However, with the introduction of the simulated firearms training pilot in 2016, a number of recruits were trained in the absence of live-fire with 100% of their pistol training occurring in a simulated environment. Simulated firearms training could be a potential alternative or addition to live fire pistol training that involves training recruits on proper handling, safety and accuracy without the use of ammunition. This innovative training approach involves the use of laser-based technology in a simulated range environment. Given the absence of ammunition, the use of simulated firearms is associated with several potential benefits over live fire, such as cost-savings (Band et al., 2016) as well as enhanced safety (Grant & Galanis, 2009). Simulated firearms may be regarded as more efficient given reduced firing range maintenance, quicker set-up, and the capacity to permit immediate feedback on shooting accuracy (Hawthorne et al., 2011). Additionally, training in a simulated environment offers the opportunity for increased trigger pulls through the unlimited number of virtual bullets (Band et al., 2016), thus increasing the opportunity for practice. Despite the systematic benefits associated with the use of simulated firearms, it is unclear whether this technology enhances current training and learning practices. While the literature is limited, the vast majority of research on the use of simulated firearms has focused on examining the effectiveness of this training modality on skill acquisition and transfer to firearms assessment, rather than on skill retention.

Impact of Simulated Firearms on Skill Acquisition

Representing the only study examining the use of simulated firearms within a correctional context, the first phase of research on CSC's training pilot examined the effectiveness of this training modality on initial firearms qualification. Hanby and Selvendren

(2018) compared 9mm pistol qualification outcomes for CO recruits trained using primarily live fire (n = 80) to those who trained in the simulated environment (n = 76). Outcomes related to theoretical understanding, accuracy, as well as safety and handling were considered. While recruits trained using simulated firearms scored significantly lower on the qualification for accuracy, overall pass/fail rates between the groups did not differ. Additionally, CO recruits trained using simulated firearms had higher scores on safety and handling at the qualification examination compared to the control group. This may partially be attributed to the additional classroom time that is afforded to firearms manipulations in the simulated environment (775 minutes vs. 650 minutes in the control group). Individual related characteristics were also explored to determine whether other factors beyond training modality might have influenced qualification outcomes. Results demonstrated that gender and grip strength often influenced outcomes more so than the type of training, with better performance observed with greater grip strength and with male recruits. The findings of this study suggested that simulated firearms training might be an appropriate alternative or addition to existing CO firearms training.

Notwithstanding this study, the research done on the use of simulated firearms training largely stems from law enforcement and military settings. Within Canada, MacLennan and Partyka (2009) assessed the use of dry-fire non-recoil simulated firearms training within the RCMP to determine if the acquired skills would transfer to a live fire assessment. The sample consisted of 21 students enrolled in a police studies program that were compared to an archival database of 337 RCMP cadets. In addition to a final qualification examination, performance was evaluated throughout the training with two benchmark sessions. While there was a significant difference in the proportion of students and cadets passing benchmark 1 (19.0% vs. 50.1%), no significant differences were observed on benchmark 2 (57.1% v. 70.6%) and the final qualification (90.5% vs. 92.3%). Results from this study suggest that students trained with simulated firearms may initially demonstrate lower performance than those trained in a live fire range (i.e., during the benchmark sessions), but that performance during final qualification is comparable.

More recently, Krätzig, Parker, and Hyde (2011) also conducted a study examining the use of simulated dry-fire non-recoil firearms within the RCMP to determine whether it is as effective as traditional live-fire pistol training. Utilizing a group of 124 RCMP cadets, 32 of

whom were trained in a simulated environment, the evaluation outcomes of cadets for two benchmark sessions and a final qualification were compared between the two types of training. Although there was no significant differences in the rates of pass/fail for the evaluation sessions of benchmark 1 and benchmark 2, a significantly higher proportion of cadets trained using simulated firearms failed the final qualification than those who were trained using live fire. However, following remedial training and final qualification retesting, recruits trained in the simulated environment had a 100% pass rate for the pistol course of fire.

Overall, the literature on the use of simulated firearms has largely focused on the skill acquisition and transfer. While research findings appear to lend support for the effectiveness of simulated firearms in this regard, only select studies have extended beyond skill transfer and have additionally considered the impact of this training modality on skill retention.

Impact of Simulated Firearms on Skill Retention

In an effort to help fill the gap within the literature on the long-term effects of simulated training on firearms skill retention, Krätzig (2014) conducted a three-year longitudinal study with RCMP cadets. Building off earlier research done by Krätzig and colleagues (2011), Krätzig (2014) examined annual pistol requalification scores of two groups; cadets trained in a simulated environment ($N = 96$)[1] and cadets trained using live fire ($N = 128$). The follow-ups demonstrated that cadets in the control group who were trained using live fire tended to score lower in the annual qualification examinations than they did during their Final Benchmark Test before they left the training academy. Following an opposite trend, those in the experimental group scored nominally higher in the annual requalification examinations than they did in the training academy. However, longitudinal analyses revealed no significant score differences over the three years for either of the groups ($p < .05$). Considering skill acquisition, no significant score differences were found between the two groups at the Final Benchmark Test, though significantly more cadets trained in the simulated environment passed than cadets trained using live fire. In turn, the highlighted findings are suggestive of the capacity of simulated firearms training to demonstrate skill retention over time. The author suggests that higher retention scores may be related to the increased number of trigger pulls that occurred in the simulated training

[1] This includes the 32 cadets trained in the simulated environment from Krätzig et al. (2011).

environment, which may have strengthened their muscle memory.

Within the Navy in the United States, Jensen and Woodson (2012) also examined how simulation-based training transfers to live fire and whether participants are able to retain these skills over time. The study consisted of 34 active military members,[2] 17 participants in the experimental group who received simulated training using the Indoor Simulated Marksmanship Trainer and 17 in the control group trained under standard naval marksmanship. To measure retention over time, participants completed a baseline (pre-training) assessment, a post-training assessment, as well as a live fire assessment, which occurred either two or four-weeks following training. Performance measures included scores on the standard Navy Handgun Qualification Course (NHQC) as well as the mean point of impact (MPI)—a measure representing the centre location of a group of shots. Considering the performance from baseline to post-training on the NHQC, both the experimental and control groups demonstrated significant improvements in scores. Additionally, the experimental group performed significantly better than the control group for the MPI post-training. While these trends are suggestive of the effectiveness of simulated firearms training at skill transfer, this study also aimed to capture skill retention. Analyses on the main effects of time gap (two-week and four-week) demonstrated no significant difference in performance from post-training to live fire between participants whose assessment took place at the two-week mark and those at the four-week mark.[3] However, regardless of whether the live fire assessment took place at the two-week mark or four-week mark, participants overall tended to show trends of slight performance degradation. While the findings from Jenson and Woodson (2012) support the use of simulated firearms training, the insufficient sample sizes and the short time lapse (i.e. two- and four-week assessments) are insufficient to meaningfully capture the impact of simulated firearms on skill retention.

Further to Jenson and Woodson (2012), Getty (2014) also examined the retention of marksmanship skills with the use of simulated firearms training. Focusing on Navy small arms training, Getty (2014) explored how well participants trained with the Indoor Simulated

[2] With the sample consisting of active military members, 81% of participants in the control group and 76% of participants in the simulation group had previously received formal marksmanship training. However, there was no significant difference between the two groups in this regard.

[3] Given the small sample sizes, comparisons between the control and experimental group at the two-week and four-week mark were not performed. Instead, data from both groups were merged to examine the effect of time.

Marksmanship Trainer performed and retained skills over a one-week period. With participants drawn from the Naval Postgraduate School (i.e., civilian staff, students, and active military members), participants were grouped by previous marksmanship experience and baseline measurements were also conducted. Participants trained in the simulated environment (n = 15) were compared to a control group of participants trained under the standard naval marksmanship without the use of the indoor Simulated Marksmanship Trainer (n = 15). Similar to Jenson and Woodson (2012), various performance measures were included, such as scores on the NHQC as well as the MPI. In regards to the maintenance of participants' performance over time, there was no significant difference between the control and experimental groups on their performance from the initial training qualification to the one-week follow-up. Difference scores from baseline to the one-week retention phase were examined for each group. While participants in both groups displayed a trend of improvement, the simulation training appeared to improve performance on certain assessments (i.e., the seven-yard line shot group and the seven-yard mean point of impact) significantly more than the standard firearms training. As such, the results from this study extend the findings of Krätzig (2014) and Jenson and Woodson (2012), suggesting that simulated firearms training is associated with retention benefits.

As it stands, the research considering skill retention associated with the use of simulated firearms is extremely limited. Importantly, the literature has tended to focus on short time intervals that do not capture the long-term retention effects of this training modality. Additionally, studies are limited to small sample sizes involving military and law enforcement settings, with none focusing on correctional samples. While the available research appears to support the use of simulated firearms training, it is unclear whether similar long-term retention benefits arise in a correctional environment with COs.

The Current Report

In an effort to determine the effectiveness of simulated firearms training on the long-term skill retention of COs, this study examines requalification scores one year-post training. Using an experimental group of CSC COs trained using simulated firearms and a control group who received live fire training, the goal of this phase of research is to determine whether the type of training influences performance at requalification (in terms of accuracy, theoretical understanding, as well as safety and handling). By focusing on skill retention and examining the

effectiveness of simulated firearms training beyond skill acquisition or initial qualification, this study will help inform whether simulated firearms is an effective approach for CO training.

To determine the extent to which firearms skills are retained one-year after training as well as if there are differences between the types of training, the following questions will be addressed:

1. How does performance during the 9mm firearms training relate to performance during requalification?
2. How do one-year requalification scores compare to initial qualification scores for the 9mm firearms testing?
3. How do initial and requalification scores compare between those trained using simulated firearms and those trained using primarily live fire?

Method

Participants

The sample consisted of 156 COs who underwent the 9mm pistol training component of the mandatory CTP. The experimental group (n = 76) consisted of three CTP cohorts that underwent 100% simulated firearms training between September 2016 and April 2017. The control group (n = 80) was comprised of COs from four CTP cohorts who received primarily live firearms training between July 2015 and November 2015. Unlike the experimental group, the firearms training received by the control group consisted of approximately 75% live fire and only 25% simulated firearms training.

Of the sample, 130 COs had requalification data available one-year following their initial firearms qualification (experimental group n = 64; control group n = 66). Requalification data was not available for 12 COs in the experimental group and 14 in the control group. In 12 of these cases (n = 6 experimental, n = 6 control group), the participants did not complete the CO process as they either failed the CTP or On the Job Training. In another 12 cases (n = 4 experimental, n = 8 control), the recruits were no longer in a position that requires requalification on the 9mm firearms (i.e., no armed posts) or no longer employed. Two COs in the experimental group were on leave at the time of the one-year requalification, so no records were available.

Procedure

For both experimental and control groups, the 9mm firearms training consisted of 25 hours of training distributed between classroom sessions, simulated firearms practice, live fire practice and testing. COs in the experimental group received more classroom time (775 vs. 650 minutes) to allow for extra time spent on immediate actions (e.g., knowing what to do when the pistol has a jam, what to do when the pistol is empty). These firearms manipulations are taught throughout the 9mm program but cannot be completed during simulation, as the weapon cannot replicate the immediate actions experienced with live fire. The experimental group also received more time in the simulated firearms practice (325 vs. 200 minutes) and less time in the live fire

practice (150 vs. 400 minutes) than the control group.[4] The additional time in simulated firearms practice was provided to mimic the range sessions to ensure that both groups received a similar amount of coaching. While the control group fired more live rounds than the experimental group (who only fired live rounds during assessments), the experimental group had a greater number of trigger pulls due to the additional classroom time.

Simulated firearms training was conducted using a system called the Professional Range SIMulation (PRISim), designed by Cubic™. PRISim uses high definition interactive videos and game engine technology to address most aspects of firearms training. The PRISim system used in the simulated firearms environment is designed to duplicate aspects of live fire training in order to create a proximal alternative. The simulated 9mm pistols used in the study contained recoil kits that are intended to replicate (i.e., about 50%) the recoil associated with live fire weapons. Attempts were made to make the simulated firearms and live fire range environments as similar as possible. Thus, COs wore the same safety equipment (duty belt, hat, ballistic vest, and safety glasses) in the simulated environment as they would on the live fire range. However, they did not wear ear protection to ensure that they were able to hear the directions provided by the trainer. Orders and procedures were called using the same language and commands in both environments.

Throughout the 9mm pistol training of the CTP, two sets of benchmark scores were collected. This provided a measurement of the recruits' accuracy performance during the firearms training and allowed them to experience live fire prior to the final qualification examination. During the first benchmark session, targets were placed at 3 and 7 meters and recruits were instructed during four-8 second sessions to complete the failure drill from holster (2 shots to body, 1 shot to head). During the second benchmark session, targets were placed at 15 and 25 meters and recruits were instructed during two-4 second sessions, two-8 second sessions and two-60 second sessions to test their marksmanship skills. Benchmark sessions provide an opportunity to identify any potential issues or deficiencies to the trainer and CO recruit that may need to be addressed in the subsequent training sessions.

[4] The live fire practice that recruits in the experimental group received occurred during benchmark sessions where the purpose was assessment and no training or coaching was provided. All (100%) of the training was completed in the simulated environment. In comparison, the control group received approximately 25% of their training in the simulated environment and 75% in the live fire range.

Most of the CTPs were delivered in English, with the exception of one CTP cohort which was delivered in French. Prior to the commencement of data collection, participants were provided with a detailed description of the study including the goals, duration, methodology, risks and significance of the study. Participants were asked whether or not they understood the project description, whether or not they had questions and were asked whether or not they consented to participate in the study.

During the qualification examination, the CO recruit must achieve 70% on each of the three components of the evaluation: theory, safety and handling (tested both in-class and during live fire testing), and accuracy. If a recruit fails the examination, they receive two hours of remedial time on the specific component that was failed. One retest of the same test was permitted following a failure on the initial evaluation.

Once recruits complete the CTP and successfully become COs, they must undergo a requalification process for the 9mm pistol skills one year following their initial qualification date. To meet training standards, COs are required to requalify (i.e., renew their past qualification) every year as long as they are in the position that requires armed posts. In order to be issued a 9mm pistol or assigned to an armed post within the institution, such as towers and mobile units, COs must complete firearms requalification. The same initial 9mm pistol examination is provided at the requalification period, utilizing the same form and pass marks for the evaluation.

In between the initial qualification during CTP and the requalification, no additional training or practice sessions for any firearms are provided. However, COs receive exposure and practice on the job while utilizing the firearm during the course of their duties. For example, COs complete certain safety and handling manipulations of firearms as a part of the equipment check for mobile patrols. While these manipulations mirror those that are tested during the requalification examination, opportunities to practice firing (either live or simulated) are not provided.

Measures

Initial firearms questionnaire. To gather information regarding sample and individual related characteristics, an Initial Firearms Questionnaire was provided to COs at the beginning of the training. The questionnaire contained questions related to demographics, previous firearms

experience, previous sport involvement, grip strength and handedness. Grip strength was measured by hand dynamometer ratings (in kilograms) of the dominant hand with three separate ratings, with the mean of the three measurements utilized in analyses. In 72 cases (47 control group, 25 experimental group), only one rating was taken and this was utilized in analyses in lieu of a mean rating.

Benchmark scores. Two sets of benchmark scores were collected during the course of the training. At the first benchmark session, a total score (/60), total head shots (/4) and total body shots (/8) were collected. At the second benchmark session, a total score (/100), number of missed shots, shots at 0, shots in 3 ring, shots in 4 ring, and shots in 5 ring were collected. During this session, 20 shots were taken and CO recruits receive a higher total score for shots closer to the centre of the target. The benchmark sessions are not a part of official testing and thus, did not have pass/fail criteria. Instead, the benchmark scores were documented for research purposes only and for trainers to assess whether participants trained in the simulated environment can transfer skills to live fire.

9mm Pistol Theory Exam. To measure theoretical understanding, COs are required to complete a written refresher exam about the 9mm pistol. The exam is 50 minutes in length and consists of 15 questions worth one point each. COs must score a minimum of 11 points in order to pass (70%). At initial qualification, the written exam was administered at the end of the in-class training, prior to the qualification examination. At requalification, it was typically administered on the same day as the qualification examination.

9mm Pistol qualification checklist. The 9mm pistol qualification checklist is used both at the end of the 9mm pistol training during initial qualification, as well as at the requalification examination one year after. The checklist consists of three evaluation measures, which include the Skills Checklist, Course of Fire, and Accuracy. To successfully reach the 9mm pistol qualification standard, COs must pass all three evaluation assessments within the checklist, alongside the 9mm Pistol Theory Exam. Obtaining a failing score (<70%) on any one of the evaluation measures results in an overall fail for qualification.

Skills Checklist. The Skills Checklist is a measure of safety and handling and is completed outside of live fire testing using dummy rounds. The Skills Checklist is scored out of

70 points and includes a range of specific assessments, such as drawing a firearm or unloading. The qualification standard required for COs to pass the Skills Checklist is a minimum score of 49/70.

Course of Fire. The Course of Fire is also a measure of safety and handling. Unlike the Skills Checklist, COs complete the Course of Fire during live fire testing. The Course of Fire is scored using 30-points and assess a range of firearm manipulation skills, such as holstering and slide lock drill. To pass the Course of Fire evaluation measure, COs must obtain a minimum score of 21/30.

Accuracy. The evaluation measure of Accuracy in the qualification checklist is assessed during live fire testing and examines the precision of 34 shots (calculated by the number of missed shots, shots at 0, shots in 3 ring, shots in 4 ring, and shots in 5 ring), as well as head shots and body shots. In order to qualify on the Accuracy component, three out of four rounds must impact within the designated head and neck area (i.e., head shots) and all 16 centres of mass rounds must impact within the silhouette (i.e., body shots). The overall evaluation of Accuracy is scored on a 170-point system and to pass COs must obtain a minimum score of 119/170.

Analytic Approach

Sample characteristics. Descriptive statistics such as percentages and frequencies were calculated to examine sample characteristics. Cross-tabulations and Pearson Chi-square analyses were carried out for categorical variables, such as the participants' gender and previous firearms experience. Means and standard deviations were calculated for continuous variables, such as age and grip strength. To examine differences between participants in the control and experimental groups, variables were further analyzed using a one-way Analysis of Variance (ANOVA), alongside eta squared (η^2) as a measure of effect size. Cramer's *V* values are reported to measure the strength of the association when relationships between variables were significant. Following Cohen (1992), Cramer's *V* values of .10, .30, and .50 were considered small, moderate, and large associations, respectively.

Performance over time. Performance was assessed through measures of theoretical understanding, accuracy, and safety and handling at the initial qualification and requalification examinations. To examine firearms skill performance over time, the participants' average percentages and overall trends of performance throughout the examinations were descriptively

assessed for each of the evaluation measures. As such, performance was assessed for the Pistol Theory Exam, Skills Checklist, Course of Fire, as well as Accuracy. To consider potential differences between participants trained using simulated firearms and those trained primarily with live fire, average percentages were descriptively compared. Additionally, Pearson correlations were performed between the examination sessions to capture how performance during training and initial qualification may relate to the participants' subsequent performance one-year after during the requalification.

Impact of training type on performance. In order to determine if training modality had a significant impact on skill retention, the performance of COs from initial qualification to requalification was examined, alongside group comparisons at each examination session. A set of three mixed ANOVAs were utilized for each of the evaluation measures (i.e., Skills Checklist, Course of Fire, and Accuracy). Time was included as the within-subject factor to account for differences in performance from initial qualification to requalification while group was included as the between-subject factor to account for differences in performance between the experimental and control groups. Importantly, only those COs with evaluation scores on both the initial qualification and requalification were included in the analysis. As a measure of effect size, the amount of variance accounted for by the factors was established using partial eta squared (η_p^2). Significant interactions were followed up with independent samples *t*-tests and paired samples *t*-tests, with a Bonferonni correction applied. Cohen's d was used to calculate effect size when significant differences between groups emerged. To further capture the impact of training modality on skill retention, qualification outcomes in regards to passing rates were compared for each group using Pearson Chi-square analyses.

Results

Description of Sample

The experimental group (n = 76) consisted of 47 males and 29 females, while the control group (n = 80) consisted of 69 males and 11 females. The experimental group had a significantly greater proportion of females than males, χ^2 (1, N = 156) = 12.18, p < .001, Cramer's V = .28, indicating a moderate association between variables. Considering the participants' age during training, the experimental group had a mean age of 29.2 years (SD = 8.3) while the control group had a mean age of 30.0 years (SD = 7.7). In both groups, the majority of participants were right-handed (90.8% experimental, 92.5% control). The mean hand dynamometer reading used to represent grip strength was 39.4kg (SD = 11.1) for the experimental group compared to 48.5kg (SD = 13.4) for the control group. In turn, participants in the experimental group had significantly lower ratings of grip strength, F(1,154) = 21.16, η^2= .12, p < .001. This difference may partially be attributed to a greater proportion of females in the experimental group given that in general, female participants demonstrated lower grip strength than males. Additionally, correlations confirmed a significant and strong relationship between gender and grip strength, r = .69, p < .001. Considering previous experience with firearms, although more participants in the experimental group had previous shooting experience and previous formal firearms training than participants in the control group, this difference was not significant (Table 1). In both groups, previous training was most often received through recreation/sport. Consistent with that outlined above, the analyses focusing only on the subsample of COs with requalification data (N = 130) yielded similar patterns of results.

Table 1

Percentage of COs with previous firearms experience

	Experimental Group (*n* = 76)	Control Group (*n* = 80)
Previous shooting experience	42.1	35.0
Previous firearms training	34.2	22.5
Previous training received:[1]		
Military	10.5	3.8
Police	2.6	5.0
Law Enforcement	2.6	2.5
Recreation/Sport	17.1	6.3
Other	9.2	7.5

Note. Previous shooting experience indicates that the participant reported shooting a firearm on more than 12 separate occasions. "Other" training settings included armoured transportation industries, college correctional programs and intelligence agencies.

[1] Type of previous training exceeds the percentage of recruits who have previously received firearms training as recruits may have received more than one type of training.

Performance over Time

To examine performance over time, average scores for the evaluation measures were transformed into average percentages, given the varying scales of the evaluation measures. As shown in Figure 1, considering the results for the full sample, the performance of COs appears to have remained relatively stable over the course of the evaluations, with the exception of performance being notably lower at the second benchmark session. Examining the performance on the four evaluation measures from initial qualification to the requalification, COs showed a slight increase on all measures. While lower than those displayed in the Course of Fire and Skills Checklist, the performance of Accuracy skills appear to have remained consistent from the initial qualification to the requalification. These trends suggest that following skill acquisition, firearms skills appear to be retained and maintained over time.

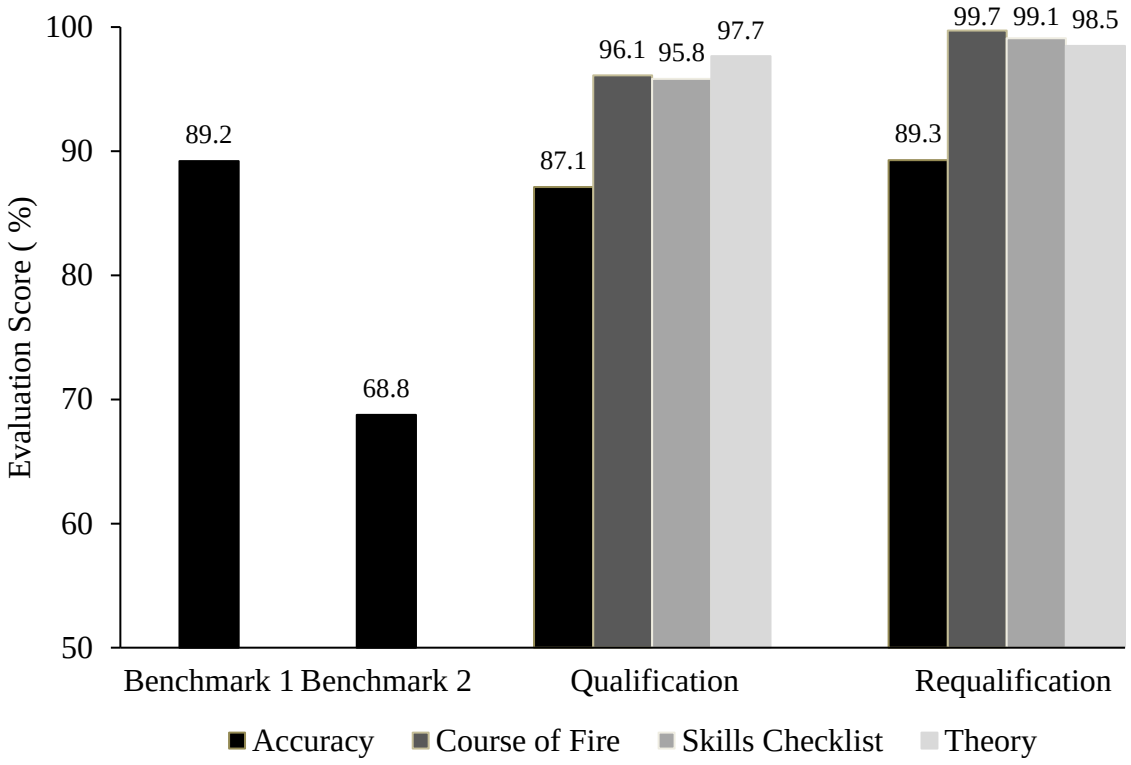

Figure 1. Mean percentage scores over time for the full sample

In regards to the measures of accuracy, both the experimental and the control groups displayed similar trends in their performance over time (Figure 2).[5] In particular, performance appears to have remained stable in both groups, with the exception of participants demonstrating lower performance at the second benchmark session. Performance was comparable at benchmark 1 and requalification between groups. COs who received simulated firearms training demonstrated slightly poorer performance in accuracy at benchmark 2 and initial qualification compared to those who received primarily live fire training.

[5] This analysis is based on the sample with available data at each evaluation session. In particular, for benchmark 1, data is reported for 75 COs in experimental group and 79 in the control group while benchmark 2 includes 76 experimental and 77 control group COs. At the initial qualification, data is reported for 55 experimental and 55 control group COs while for requalification data is reported for 59 COs in the experimental group and 64 in the control group.

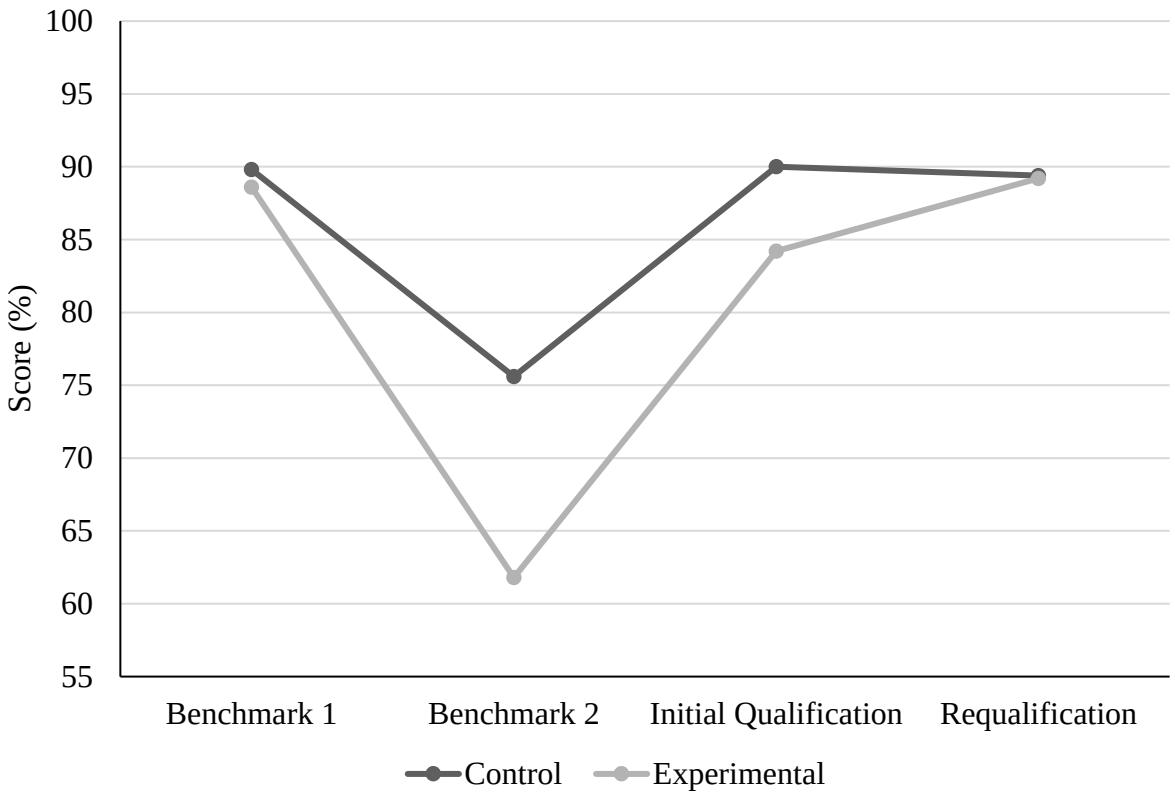

Figure 2. Mean Accuracy percentage scores over time for the experimental and control groups

To capture how performance during training relates to requalification, a series of Pearson correlations were performed. Performance at benchmark 1 and benchmark 2 both showed slight correlations with Accuracy scores during requalification (r = .24, p = .01; r = .31, p = .001). With the benchmark sessions representing a measure of firearms accuracy skills, these positive correlations are expected. However, more strongly correlated to Accuracy scores at requalification are Accuracy scores during initial qualification (r = .47, p = .001). These relationships suggest that, once acquired, accuracy skills remain relatively stable and thus, may be retainable over time. In terms of safety and handling, correlations were not calculated given the lack of variability in scores on the Skills Checklist and Course of Fire at requalification (i.e., all COs scored perfect or near perfect). As such, it was not possible to examine the relationship of safety and handling performance between training and one-year later during requalification.

Impact of Training Type on Performance

To determine whether the type of training has an impact on skill retention and the overall performance of COs throughout the qualification examinations, three mixed ANOVAs were carried out for each evaluation measure (Skills Checklist, Course of Fire, and Accuracy). In turn, this line of research addresses how requalification scores one-year post training compare to initial qualification scores, as well as how performance on the evaluation measures compares between groups. Table 2 presents the descriptive statistics for the experimental and control groups on each evaluation measure throughout the examinations.

Table 2

Differences in mean scores between experimental and control groups

Evaluation Measure	Evaluation Component	Possible Values	Experimental $N = 76$			Control $N = 80$		
			n	*M*	*SD*	*n*	*M*	*SD*
Initial Qualification[1]								
Written Exam	Theory	15	76	14.66	.56	80	14.64	.58
Skills Checklist	Safety	70	76	67.72	2.91	80	66.48	3.79
Course of Fire	Safety	30	55	28.85	2.09	60	28.80	3.18
Accuracy[2]	Accuracy	170	55	143.09	15.27	55	153.07	10.33
			Experimental $N = 64$			Control $N = 66$		
Requalification[1]								
Written Exam	Theory	15	62	14.66	.75	65	14.88	.38
Skills Checklist	Safety	70	63	69.67	.97	64	69.09	2.14
Course of Fire	Safety	30	63	30.00	.00	63	29.83	.75
Accuracy[2]	Accuracy	170	59	151.61	12.55	64	151.94	11.69

[1] If COs did not qualify in the qualification examination based on missed head shots and body shots, then the Course of Fire and Accuracy portions of the test were not completed. This explains the smaller sample sizes for these variables.
[2] Due to inconsistent reporting, the scores for head shots and body shots were infrequently recorded during examinations. As such, mean scores for these outcome variables are not examined.

As demonstrated in Table 2, no differences emerged between groups in theoretical understanding as measured by the Written Exam. Further, scores remained unchanged from initial qualification to requalification. As such, no further comparative analyses were conducted on the Written Exam.

Safety and handling. Safety and handling was first assessed through the Skills Checklist, tested outside the live fire range at final qualification. Skills Checklist scores were available for the full sample at initial qualification. Of the participants with requalification data, 1.6% (n = 1) of the experimental group and 3.0% (n = 2) of the control group were missing scores and only had the pass/fail outcome available. As such, the following analyses were restricted to the 63 COs in the experimental group and 64 COs in the control group who had both initial qualification and requalification data scores available for the Skills Checklist.

There was a significant effect of time, indicating that COs in general had higher scores on the Skills Checklist at requalification (mean score = 69.38) compared to initial qualification (mean score = 67.26), $F(1,125) = 42.77$, $\eta_p^2 = .26$, $p < .001$. There was also a significant effect of training modality, $F(1,125) = 6.44$, $\eta_p^2 = .05$, $p = .012$. This indicates that COs who received simulated firearms training performed better on the Skills Checklist compared to COs who received primarily live fire training, both at initial qualification and requalification. The effect sizes indicate that time accounts for a larger proportion of the variance in Skills Checklist performance than training modality (26% versus 5%). There was no significant interaction between training modality and time, indicating that performance on the Skills Checklist at the qualification periods did not differ significantly between the simulated firearms and live fire training groups, $F(1,125) = .72$, $\eta_p^2 = .01$, $p = .398$. Figure 3 depicts the mean Skills Checklist scores expressed as a percentage, in order to permit comparisons across evaluation measures.

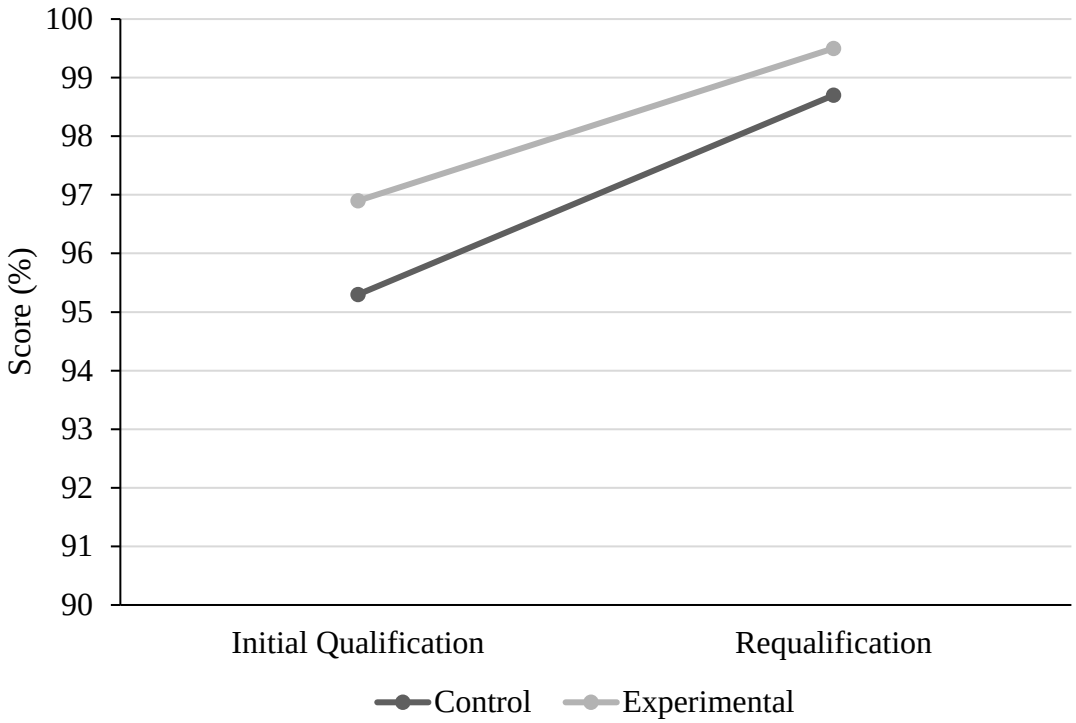

Figure 3. Mean Skills Checklist percentage scores at initial qualification and requalification by group.

Alongside the Skills Checklist, the other measure of safety and handling was the Course of Fire, which was assessed within the live fire range after COs passed the Skills Checklist. During the initial qualification, 27.6% (n = 21) of the experimental group and 25.0% (n = 20) of the control group had missing Course of Fire scores. Of the COs with requalification data, 1.6% (n = 1) of the experimental group and 3.0% (n = 2) of the control group were missing scores and only had the pass/fail outcome data available for the Course of Fire. As such, the following analyses were restricted to the 51 COs in the experimental group and 50 COs in the control group who had both initial qualification and requalification data available for the Course of Fire. Given the large proportion of missing data due to inconsistent record scoring, the results should be interpreted with caution.

Similar to the Skills Checklist, there was a significant effect of time, indicating that COs had higher scores on the Course of Fire at requalification (mean score = 29.91) compared to their scores at initial qualification (mean score = 29.03), $F(1,99) = 13.80$, $\eta_p^2 = .12$, $p < .001$. The effect size indicates that 12% of the variance in Course of Fire performance is accounted for by

time. However, there was no significant effect of training modality, $F(1,99) = .03$, $\eta_p^2 = .00$, $p = .866$. This means that performance on the Course of Fire was essentially the same for both COs who received simulated firearms training and those who received primarily live fire training. As demonstrated in Figure 4, compared to the COs who received primarily live fire training, the COs trained in the simulated environment performed slightly lower at initial qualification, but slightly higher at requalification on the Course of Fire. However, the interaction between training modality and time was not significant, $F(1,99) = .86$, $\eta_p^2 = .01$, $p = .357$.

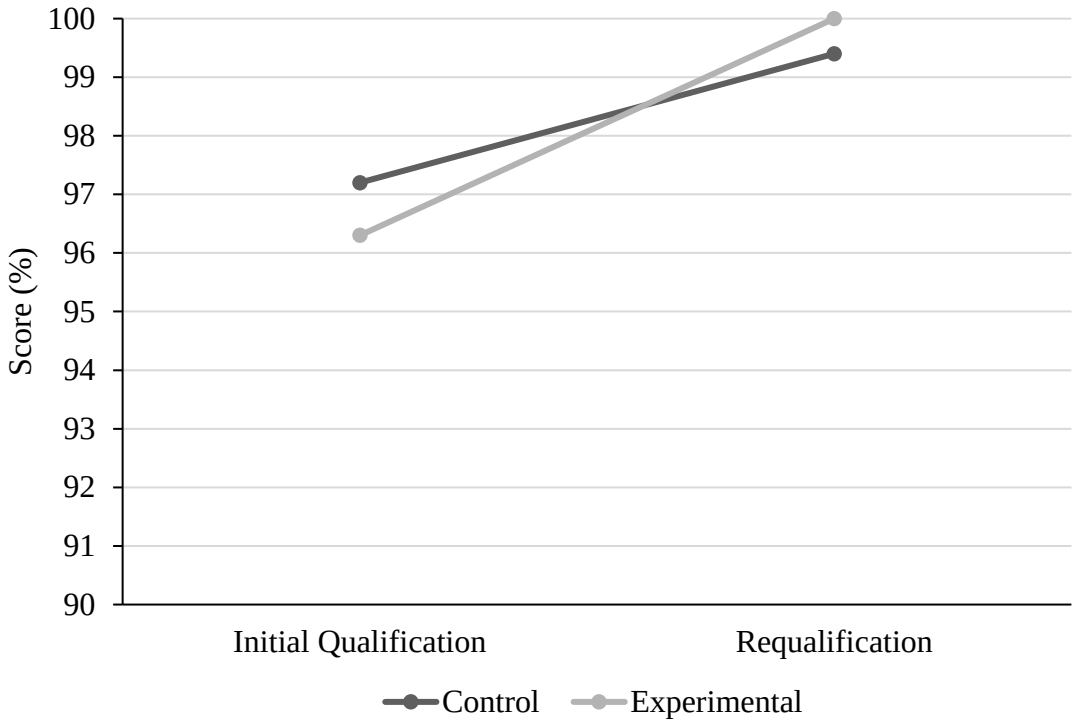

Figure 4. Mean Course of Fire percentage scores at initial qualification and requalification by group

Accuracy. At initial qualification 27.6% ($n = 21$) of the experimental group and 31.3% ($n = 25$) of the control group did not complete the Accuracy evaluation as they had failed the safety and handling components of the evaluation.[6] At requalification, the full sample completed the

[6] In one case in the control group, the CO had data available for the Accuracy evaluation despite failing the Course of Fire component. To maximize sample sizes, this score was included.

Accuracy evaluation, however 7.8% (n = 5) of the experimental group and 3.0% (n = 2) of the control group were missing scores and only had the pass/fail outcome available.[7] As such, the following analyses were restricted to the 49 COs in the experimental group and 48 COs in the control group who had both initial qualification and requalification data available.

As with the safety and handling evaluation components, COs also demonstrated higher scores on the Accuracy component at requalification (mean score =153.06) compared to the initial qualification (mean score = 148.27). This was evidenced by the significant effect of time, $F(1,95) = 13.21$, $\eta_p^2 = 12$, $p < .001$. Regardless of the qualification period, COs who received simulated firearms training had lower Accuracy scores compared to COs who received primarily live fire training. This was demonstrated by the significant effect of training modality, $F(1,95) = 5.66$, $\eta_p^2 = .06$, $p = .019$. The effect sizes indicate that 10% of the variance in Accuracy scores is accounted for by time, while 6% is accounted for by training modality.

There was a significant interaction between training modality and time, indicating that performance on the Accuracy component at different qualification examinations differed between the simulated firearms and live fire training groups, $F(1,95) = 10.16$, $\eta_p^2 = 10$, $p = .002$. To investigate the significant interaction displayed in Figure 5, four follow-up t-tests were conducted. There was a significant difference between the experimental and control groups at initial qualification, $t(108) = 4.02$, $p < .001$ (two-tailed). This indicates that COs who received primarily live fire training had higher Accuracy scores at initial qualification than the COs who received simulated firearms training. The effect size was .77, indicating a large difference between the groups at the initial qualification. However, there was no significant difference between groups at the requalification examination one-year following training, $t(121) = .15$, $p = .881$ (two-tailed). Considering the results from the initial qualification to requalification for COs trained in the simulated environment, there was a significant difference in performance on accuracy whereby COs tended to show higher performance at requalification, $t(48) = -4.26$, $p < .001$ (two-tailed). The effect size was .64, which is medium. For COs that had received primarily

[7] It should be noted that the seven COs with missing scores at requalification all failed the examination. As such, a more noticeable difference between groups may have been observed had the failing scores been recorded. The impact of the missing data on the results was tested by inputting the highest failing Accuracy score (i.e., 118/170) for the seven missing scores. The mixed ANOVA was performed on this hypothetical dataset. The pattern of results was consistent with those reporting here, suggesting that the missing data did not result in erroneous conclusions.

live fire training, there was no significant difference from initial qualification to requalification performance, $t(47) = -.38$, $p = .709$ (two-tailed).

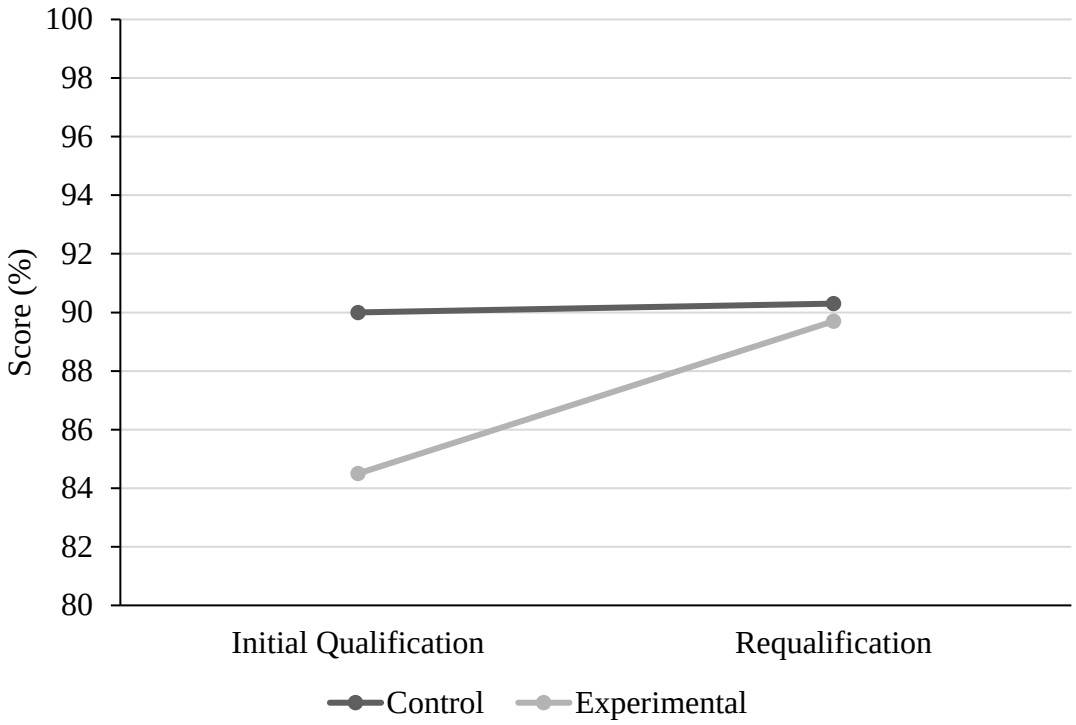

Figure 5. Mean Accuracy percentage scores at initial qualification and requalification by group.

Qualification outcomes. Beyond the examination of scores, the outcome of whether a recruit passes or fails an examination is of key importance. More specifically, at initial qualification, passing the 9mm pistol examination ultimately determines whether the CO recruit can continue in the CTP. Failing both the qualification and a retest results in removal from the CTP. At annual requalification, passing the examination is necessary for holding armed post positions. Failing the annual qualification results in removal from working any posts that employ the weapon they failed.

The rates of pass/fail outcomes were compared between the experimental and control groups at initial qualification and requalification. As demonstrated in Table 3, at the initial qualification, pass rates were comparable between COs trained using simulated firearms and those trained primarily with live fire. Chi-square tests yielded no significant differences between training type and the overall outcome of initial qualification, χ^2 (1, $N = 156$) = .015, $p = .902$.

The experimental and control groups were identical in their performance on the Skills Checklist, with all COs passing this portion of the assessment. There were also no differences between groups in their pass rates on the Course of Fire, χ^2 (1, N = 156) = .02, p =.877, or the Accuracy component, χ^2 (1, N = 156) = .002, p = .965, at the initial qualification. Following retest examinations, 90.8% of the experimental group (n = 69) and 92.5% of the control group (n = 74) passed and therefore, successfully completed the 9mm pistol qualification.

Table 3

Pass rates for experimental and control groups at initial qualification and requalification

	Experimental (N = 76)	Control (N = 80)	Cramer's V
Evaluation Measure	*Percent (n)*	*Percent (n)*	
Initial Qualification	**68.4 (52)**	**67.5 (54)**	**.01**
Skills Checklist	100 (76)	100 (80)	.
Course of Fire	72.4 (55)	71.3 (57)	.01
Accuracy	68.4 (52)	68.8 (55)	.00
	Experimental (N = 64)	Control (N = 66)	
Requalification	**90.6 (58)**	**97.0 (64)**	.13
Skill Checklist	100 (64)	100 (66)	.[a]
Course of Fire	100 (64)	100 (66)	.[a]
Accuracy	90.6 (58)	97.0 (64)	.13

[a] Measures of association were not computed given that the groups had the same outcomes.

Considering outcomes during requalification one-year post training, COs trained using live fire had slightly higher rates of passing than COs trained in the simulated environment, however this difference did not reach significance, χ^2 (1, N = 130) = 2.27, p =.132. This difference in performance can be attributed to the outcome on the Accuracy component, as COs that had been trained using simulated firearms had a lower pass rate in terms of the Accuracy at requalification, though this difference was also not significant, χ^2 (1, N = 130) = 2.27, p =.132. Both groups demonstrated a solid understanding of safety and handling, as all COs in the experimental and control groups passed the Skills Checklist and Course of Fire components of

the requalification. Following retest examinations, 100% of the experimental group (n = 64) and 100% of the control group (n = 66) passed the 9mm pistol requalification.

Discussion

The focus of this report was to examine the long-term impacts of firearms training delivered in a simulated environment in comparison to the previous firearms training for CO recruits using live fire. The primary objective of this study was to determine whether the type of training influenced skill retention in terms of requalification outcomes one-year post-training. Performance was assessed through measures of theoretical understanding, safety and handling, as well as accuracy at the initial qualification and requalification examinations. Overall, there were no differences in requalification pass/fail rates between COs trained in a simulated environment and COs who received primarily live firearms training.

Compared to COs who received live fire training, COs trained in the simulated environment demonstrated higher scores on safety and handling as assessed by the Skills Checklist. There were no differences between the groups on safety and handling assessed in the Couse of Fire on the live fire range or on theoretical understanding, as measured by the written exam. However, while COs in the simulated firearms group had lower scores on accuracy at initial qualification, there were no differences between the groups at requalification. Additionally, considering the performance on Accuracy from initial qualification to requalification, COs trained in the simulated environment tended to show significantly higher scores at requalification. Taken together, these findings indicate that firearms training delivered in a simulated environment has long-term skill retention benefits as measured through performance at requalification.

Performance on firearms skills were also examined over time throughout training and up to requalification for the full sample of COs. The long-term 9mm pistol skill retention was apparent in all COs regardless of training modality, suggesting that COs do not regress in their 9mm firearms skills once acquired. In general, COs performed better on accuracy, safety and handling (both tested in-class and on the live range) and theoretical understanding at requalification in comparison to initial qualification. The performance of COs appears to have remained relatively stable over the course of the evaluations, with the exception of performance on accuracy being notably lower at the second benchmark session. Both the experimental and control groups displayed similar patterns in their performance over time. While scores were

comparable between groups at the first benchmark session and requalification, COs who were trained in a simulated environment demonstrated slightly lower scores at the second benchmark session and initial qualification. These trends suggest that following skill acquisition, firearms skills appear to be retained and maintained over time regardless of training modality.

Conclusions

This report builds on the first phase of this study, which focused on the impacts of firearms training delivered in a simulated environment on skill acquisition and initial qualification outcomes. This phase of the study extended the research to assess the impacts on annual firearms requalification, and in turn, long-term skill retention. There is a very small body of research that considers skill retention following simulated firearms training, and typically the follow-up periods are insufficient to assess long-term skill retention. One of the strengths of this study is the one-year follow-up period for requalification as it better captures skill retention over time. This is also one of the few known research studies to evaluate the effectiveness of simulated firearms training within a correctional setting.

Overall, the results of the study provide evidence that simulated firearms training can provide a suitable alternative or addition to live fire training for CO recruits. COs that had been trained in a simulated environment performed equally as well at requalification to those trained with live fire, and in some instances (i.e., in-class safety and handling), better. This demonstrates that long-term skill retention benefits are comparable between simulated firearms training and live fire training for COs. While COs trained in a simulated environment may have had lower scores during training from an accuracy perspective, these challenges had faded one year post-training. Ultimately, there were no differences in meeting the shooting standard (i.e., pass/fail rates) at initial qualification or requalification. This is a key finding as the proportion of recruits passing and failing training has resource implications for the organization. At initial qualification, passing the 9mm pistol examination is required to continue in the CTP. At annual requalification, passing the examination is necessary for holding armed post positions. Both methods of training were effective in training COs on the fundamentals of the 9mm pistol, and with an absence of skill perishability from initial training to requalification one year later.

These conclusions are somewhat consistent with previous research involving RCMP cadets, which has found that requalification scores are in fact higher for those trained in a

simulated environment versus those trained in a live fire range (Krätzig, 2014). Although requalification scores typically decrease in the years following graduation, cadets trained in the simulated environment actually scored higher during requalification compared to their scores achieved in the training academy. Similar to the findings with RCMP cadets, the increased number of trigger pulls permitted with simulated firearms may have contributed to skill retention. The findings of the current study are also promising given that the literature tends to identify firearms skills as perishable in that they deteriorate over time without practice (Angel et al., 2012; Arthur et al., 1998; Centre for Organizational Research And Development, 2010; Gallo, Collyer, Gallagher, 2008; Morrison, 2003). Of course, this study did not account for exposure or practice that may have occurred throughout the year from initial qualification to requalification.

Given that it is commonly understood in the industry that simulated firearms reduce costs, this training modality may offer a viable option for CSC's firearms training program. Simulated firearms have been proposed as an opportunity for organizations to reduce costs related to live fire ammunition, weapons, and the ranges themselves (Band et al., 2016; Sizemore, 2013). For COs in armed posts, the appropriate and effective use of firearms is a required skill. However, the use of firearms by COs is notably extremely rare. In 2017/2018, there were only 16 instances nationally where a firearm-warning shot was taken, and no instances of firearm-aimed shots (Office of the Correctional Investigator, 2018). As previous research has identified simulated firearms training as less expensive and more efficient, the current study's support of the training as equally as effective as live fire training further supports the use of simulated training environments. This may allow for more resources to be directed at the training of skills that may be more relevant to COs' day-to-day duties.

Efficiencies beyond cost savings have also been cited. For instance, simulators have allowed for more effective use of range time as the time normally reserved for cleaning up the range can be used for additional practice (Hawthorne et al., 2011). One of the advantages of simulated firearms is that instructors are able to get closer to trainees to better detect errors in weapon handling. There are vast differences in the sounds, smells and sights experienced in a simulated environment versus a live fire range. In a simulated environment, there are no barriers between recruits, the sounds are not as loud, and there are no odours of freshly fired rounds as in

live fire. Although attempts were made to make the two areas as similar as possible, the simulated range may provide a more relaxed environment for recruits to better absorb the direction provided. Ultimately, this may result in a higher quality of training.

Every effort was made at the data collection stage of this study to obtain reliable and valid findings as presented in this paper. However, drawing on operational data from the field is not without its challenges resulting in the main limitation of this study being missing data. Some of the missing data is expected; for instance, when COs fail one of the first stages of the evaluation (e.g., safety and handling) then they would not be tested on later stages (e.g., accuracy). A number of COs in the sample were also lost between the initial phase of this study and the current phase either because they failed the CTP and were not employed as COs, or were employed by CSC but were not in positions that required firearms requalification. As such, data was reported for the full sample of COs where possible. Other missing data was attributed to inconsistent record keeping (e.g., recording only the average hand dynamometer rating rather than all three ratings, not recording the score on a particular evaluation component if the CO failed). While efforts were made to standardize data collection and record keeping, the impact of the missing data should not be understated. In some analyses where both initial qualification and requalification scores were required, COs were excluded if they were missing at least one score. These deficiencies highlight the need for rigorous data collection procedures, particularly when data is being collected in an operational setting over a considerable time period and with different individuals recording and tracking data.

The results of this study indicate that simulated firearms can be utilized as a viable alternative to live fire, as demonstrated by the comparable rate of pass/fail outcomes at both initial qualification and requalification. In this study, 100% simulated firearms training was compared to a combination of 75% live fire and 25% simulated firearms training. However, research has yet to determine the optimal combination of simulated firearms training and live fire training. This line of research could also examine what parts of training can effectively be conducted in simulation, and what parts are more suitable to a live fire environment. To enhance firearms training and optimize positive outcomes for CO recruits, future research should also examine the appropriate level of classroom time needed within a simulated firearms training environment.

With the advancement of simulation technology, more opportunities will arise to make training more dynamic in terms of resembling scenarios a CO may encounter on the job. Unlike the live fire range, training in a simulated environment can safely be conducted with moving targets and involve various shooting positions with realistic, high-stress decision-making scenarios (Band et al., 2016). In comparison to live role player scenarios, simulation offers the advantage of being able to measure accuracy during realistic scenarios (Band et al., 2016). This study assessed skill acquisition and retention, but did not assess the decision making process involved in determining if and when to shoot (Krätzig, 2014). Given the positive findings related to simulated firearms training present in this study, more advanced technology should be explored, in order to further add realism to training.

References

Adams, J.A., (1987). Historical review and appraisal of research on the learning, retention, and transfer of human motors skills. *Psychological Bulletin, 101,* 41-74. doi.org/10.1037/0033-2909.101.1.41

Adams, B. D., Webb, R. D. G., Angel, H. A., & Bryant, D. J. (2003). *Development of theories of collective and cognitive skill retention*. Guelph, ON: Humansystems Incorporated.

Angel, H., Adams, B. D., Brown, A., Flear, C., Mangan, B., Morten, A., Ste-Croix , C., & Gruson, G. (2012). *Review of the Skills Perishability of Police Use of Force Skills*. Guelph, ON: Humansystems Incorporated.

Arthur, W. Jr., Bennett, W. Jr., Stanush, P. L., & Mcnelly, T. L. (1998). Factors that influence skill decay and retention: A quantitative review and analysis. *Human Performance, 11,* 57-101.

Band, D., Dragotta, D., & Sizemore, E. (2016). Virtual firearms ranges. *Federal Law Enforcement Training Center (FLETC) Journal, 16,* 21-26.

Centre for Organizational Research and Development. (2010). *RCMP Skill Retention and Perishability Literature*. Retrieved from: http://docplayer.net/28493980-Rcmp-skill-retention-and-perishability-literature.html

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112,* 155-159. doi:10.1037/0033 2909.112.1.155

Gallo, F. J., Collyer, C. E., & Gallagher, P. L. (2008). Prevalence of force by police in Rhode Island jurisdictions: Implications for use-of-force training and reporting. *Criminal Justice Review, 33*(4), 480-501.

Getty T. J. (2014). *A comparison of current naval marksmanship training vs. simulation-based marksmanship training with the use of Indoor Simulated Marksmanship Trainer (ISMT).* (Unpublished master's thesis). Naval Postgraduate School, Monterey, CA.

Ginzburg, S., & Dar-El, E. M. (2000). Skill retention and relearning - a proposed cyclical model. *Journal of Workplace Learning, 12,* 327-332.

Grant, S. C. (2013). *Small arms trainer validation and transfer of training: C7 Rifle* (Rep. No.TR 2007-163). Toronto, ON: Defence Research and Development Canada.

Grant, S., & Galanis, G. (2009). Assessment and Prediction of Effectiveness of Virtual Environments: Lessons Learned From Small Arms Simulation. In J. Cohn, D. Nicholson, & D. Schmorrow (Eds.), *The PSI Handbook of Virtual Environments for Training and*

Education: Developments for the Military and Beyond (pp. 206-216). London: Praeger Security International.

Hanby, L., & Selvendren, L. (2018). *The Effectiveness of Simulated Firearms Training for Correctional Officer Recruits.* (R-408). Ottawa, ON: CSC.

Hawthorne, S., Wollert, T., Burnett, R., & Erdmier, K. (2011). Firearms simulation study. *Federal Law Enforcement Training Center (FLETC) Journal*, *8*, 26-32.

Jensen, T. & Woodsen, J. (2012). *Enable marksmanship training transfer study: The use of indoor simulated marksmanship trainers to train for live fire*. (Unpublished master's thesis). Naval Postgraduate School, Monterey, CA.

Krätzig, G. P. (2016). *Skill retention: A test of the effects of overlearning and skill retention interval on maintenance of infrequently used complex skills* (Unpublished doctoral dissertation). University of Regina, Regina, SK

Krätzig, G. P. (2014). Pistol skill acquisition and retention: A 3-year longitudinal study. *Interservice/Industry Training, Simulation & Education Conference, 14042.*

Krätzig, G. P., Parker, C., & Hyde, M. (2011). Pistols skills transfer from a synthetic environment to real world setting. In *The Interservice/Industry Training, Simulation & Education Conference, (I/ITSEC),* Orlando, FL.

Morrison, G. B. (2003). Police and correctional department firearm training frameworks in Washington State. *Police Quarterly, 6*(2), 192-221. doi: 10.1177/1098611103253453

Sizemore, E. (2013). A continuous story of firearms simulation. *Federal Law Enforcement Training Center (FLETC) Journal*, *11*, 8-10.

Wells, R., & Hagman, J. D. (1989). *Training procedures for enhancing reserve component learning, retention, and transfer* (Technical Report 860). United States Army Research Institute for the Behavioral and Social Sciences, Alexandria, VA.

Zinger, I. (2017). *Annual report of the office of the correctional investigator 2016–2017.* Ottawa, ON: Office of the Correctional Investigator.