Skill retention: A test of the effects of overlearning and skill retention interval on maintenance of infrequently used complex skills

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Abstract

While researchers have suggested that overlearning increases the likelihood of skill retention, there is little consensus or evidence as to how much overlearning is required, and how such overlearning interacts with distributed practice schedules. Additionally, most research has measured skill retention based on relatively short re-testing intervals of 56 days or less; however, little is known about whether overlearning can mitigate skill degradation when the retention interval is 6 or 12 months in duration. This research examined the relationship between overlearning and retention by measuring the amount of overlearning attained in a pistol training program and measuring skill across retention intervals of 1, 6 or 12 months. The results indicate that both test and re-test performance was better over 18 sessions vs. 9 sessions, although, doubling the number of trials for the participants who trained over 18 sessions demonstrated no discernible improvement. However, the number of sessions was not the only variable that predicted performance. It was clear that overlearning resulted in better overall skill retention and that when skill retention is critical, focusing solely on the number of training sessions will achieve only partial success of those goals.

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Dedication

I dedicate this dissertation to the most important people in the world…my family. To my wife and best friend Kimberly, who has been, and always will be my partner in life and has joined me during my academic journey. She has always been my biggest inspiration, and always encouraged me through the long hours of writing, and the frequent occurrences of writer’s block. You kept me focused, and always believed in me, and I can never say thank you enough; you are my “forever eternal”. You made many sacrifices for me, which is one of the many reasons I love you. I want to thank my son Warner and my daughter Erika, who have only known their “Daddy” as a student. Both of you always showed me the innocence of childhood and brought perspective to me when I needed it the most. At times, to often to count, and always when I was in front of the computer, you would wander into the study and wriggle your way onto my lap….your timing was always perfect.

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I. Introduction

Collins English Dictionary and Thesaurus (1999) defines skill as a "special ability in a sport, etc., or something requiring special ability or manual proficiency", which is a definition in keeping with Pear's (1928) work. Pear suggested that skill is dependent on habit, that it should only apply to "higher types of well-adjusted performance" (p. 611) and has clear reference to the "quantity and quality of output" (p. 42), which is an important consideration when performance of a particular task is examined (Adams, 1987). Yet there is disagreement among scientists as to the strength of this definition (Summers, 2006). This is particularly salient when comparing the automaticity for an adult grasping a glass compared to a toddler doing the same thing or an Olympic gymnast executing a complex maneuver, something that very few people would be capable of (Summers, 2006).

While the primary focus of the present research is to investigate factors that influence retention of a skill, it is important to note that acquisition and retention are not independent. Careful consideration must be given to how skills are acquired and when competency (e.g., criterion, test score) is achieved in order to adequately measure skill retention over time. Successful employment is in part contingent on how well an individual develops competence in one or more skills. How well those skills are acquired will determine how skilfully a person performs in their job or competes in sport. Consider, for example, a person who plays golf once per week. It is unlikely that this amount of effort would have them qualify for any professional tournament, although it may be enough to allow them to be competitive at their annual company golf tournament.

In northern climates where year-round outdoor golfing is often not possible, many golfers take a hiatus during the winter months. Once the weather improves and golf courses re-open, many golfers need to re-practice their skills before achieving the same level of competence they had before the previous season had concluded. While even a professional golfer’s performance can vary significantly between weekend tournaments, their livelihood depends on constant practice and coaching in order to stay competitive.

The medical profession also relies heavily on establishing skill competence before being allowed to practice medicine independent of a teacher (Bashook & Parboosingh, 1998). However, as a physician establishes a new practice there is a tendency to develop different areas of expertise that are not as broad as evidenced during their education, and as a result student’s skills and knowledge within a cohort will vary considerably (Bashook, & Parboosingh, 1998). In the United States doctors must voluntarily participate in a recertification process; however, this recertification is tied directly to being “board certified”, which directly impacts compensation, and hospital access (American Board of Medical Specialities, 1996). The same can also be said for professions that require a minimum skill level to be achieved in order to continue employment; those who do not meet the minimum (an often arbitrarily assigned) standard may require remedial training whereas those who demonstrate superior skills are often recognized with promotions or other rewards (Ericsson et al., 1993). Further to this, Brunstein and Gollwitzer (1996) looked at failure and the effects on performance. They argue that failures during the training task can result in test performance decreases. Motowidlo (2003) suggest that these failures may fall below the expected value that an organization places on an individual, and that if improvement is not demonstrated then future employment may be terminated.

There is a great deal of skill acquisition research in areas such as athletics training (e.g., Guadagnoli, Dornier, & Tandy, 1996; Summers, 2006), typing (e.g., Baddeley & Longman, 1978), and medical training (e.g., Seymour et al., 2002; Stefanidis, Korndorffer, Sierra, Touchard, Dunne, & Scott, 2005; Wik, Myklebust, Helge, Auestad, & Steen, 2002)[1]. Despite this renewed interest, the extant literature indicates that a significant gap exists in research that examines the role of overlearning and duration of the retention interval as it pertains to motor skill retention.

I.A Motor Skill Acquisition

Early research identified several factors that influence skill acquisition (Adams, 1987), but research lost momentum by the early 1970s, and it was not until almost twenty years later that investigators began to show a renewed interest in this area. For example, Wade and Whiting (1986) argue that motor learning, control, and development share a theoretical foundation with skill learning, whereas Newell (1991) posits that the acquisition of motor skills should also consider instructional theory as well as the role of the instructor. However, the existing view (Newell, 1991) of motor skill acquisition places less emphasis on instruction and instead, researchers have focused on two areas. The first area is the context. Physical pursuits such as football, running, or swimming take into account the actions of the whole body and may consider posture, movement, or

[1] The current direction of research investigating the retention of surgical skills may be a result of a paradigm shift from training in situ to training in a synthetic environment (Seymore et al., 2002; Stefanidis et al., 2005; Wik et al., 2002).

both. In contrast, human-machine interactions such as driving a car or shooting a gun may only consider the hands and how they are manipulated. The second area of interest is the limitations of the task. For example, Newell (1991) suggests that posture, movement, and manipulation will enable the learner to participate in a host of different motor skills that are defined by the limitations of those tasks. For example, standing at a fixed point in front of a basketball net, and trying to put the ball in the net utilizes specific skills; however, when that player is competing against another team, movement and manipulation become important. Demonstrating that a player can successfully sink a basket while standing at a fixed point on a basketball court, compared to scoring while moving and avoiding the opposing players are important components. It is these differences that have resulted in the separation between theory and practice research.

The role of instruction has also been debated. For example instruction that refers to describing how movements of specific body parts (internal focus) should occur have been found to be an ineffective method of teaching (Wulf, 2007). In a more recent study, Wulf, Shea, and Lewthwaite (2010) argued that directing attention to the effects that the movements of an individual has on their environment (external focus) results in more effective performance and learning.

While there is no predominant theory of motor skill acquisition, there is agreement that motor skill involves a permanent change, although this change is not considered absolute in nature but instead skills are measureable variations in performance (e.g., while the “act” of throwing a baseball and javelin are similar in appearance performance differences will be apparent) in an individual’s ability to perform a task

(Schmidt, & Lee, 2005). Researchers often manipulate the amount of practice and the interval of retention to examine these factors' impact on performance changes (Wulf et al., 2010).

I.B Skill Retention

Routinely used skills that receive considerable practice beyond the level of initial competence (i.e., overlearning) tend to become automatized (Logan, 1988), and when degradation of skill performance is observed in this instance, it is likely due to interference from a newly acquired skill rather than actual degradation of the skill (Brown, & Thomas, 1989; Poldrack et al, 2005). However, a review of the literature found that skill retention, whether physical or cognitive in nature, does benefit from overlearning, but there was little agreement about how much overlearning was needed. For example Krueger (1930) found that as overlearning increased from 100% to 150% retention increased at the same rate; however retention benefits were no longer evident when overlearning increased to 200%, while Schendel & Hagman (1982) found that 100% overlearning was optimal for retention. Driskell, Willis & Copper (1992) conducted a meta-analysis of 88 different hypothesis tests and found that while both cognitive and physical tasks benefited from overlearning, it was the cognitive tasks that degraded to a greater degree the longer the retention interval.

Researchers investigating retention intervals have, for the most part, focused on short interval lengths in the range of 1 to 56 days (Adams, 1987; Day et al., 2001; Krueger, 1930; Mackay, Morgan, Datta, Chang, & Darzi, 2002). In fact Driskell, Willis & Copper's (1992) meta-analysis of 88 different hypothesis tests found that only thirteen had retention intervals exceeding 28 days. A paucity of research investigating the effects of overlearning and skill retention using intervals of 6 months or longer suggests that this area is under-represented in the literature and requires further investigation (Baddeley & Longman, 1978). This is a particularly salient point for regularly scheduled professional skill re-certification requirements (e.g., CPR, firearms re-qualification). Although most professional re-certification intervals range between 1-3 years, this interval length has been determined in large part by best practices[2], input from subject matter experts and, in some cases, court decisions that were not based on scientific evidence. This is a particularly important point to consider when investigating skills that are critical for performance, such as a police officer needing to know how to use their pistol but rarely using it on the job.

A review of the literature identified seven factors that influence skill acquisition and retention: amount of overlearning (Craig et al., 1972; Day, Arthur, & Gettman, 2001; Driskell, Willis, & Copper, 1992; Jones, 1989; Krueger, 1930; Mackay et al., 2002; Péladeau, Forget, & Gagné, 2003), time between training sessions (Day et al., 2001; Mackay et al., 2002), task characteristics (Anderson, Magill, & Sekiya, 2001; Guadagnoi, Dornier, & Tandy, 1996; Shanteau, 1992), how the skill is acquired and tested (Alliger, & Janak, 1989; Alliger, Tannenbaum, Bennett, Traver, & Shotland, 1997; Dreyfus & Dreyfus, 1980; Handley & Handley, 1998), retrieval conditions (Anderson et al., 2001; Marx, 1986), training methodology (Alliger et al., 1997; Day et al., 2001; Dreyfus & Dreyfus, 1980; Handley & Handley, 1998; Jones, 1989), and training strategies

[2] Best practices consist of integrating conventional, but not necessarily empirically tested, wisdom from subject matter experts.

(Anderson et al., 2001; Day et al., 2001; Kluger, & DeNisi, 1996; Vickers, Livingston, Umeris-Bohnert, Holden, 1998). Although skill acquisition research has largely focused on the fields of athletics and medicine (e.g., Stefanidis et al., 2005; Summers, 2006; Wik et al., 2002), this paper will focus on the relationship between overlearning and retention interval on the acquisition and maintenance of motor skills (Anderson et al., 2001; Adams, 1987; Newell, 1991).

I.C Overlearning and Retention Interval

Overlearning is an intentional overtraining of a particular task past a criterion (e.g., one error free evaluation session; Akerman, & Cianciolo, 2000; Driskell, Willis, & Copper, 1992; Rohrer, Taylor, Pashler, Wixted, & Cepeda, 2005). There is, however, considerable debate about the operational definition of several key variables in the overlearning literature (Driskell et al., 1992; Kruger, 1930; Rohrer et al., 2005; Schendel & Hagman, 1982). For example, there is variability of how criterion is defined (i.e., one evaluation session without an error; Driskell et al., 1992; Rohrer et al., 2005 vs. average over 3 trials; Akerman, & Cianciolo, 2000). Fitts (1967) suggested that the criterion was often an arbitrary point although he goes on to say that practicing beyond the operationally defined criterion is critical to retaining a skill.

There is also no agreement on the optimal amount of overlearning (e.g., 50% above the criterion; Kruger et al., 1992; vs. 100% above the criterion; Schendel & Hagman, 1982). However, disagreement in this area may be in part because the degree of retention is dependent on the task (or skill), how much overlearning is experienced, and the length of the retention period (Driskell et al., 1992; Kruger, 1930; Salas & Cannon-

Bowers, 2001). When Kruger (1930) measured skill retention (e.g., word list recall) following delays of up to 28 days, he found that overlearning exceeding 50% above criterion proved to have little impact on the degree of skill retention. In contrast, Schendel and Hagman (1982) suggested that overlearning was most effective at 100% above the criterion following their testing sessions (e.g., assembly/disassembly of a machine gun) of delays of up to 56 days.

A meta-analysis of overlearning and retention by Driskell et al. (1992) found that the retention period for various studies ranged from less than 1 day (Richardson, 1973) to 56 days (Schendel & Hagman, 1982). Rohrer et al. (2005) argued that participants who overlearned a cognitive task (i.e., word-pair recall) out-performed those who did not receive the extra learning opportunity; however, the performance difference was robust only after participants were tested following a delay period of 7 days. When the period of delay increased from 7 to 63 days, they observed fewer performance differences between the overlearning and regular learning groups. Additionally, Driskell et al. (1992) suggest that the small effect size for overlearning (e.g., Kruger, 1930) and the differences in the degree of overlearning (e.g., 50%; Kruger, 1930; 100%; Schendel & Hagman, 1982) and retention period (Richardson, 1973; Rohrer et al., 2005; Schendel & Hagman, 1982) make theoretical conclusions difficult. This point is particularly salient when prolonged skill inactivity in excess of 8 weeks is considered (Annett, 1979; Fan, 1987; Hurlock & Montague, 1982; Naylor & Briggs, 1961; Prophet, 1976).

The literature thus remains vague as to how much overlearning is required for skill acquisition (Arthur, Bennett, Stanush, & McNelly, 1998; Farr, 1987, Schendel &

Hagman, 1982) even for short retention periods; and there is no agreement about whether or not there is an optimal retention period before the overlearning benefit asymptotes (Kruger, 1930; Schendel & Hagman, 1982). Nor is it clear if the retention period and overlearning are correlated evenly for all skills (Arthur et al., 1998; Schendel & Hagman, 1982). Moreover, in the extant research, overlearning rarely exceeds 70% above criterion (Arthur et al., 1998). Arthur et al. (1998) and Farr (1987) also suggest that there were retention differences between cognitive tasks and physical tasks; specifically, they concluded that physical skills decay more rapidly than cognitive skills (see also Driskell, Copper & Moran, 1994). Furthermore, while it is argued that cognitive skills need to be considered separate from motor skills, the converse is not necessarily true. For example, Fleishman (1972) posits that for motor skill acquisition, cognitive abilities are important early on, but become less of an issue as practice advances and a skill becomes more automatic. This theory may explain why RCMP cadet performance asymptotes mid-way through training (Figure 3), as the skill has become more automatic. Although Ryan and Simons (1981) and Driskell et al. (1994) suggest that cognitive skills are better retained than motor skills because of mental practice, the results of a meta-analysis by Arthur et al. (1998) contradict those conclusions as their review suggests that physical skills decay less than cognitive skills.

Upon review of this literature it is evident that there is no agreement regarding the operational definition of overlearning, nor is there agreement regarding what length retention periods should be. Furthermore, the degree of overlearning and the retention period may not be independent. Rawson and Dunlosky (2011) found very few studies that simultaneously examine the effects of learning to criterion and of overlearning on durability. They state that there have been many studies that have examined each of these areas, but very few have investigated them together. Regardless of the exact relationship between overlearning and retention, as well as the mechanisms underlying the influence of overlearning on retention, these questions require clarity through further investigation.

I.D Practice: Distribution and Engagement

Baddeley and Longman (1978) posit that training programs need to consider the job task and when superior performance is evidenced such performance is due to experience and practice (Ericsson, Krampe, & Tesch-Römer, 1993). Patterson and Lee (2008) elaborate on the suggestion that 10,000 hours (Ericsson et al., 1993; Ericsson, Charness, 1994; Ericsson, 1996) of practice is required to achieve expert status, arguing that it is not just repetitive practice that elevates a person to expert status, but rather using knowledge of the previous exposure and building on that knowledge before engaging in the next iteration. It is this type of learning that is an underlying mechanism of the benefits of distributed learning.

While research investigating distributed practice as a means to improve recall of to-be-remembered information is well established (Baddeley & Longman, 1978), investigating the effects within an applied setting (e.g., classroom) has not been widely studied. However, in a recent study Seabrook, Brown and Solity (2005) investigated this area and argued that the classroom, much like a professional training institution, is conducive to distributive instruction. Seabrook, et al (2005) argued that, while the advantages of distributed practice are well established, it is not an area that has been heavily researched in an applied setting. Seabrook et al. (2005) also found that while clustered instruction (e.g., paired instruction followed by a delay and repeated) was better than massed, it was only those students who were instructed using a distributed approach that demonstrated a significant improvement.

Bryan and Harter (1897; in Ericsson et al., 1993) found that performance improves through intentional effort, while Baddeley and Longman (1978) propose that "operational considerations" (pp. 634), such as employee scheduling, as well as training duration and frequency should be considered for training. Baddeley and Longman further question whether training effects on retention are limited to discrete motor skills. Although it has been suggested that skills degrade if a task is not practiced (Craig et al., 1972; Krueger, 1930; Schendel & Hagman, 1982), it is also evident that “volume” of practice alone is not predictive of skill level (Ericsson, 1996). Lee, Swinnen, and Serrien (1994) suggest that the student must be engaged in their learning session and that cognitive effort during practice, rather than practice duration itself, is most predictive of performance (Bjork & Bjork, 2011). Similarly, Ericsson (1996) notes that intentional practice or engaged learning, rather than just additional time spent on the task, is a critical process in the development of a skill. This emphasis on the quality of attention during practice presents an interesting dilemma when investigating purposeful job skills such as piloting, golfing, or firing a pistol.

I.E Purpose of the Present Study

Although police course-of-fire (COF) training programs have been modified over time, most of this change had more to do with each agency’s “notion” of how their respective pistol training should be delivered, instead of using empirical evidence (Morrison &Vila, 1998). In 1895, the Police Commissioner of New York City, introduced handgun training to his police officers. Although their training consisted of a dry-fire warm-up session followed by shooting 10 rounds at a bull's-eye target, at the time this training was considered the best training available and would be until the 1920s. It was not until the National Rifle Association (NRA) created a handgun course that this type of training gained any traction with American police agencies (Morrison &Vila, 1998). This training was considered the standard for all police agencies until the FBI's practical handgun course, now known as the practical pistol course (PPC; Morrison, & Vila, 1998; Weston, 1973), usurped the NRA training.

A review of the literature has revealed a paucity of research in the area of skills acquisition and retention in the area of pistol training, let alone in a law enforcement setting. In fact the Morrison and Vila (1998) paper is one of a few that discuss pistol training; however, only within the context that course-of-fire scores do not predict accuracy performance during an active shooter situation. In fact there is no literature that investigates the amount of practice needed and what the retention interval should be to maintain pistol shooting ability as determined by a course-of-fire score. While three articles were found that were designed to examine pistol skills acquisition using simulation and whether those skills were transferable in situ (MacLennan & Partyka, 2009; Kratzig, 2014; Kratzig, Parker, & Hyde, 2011), they also were the only ones that considered acquisition; however, of the three only one examined pistol skills retention using a 12 month retention interval (Kratzig, 2014) yet factors such as overlearning have not been investigated.

Ambiguity about the critical factors remains throughout the overlearning and skill retention literature. In particular, this is evident in defining the learning criterion (Driskell et al., 1992; Rohrer et al., 2005; Fitts, 1967), how much overlearning is required (Arthur et al., 1998; Rawson & Dunlosky, 2011; Schendel & Hagman, 1982), practice conditions such as distribution and engagement (i.e., the degree of attention, interest and motivation the learner has toward the to-be-learned material), and the amount overlearning impacts task performance based upon the length of the retention interval (Baddeley & Longman, 1978; Day et al., 2001; Driskell et al., 1992; Lee et al., 1994; Stothard & Nicholson, 2001). This issue is further complicated when individual responses to training requirements within a predetermined time frame are considered, as not all participants will meet the criterion at the same time (Holmgren, Hilligoss, Swezey, & Enkins, 1979; Shields, Goldberg, & Dressel, 1979). This last point is particularly salient when training is uniformly delivered to a group of students who must complete a job training program in a set amount of time (e.g., police academy students). While these types of programs assume that the skill level for all incoming job applicants is equal, (e.g., all new police officers must complete the same firearms course regardless of their past experience) it is likely that individuals will achieve the operationally defined criterion at different points in time.

Perhaps most importantly, it is unclear whether or not the existing findings about skill acquisition and retention can be applied to retention periods of a year or longer. This is particularly salient when professionals need to be regularly re-certified on certain skills (e.g., annual medical re-certification; Bishop, Michaalowski, Hussey, Massey, & Lakshminarayan, 2001), a point raised by Arthur et al. (1998) and Schmidt and Björk (1992) who argue that skill acquisition and retention cannot be considered independently.

The purpose of the present research is to systematically investigate the influence of the factors of overlearning and retention interval on motor skill retention. The overlearning was not manipulated, but rather assessed relative to five skill tests given throughout learning (i.e., a quasi-experimental factor). Retention intervals were assessed to a maximum duration of one year. The issue of practice distribution was also examined in concert with these factors. Given the possible importance of motivation and engagement during practice, these factors were also assessed.

I.F Study Context

For the current skill retention study, pistol skills were measured. This skill was chosen both because it is an important, but infrequently used skill necessary for public and police officer safety, and because it is a motor skill that may be particularly sensitive to skill decay (Arthur et al., 1998; Driskell et al., 1994). Arthur et al. (1998) note that skill decay becomes problematic if a person receives initial training but is not called upon to use that skill for an extended period of time. This is particularly salient when police firearms training is considered. Police recruits/cadets complete a comprehensive training program, which includes firearms training. Following this training the officer is deployed to the field, and the overwhelming majority never un-holster their pistol until they are required to re-certify with their pistol. Because there is a significant period of delay between acquisition and retention (i.e., 12 or more months), any skill decay could result in serious harm or death if the officer is confronted with situation that requires the use of their pistol.

For the current study, a research protocol was developed to investigate retention of shooting proficiency based on the existing pistol-training program of the Royal Canadian Mounted Police (RCMP). The RCMP's pistol training occurs over 18 weeks of the 24-week Cadet Training Program. The training is designed to teach police cadets how to shoot their standard-issue pistol. This course was created with the input of in-house fire-arms subject matter experts, and "best practices" which examined pistol-training programs from other partner police agencies; however, the design of this and other similar programs was made without empirical evidence. There are three benchmarks incorporated into the training program that measure the progress of the cadet. However, the optimum amount of practice that is needed to both attain and retain the skill, as measured through the annual pistol requalification, has not been assessed.

Police training at the RCMP training academy in Regina, Saskatchewan, Canada, takes place over a 24-week period. The training programme is designed to give each cadet the skills they need to effectively police their community. As in most police training programs, part of the RCMP skills training includes successfully completing eighteen 50-min pistol (i.e., 9mm Smith & Wesson model 5946) training sessions. These training sessions include three 50-minute evaluation sessions, or benchmarks (Benchmark 1; BMK1, Benchmark 2; BMK2, Final Qualification; FQ). Typically, a cadet will shoot 1,442-9mm rounds from their RCMP issued service pistol; however, cadets who do not pass any of their three-benchmark evaluation sessions are given extra firearms training. Also cadets who fail each of their three benchmarks[3] can have additional practice to a maximum of 672 additional rounds, bringing the total rounds shot for any one cadet to 2,114.

I.F.i Benchmark 1. Benchmark 1 occurs after the completion of six 50-min training sessions. Cadets shoot two human form silhouettes with dimensions of 50.8cm x 82.6cm (see Appendix A), with the first shot being for practice purposes only. The target area is 91.4cm x 58.4cm in diameter and is marked in three shades of either green or blue, from dark on the outside to light on the inside. These three shades help to define the three distinct target regions. While scoring is important[4], not all cadets are expected to pass the benchmark 1 evaluation session (i.e., a score of 83% is required to pass benchmark 1) and it is not uncommon to see a failure rate of >50%[5] . For cadets who fail the benchmark 1 evaluation, there are learning assistance opportunities that provide time to practice shooting during two additional 50-min training sessions followed by a second opportunity to shoot benchmark 1. While success is not guaranteed the second time, cadets who fail this second attempt receive documentation to that effect in their training file, but are not sanctioned further. Additionally, archival (RCMP, 2015) data suggests that at least 65% of the cadets who failed the first benchmark evaluation will pass their second attempt.

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[3] There are minimum standards that a cadet must achieve to pass each benchmark evaluation session, as discussed in detail in the following pages (Table 1).

[4] Two points are awarded for shots placed in the outer ring, 3 points are awarded for shots placed in the middle ring, and 5 points are awarded for shots placed in the centre ring.

[5] An archival database spanning five years and including data from over 5,000 police officers was used to determine the exact failure rates.

I.F.ii Benchmark 2. Benchmark 2 occurs after six more training sessions and consists of four stages. In the training sessions preceding this assessment, cadets fire more rounds per session than in the initial training sessions because many of the initial safety skills have been learned, and instruction is now focused on quick mechanical corrections instead of the lengthy hands-on (e.g., instructors physically manipulating the cadets hands on the pistol, helping the cadet squeeze the trigger) instruction witnessed earlier in the training program. With this in mind, it is expected that each cadet will shoot approximately 1,119 rounds over the course of training sessions 6-14. Targets used by the cadets are the same as for the Benchmark 1 evaluation session. However, similar to Benchmark 1, if a cadet does not pass their Benchmark 2 (i.e., a score of 80% is required to pass Benchmark 2, plus they must pass each of the 4 stages) test they are given a second opportunity to reshoot following learning assistance before continuing training towards their final qualification test. As in Benchmark 1, cadets who fail their second attempt at Benchmark 2 receive documentation in their training file, but continue to train towards the next benchmark exam.

I.F.ii.a Benchmark 2 Stage 1-4

I.F.ii.a.1 ***Stage 1.*** This test consists of four different stages or tasks, and the benchmark test begins with this stage. For the first stage each cadet must shoot 14 rounds at a large target placed 25 m from the cadet and they must achieve a minimum point total of 46/70. The cadet uses a vertical beam (i.e., barricade support) secured to the floor as a support mechanism to steady their hands. During this stage, the cadet must stand and shoot 5 rounds with their dominant hand using the barricade as support, followed by 2 rounds using their non-dominant hand using the barricade as support. Once complete, the cadet must drop to a kneeling position (i.e., one or two knees) and shoot 5 live rounds using their dominant hand and barricade as support; however, a 6th (dummy) round is also inserted into the magazine. This is done to replicate what would happen if there is a failure in the shooting cycle, and what the cadet must do to clear the obstruction and continue shooting. After these five live rounds (plus 1 dummy round) are fired they must quickly change magazines (i.e., a magazine holds 15 rounds of ammunition). The magazine change is important as the cadet must demonstrate that they can quickly and accurately reload their pistol while engaged in a gun battle. The last two rounds are shot in a prone position. After the cadet has shot 14 live rounds plus "cleared" the single dummy round, the target is retrieved, scored and a fresh target is placed at a distance of 15 m away.

I.F.ii.a.2 ***Stage 2.*** A cadet shooting during this stage must shoot 4 rounds in the standing position and 4 rounds in the kneeling position within a time limit of 20 s. The cadets are to use their dominant hand for all 8 rounds without the assistance of the barricade. The minimum point score require to pass this stage is 26/40.

I.F.ii.a.3 ***Stage 3****.* This stage requires the target be placed 7 m away from the cadet. This stage is the only stage where the cadet will begin the session with their pistol out of their holster, holding their pistol in both hands at waist level with the barrel pointed towards the floor (i.e., low ready). Cadets will have 2 s to shoot two rounds and they will start from the far right of their lane. They will shoot two rounds, then move to the far left of their lane (i.e., approximately 91.4 cm) and resume the low ready position.

The cadet then repositions to the centre of their lane, shoots two rounds in 2 s, shifts to the far right of their lane and resumes the low ready position. These two timed shooting positions will repeated one more time. Once their 8 rounds have been shot, they have to reload and re-holster their pistol. The minimum point score for this stage is 26/40.

I.F.ii.a.4 ***Stage 4.*** The target is placed 5 m away from the cadet. They have 5 s to shoot two rounds to the centre of the target and one round to the head and then re-holster. They will repeat this exact procedure three more times for a total of 12 rounds. The minimum point score for this stage is 40/60.

I.F.iii Final Qualification. This test (see Table 1) is the last evaluation session, and occurs after 6 additional training sessions have been given following the Benchmark 2 assessment session. During this interval the cadet will shoot approximately 891 rounds. The consequences following a failure of the Final Qualification are much more serious than failure of the benchmark assessments. Failure after the first attempt results in additional learning assistance and a second opportunity to pass the Final Qualification; failure the second time can result in termination from the Cadet Training Program. Scoring for this evaluation session is similar to Benchmark 2; however, cadets must achieve a minimum point score of 200/250 and pass each of the 5 Stages. Stages 1-4 are as described in the Benchmark 2 discussion.

I.F.iii.a ***Stage 5.*** This stage requires the cadets to shoot at a target positioned 3 m away. For this stage a cadet must shoot 8 rounds, beginning with one round already in the chamber of the pistol. They must shoot 4 rounds using only their dominant hand, reload with both hands, and shoot 4 rounds using only their non-dominant hand. This is the only stage in which the cadet must complete the Minimum point score which, for this stage, is 26/40.

While this RCMP course-of-fire training program has incorporated “best practices” from both local and international police agencies, there are cadets who are unable to succeed in passing the FQ (i.e., the only firearms test which could result in their termination from the program). Furthermore, each RCMP member needs to demonstrate pistol proficiency by passing the FQ once per year; failure to do so results in remedial training or reassignment to administrative duty until they pass. Although the majority of the cadets who go through training pass the course-of-fire, the factors influencing the acquisition of pistol skills and the subsequent retention of that skill are not well understood.

As discussed earlier, in various studies learning criterion has been operationally defined as either one, or an average of a number of error free sessions. However, because the test for the current study test has five components (Stage 1 – 5), criterion was defined as an error free stage. Therefore, for this experiment, criterion is operationally defined as achieving 100% per stage.

II. Methods

II.A Participants

Participants were recruited from the Department of Psychology Participant Pool, and the Department of Police Studies at the University of Regina. Additional participants were recruited from the civilian staff population at the Royal Canadian Mounted Police Training Academy in Regina (see Table 2 for complete demographics). Ninety-one participants were recruited for this study (53 male and 37 female); however, 6 participants, distributed over all four conditions, were excluded from analysis (2 female and 3 male participants were excluded because they withdrew during the study and 1 female participant moved across country and could not complete the retention test). The remaining participants (N = 85) had a mean age of 33.47 years (SD = 10.35). The design of the study involved two sessions (9 or 18 training sessions), number of shots relative to usual training protocols (usual or double trials), and retention interval (1, 6, or 12 months). Participants were randomly assigned to one of 4 training conditions (i.e., Group A 1154 trials over 9 training sessions, Group B 2308 trials over 9 training sessions, Group C 2504 trials over 18 training sessions and Group D 5008 trials over 18 training sessions) combining these factors, with 6 – 11 participants in each condition. Upon completion of the final test (after their assigned retention interval) the participants had their names entered to win an iPad.

II.B Apparatus and Materials

A computer generated synthetic firearms training environment (AIS, 2007) was used to teach each participant how to shoot. The software used to create the synthetic range environment was PRISim version 4.7 Marksmanship software installed on a Hewlett Packer PC 2.47 (Intel® Core™ i5-4460 processor) running Windows 7.0. This software allows up to 16 participants to simultaneously complete the training; however, most sessions saw no more than 8 participants train at any given time. The targets were projected on a 100 cm X 187 cm screen that was placed 144 cm from the participants. The image was projected onto the screen using a Panasonic Projector PT-FW430U using a wide-angle lens. The standard RCMP issued 9mm Smith and Wesson pistol was used during each training session; however, this pistol had been modified with laser technology that emits a laser burst at the target instead of a live-round, with all live-fire capabilities being disabled. A sensor in the room captured each laser burst and accurately translated this burst into a visual representation of a bullet hole in the target. Each participant was outfitted with a standard issue RCMP duty-belt, which allowed each person to holster their pistol.

Table 1. Demographic Variables

Sex	Male	48 (56.5%)
	Female	37 (43.5%)
Age	Male	33.48 (SD = 10.04)
	Female	32.08 (SD = 11.77)
Handedness	Right	81 (95.3%)
	Left	3 (3.5%)
	Ambidextrous	1 (1.2%)
Vision	Uncorrected	43 (50.6%)
	Corrected (Glasses)	31 (36.5%)
	Corrected (Contacts)	11 (12.9%)
Firearms Experience	None	59 (69.4%)
	Minimal (< 20 Rounds)	22 (25.9%)
	Hunting, target shooting.	4 (4.7%)
Video Game Experience (Hours per month)	Zero	26 (30.6%)
	0.5 – 5 Hours	36 (42.4%)
	5.5 – 10 Hours	16 (18.8%)
	10.5 – 15 Hours	7 (8.2%)
	15.5+ Hours	0 (0.0%)

II.C Design and Procedure

The study was designed to examine three manipulated factors, training distribution (9 or 18 training sessions), practice trials (1x or 2x number of typical shots fired), and retention interval (1, 6, or 12 months), as well as one quasi-experimental factor (overlearning). Specifically, four training conditions (henceforth labeled groups) were conducted: Group A completed 1154 trials over 9 training sessions, Group B completed 2308 trials over 9 training sessions (i.e., twice the number of trials as Group A), Group C completed 2504 trials over 18 training sessions and (Group D completed 5008 trials over 18 training sessions (i.e., twice the number of trials as Group C). The three retention intervals were tested for all groups (i.e., 12 conditions in total). Additionally Group A and C were initially allotted 1 hour to complete each training session, conversely Group B and D were allotted 2 hours. However, as the participants acquired the skill, the length of time needed to complete the number of required trials decreased to 45 and 90 mins respectively.

Following informed consent, each participant received instructions about the experiment. Participants were taught the RCMP pistol course-of-fire in the computerized synthetic training environment. The number of training sessions and trials were determined by their randomly assigned Group. While this study was not designed as a traditional overlearning experiment because overlearning was not manipulated, it is important to note that the experiment was structured to be ecologically valid while combining overlearning with distributed practice. The computer calculated the number of trials and score for each participant.

Before participants began the experiment they were instructed on all aspects of range safety (e.g., where to point the pistol barrel, follow commands of range safety officer), in addition to the correct use of equipment including being fitted with a belt, holster and body armour. Additionally, some participants were provided police training pants because the police belt has snaps that secure to the shooter’s own personal belt. This ensures that the pistol is easy to remove from the holster. Because firearms training includes more than a bullet hitting a target, each participant was taught how to holster and un-holster their pistol, how to shoot using only one hand, and how to shoot from three different positions (i.e., standing, kneeling and prone). One the artefacts of training in a simulated range environment is evident when the target is placed at 25 m and 15 m, but only if the shooter has to change their physical orientation during the stage (e.g., moving from a standing to kneeling to prone position on the same target). Although the target is sized to appear as it would at 25 m, the projected image is only 3.4 m from the shooter. As the shooter transitions from the standing to kneeling to prone positions, the target “follows” the shooter to maintain the same line of sight. This is done in order to maintain shooting accuracy and to present the target as would be evidenced in a real world range environment. Following this, each group was taken to the synthetic range environment to begin their training. Both the initial test immediately following the last training session, as well as the retention test for the 1 month, 6 month or 12 month retention interval test occurred in the simulated range environment.

This research was a lengthy study and in order to measure how motivated and engaged the participants were, each person completed three self-report measures Motivation to Participate (Appendix C), Engagement (Appendix D), Motivation Scale (Appendix E), and the Training Assessment Questionnaire (Appendix F). These self-report measures were completed immediately prior to the test following the final training session.

II.C.i Training Sessions Participants were trained using the RCMP's pistol course-of-fire (Table 3); however, for this study images of targets (Illustration 1) were 3.66 m from the participants, but were sized according to the distance dictated by each stage. Scoring for each stage was determined by where the laser shot registered on the blue silhouetted image of a human head and torso that was projected on the wall in front of each participant. The training that occurred during Session 1 consisted of shooting only at the Benchmark 1 target; however, this target was used in subsequent sessions only as a practice target before the training session began.

II.C.i.a Stage 1 The target for stage 1 was sized to look as it would appear (simulate) at a distance of 25 m, and points were awarded based where on the target the laser hit was recorded. Five-points were awarded for each hit that registered in the two inner ovals of the target (i.e., A and B in Illustration 1), 3-points were awarded for hits that registered in the third oval ring (i.e., C in illustration 1), and 2-points were awarded for registered laser hits in the outer most part of the target as well as the head (i.e., D, E and F in Illustration 1). Any hits that registered outside of the target were not awarded points. Participants were allowed 14 trials for this stage, and were required to shoot from three different positions, as described above. Participants were required to complete this stage in 120 s or less and were scored out of a maximum of 70 points.

II.C.i.b Stage 2 The target for stage 2 was sized to simulate a distance of 15 m. Participants were allowed 8 trials over 20 s to complete this stage and were scored out of a maximum total of 40 points. Hits were scored the same as for stage 1.

II.C.i.c Stage 3 The target for stage 3 was sized to simulate a distance of 7 m and were scored out of a maximum total of 40 points over 8 trials, and scored as in the previous stages. This stage did not require the participant to complete all trials concurrently; instead the participant was given 2 s to register 2 hits on the target. Following the 2 s, the target faced away from the participant for 8 s. This allowed the participant to take 2 steps left before the target turned to face the participant. Once the target turned, the participant had 2 s to register 2 hits on the target before it turned to face away from the participant. This procedure repeated 2 more times for a total of 8 trials between 4 facings.

II.C.i.d Stage 4 The target for stage 4 was sized to simulate a distance of 5 m and were scored out a maximum of 60 points over 12 trials. As with stage 3, this stage did not require the participant to complete all 12 trials concurrently. Instead when the target faced the participant, they had 5 s to remove their pistol from their holster and register 2 hits to the body and 1 hit to the head. Once the allotted time had elapsed, the target faced away from the participant at which time they had to return their pistol to their holster. Following a delay of 8 s the participant repeated this process three more times for a total of four exposures.

II.C.i.e Stage 5 The target for stage 5 was sized to simulate how it would appear at a distance of 3 m and were scored out a maximum of 40 points over 8 trials. This is the only stage that required the participants to complete the task using only one hand. Once the target faced the participant they had to remove their pistol from their holster. Using their dominant hand they had to register 4 hits on the target then reload before transferring the pistol to their non-dominant hand and register an additional 4 hits on the target. Participants had 15 s to complete this stage.

II.C.ii Scoring Each stage produced a raw score between 0 and 5 for each registered hit on the simulated target. The computer tabulated the scores by stage for each participant; however, the database did not allow for the transfer of data directly into SPSS (SPSS 21.0), so all data was entered by hand for later analysis. Raw scores were converted into a percentages based on the maximum score allowed per stage, and these percentage scores were used for all analyses.

For the final training test (analogous to FQ), participants were tested 2 – 3 days following their last training session. Before this test, participants were allowed 18 practice trials on a target that was sized to simulate a distance of 15 m. These practice trials allowed the participants to re-familiarize themselves with the pistol, aiming, and trigger weight. Once all 18 practice trials had been completed, the participants were sequentially tested on stages 1 through 5 (i.e., Test). For the retention test portion participants from each Group were randomly assigned to one of three retention intervals; (i.e., 1 month, 6 months or 12 months following their initial test).

II.D Results

A performance curve was plotted using participant data over 9 training sessions (Figure 1) or 18 training sessions (Figure 2). What was observed in both instances was after an obvious increase, performance appeared to asymptote around the 9th session of training, regardless of the training condition

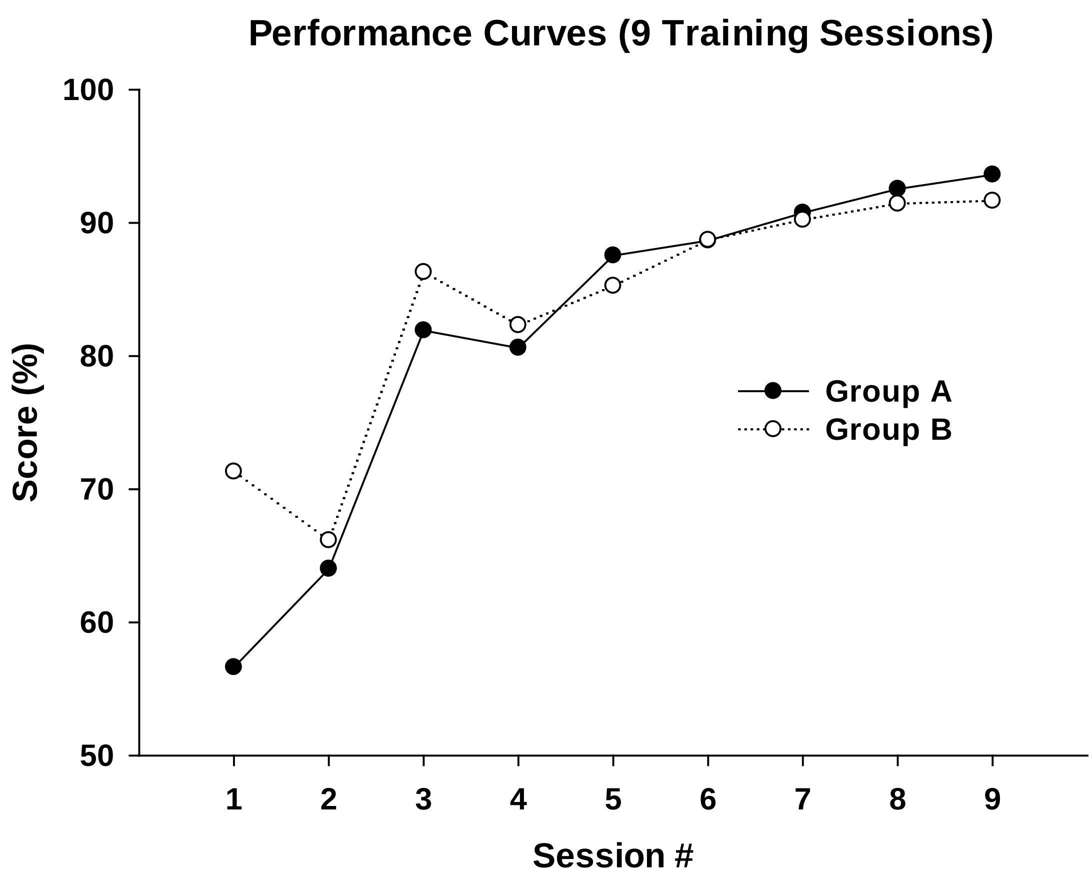


Figure 1. Performance Curves
Note. Group A = 9 Training Sessions, 1154 Trials, Group B = 9 Training Sessions, 2308 Trials

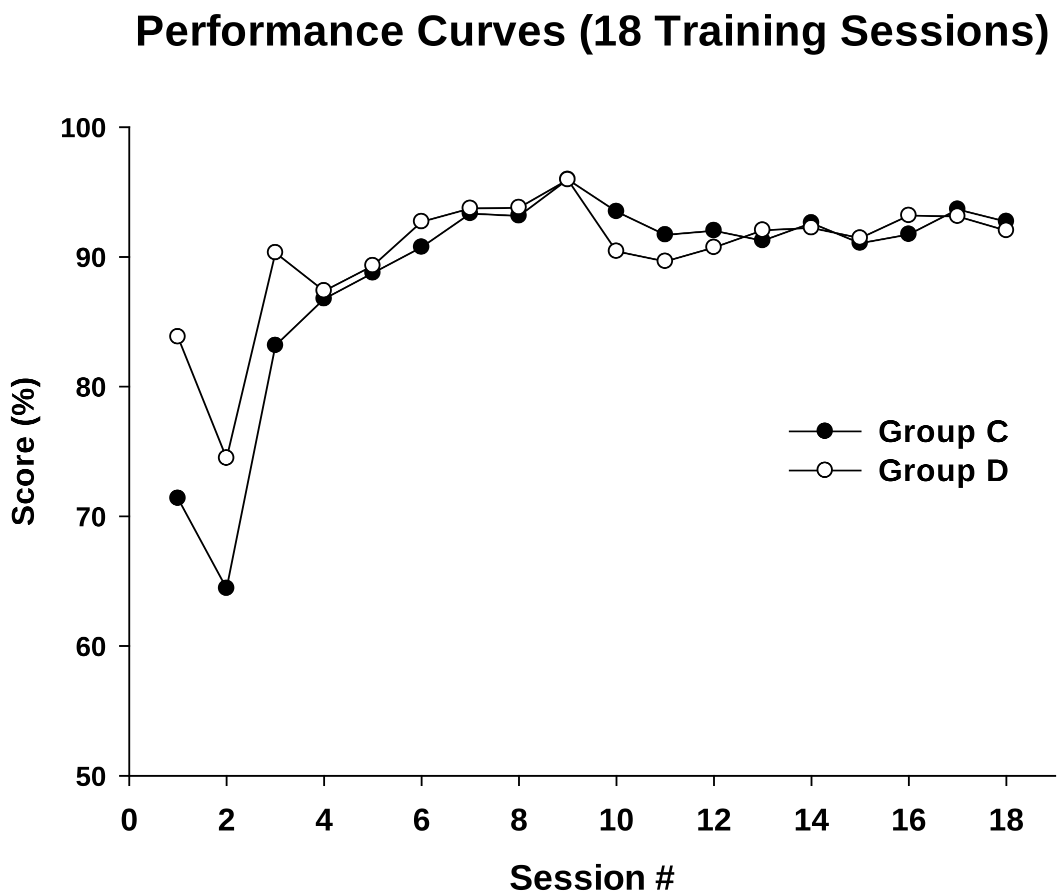


Figure 2. Performance Curves Group C = 18 Training Sessions, 2504 Trials, Group D = 18 Training Sessions, 5008 Trials

Although not part of the study, a performance curve (Figure 3) was plotted using archival RCMP (RCMP, 2015) cadet data (N = 1203), and while there is a minimum number of hours cadets receive in training, if time allows then extra time can be spent on the firearms range, which results in some cadets receiving up to double the number of trials than their peers. It should also be noted that such extra trials are confounded with distributed practice, since these extra sessions occur after hours after the training has concluded; however, the performance curves for cadets and the participants of this research are similar.

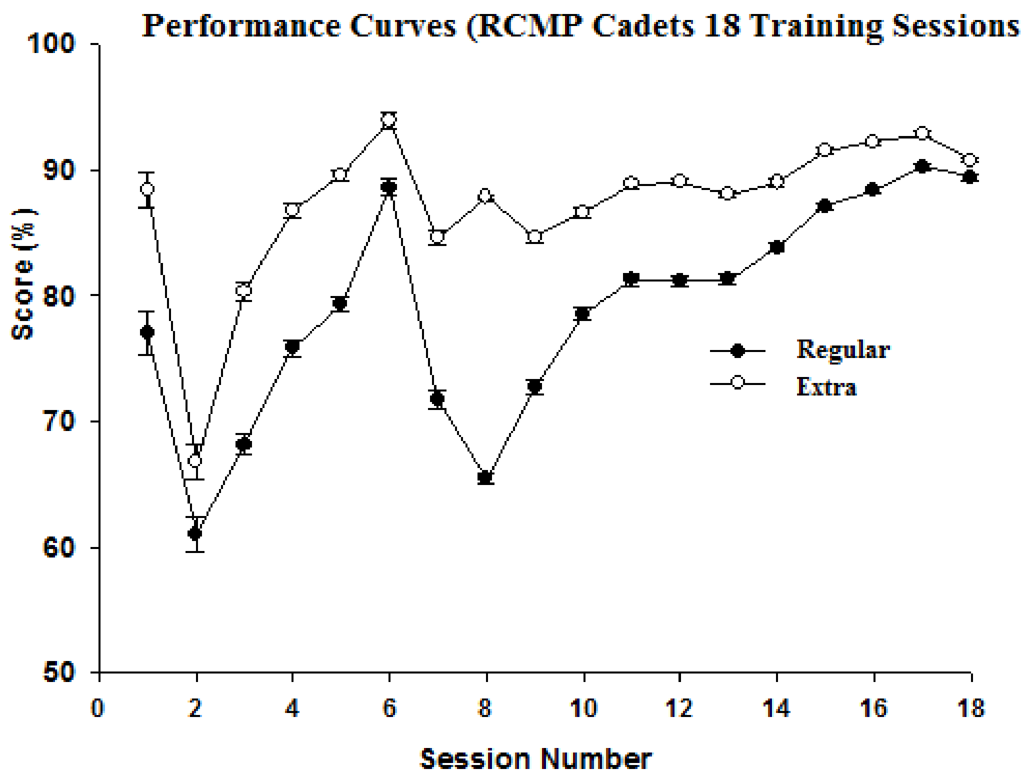


Figure 3. Performance Curve (Police Cadets)
Note. Regular = the number of trials cadets would typically receive in their respective training session, Extra = the number of trials cadets received in addition to their minimum training requirement.

Distribution and Retention Interval

Study participants' scores were analyzed using a 2 (Test session; Test, Retention Test) x 2 (Sessions; 9 vs 18) x 3 (Retention Interval; 1 month, 6 months, 12 months) Repeated Measures ANOVA with Session and Retention Interval as Between Subjects factors. This analysis indicated a main effect of Session, $F(1,77) = 17.26$, $MSE = 24.03$, $p < .001$ (Figure 4), with scores higher for participants who trained over 18 sessions (94.88%) vs 9 sessions (91.68%). There was also a main effect of Test, $F(1,77) = 4.95$, *MSE* = 10.71, *p* = .029, with higher scores for Test (93.84%) vs. Retention Test (92.72%). All other results were *p* > .05 (see Table 2 for complete means).

Table 2. Mean Percentage Scores by Group, Retention Interval, Test and Retention Test

Retention Interval	Training Condition	Test Mean	Test SE	Retention Test Mean	Retention Test SE
1 Month	9 Sessions	91.94	1.23	89.63	.976
	18 Sessions	96.14	1.12	95.48	.886
6 Months	9 Sessions	94.08	1.19	92.40	.943
	18 Sessions	95.14	1.23	92.91	.976
12 Months	9 Sessions	90.87	1.39	91.16	1.10
	18 Sessions	94.90	1.33	94.70	1.06

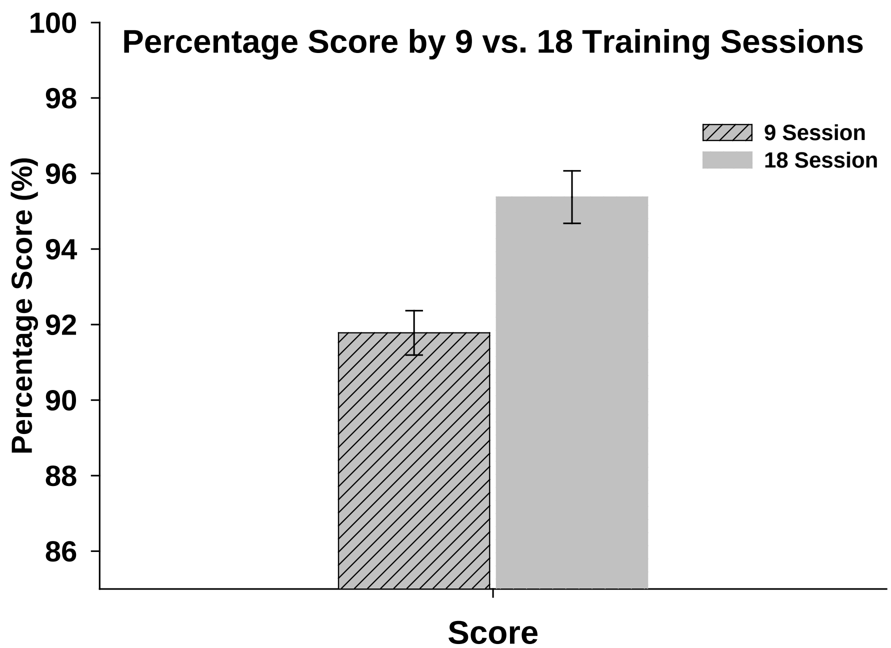


Figure 4.
Note. 9 Sessions = Groups A and B; 18 Sessions = Groups C and D; Error bars ±1.96 SE=95%CI

Although there was no effect of retention interval in the overall analysis, examining the effect of learning durability by retention interval was a central purpose of the present study so scores for each retention interval were examined using independent t-tests to compare retention test scores as a function of training sessions. These analyses indicated that the effect of distributed learning (9 vs. 18 sessions) was significant at the 1 month retention interval: 9 sessions (M = 89.63, SD = 6.17) vs 18 sessions (M = 95.48, SD = 1.57); $t(14.39) = -3.46$, $p < .004$; and at the 12 month interval: 9 sessions (M = 91.16, SD = 2.56) vs. 18 sessions (M = 94.70, SD = 2.95); $t(20.95) = -3.081$, $p = .006$); however, differences were not significant at the 6 month retention interval (Figure 5 and Figure 6).

Trials

Independent t-tests were conducted between Group B and Group C to determine whether group differences were entirely attributable to the number of sessions as opposed to the number of practice trials (Group B; 2308 trials over 9 sessions, and Group C; 2504 trials over 18 sessions). Although the number of trials are not identical between the two groups (8.4% more trials in Group C vs. Group B; or 10.8 additional trials per session) the difference in the number of trials was not likely large enough to substantively influence learning. The previous overall analysis indicated that participants who received training over 18 sessions scored higher than those who received 9 sessions. The t-test analysis between Group B and Group C were consistent with those previous findings for both test and retention test: Group B (M = 90.73, SD = 5.77) and Group C (M = 95.20, SD = 2.98) at test, $t(31) = -2.82$, $p = .008$ (Figure 7); and retention test, $t(31) = -2.44$, $p = .021$ (Figure 8), Group B (M = 90.88, SD = 5.83) and Group C (M = 95.04, SD = 3.81).

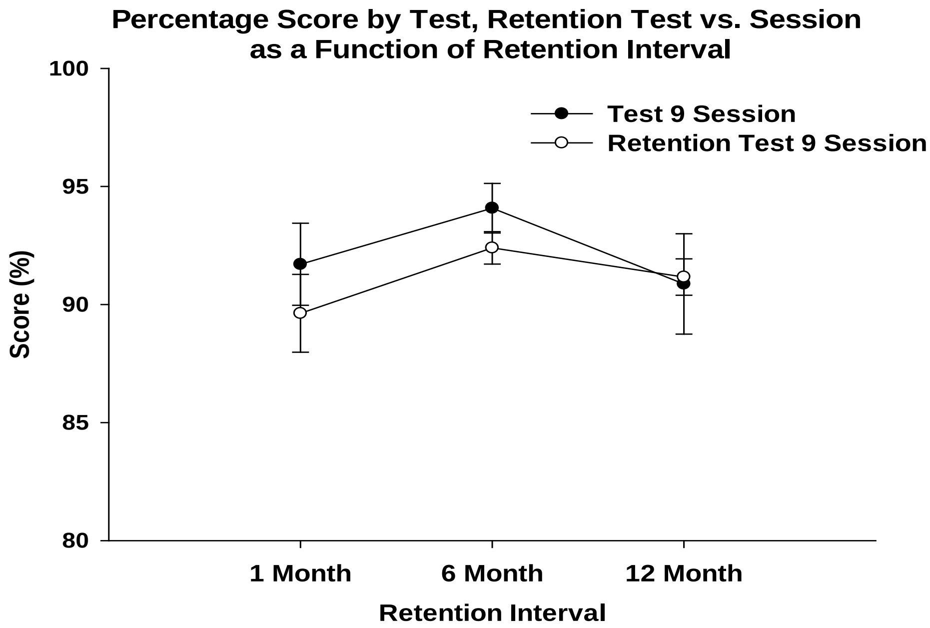


Figure 5.
Note: Participants who received Test = Immediate test following completion of the last training session; Retention Test at the 1, 6 or 12 month retention interval;
Error bars ±1.96 SE=95%CI .

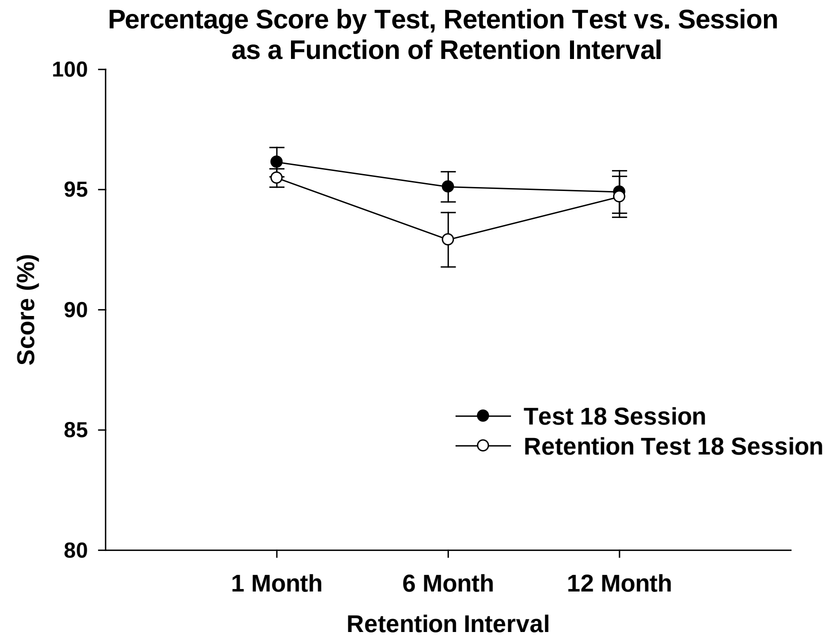


Figure 6.
Note: Participants who received Test = Immediate test following completion of the last training session; Retention Test at the 1, 6 or 12 month retention interval;
Error bars ±1.96 SE=95%CI .

As another test of the influence of the number of trials, independent t-tests were conducted between Group C and Group D to determine whether doubling the number of trials over the same number of training sessions influenced learning and retention. These analyses found that doubling the trials over the same number of sessions had no significant effect on either test, Group C (M = 95.20, SD = 2.98 vs. Group D (M = 95.63, SD = 2.41), $t(41) = -.522$, $p = .605$ (Figure 7) or retention test outcomes, Group C (M = 95.04, SD = 3.81) and Group D (M = 94.03, SD = 2.66), $t(41) = 1.02$, $p = .314$ (Figure 8). Given the insignificant effect of doubling the number of trials, it is likely that the small increase in the number of trials between Groups B and C had no impact on the validity of that comparison.

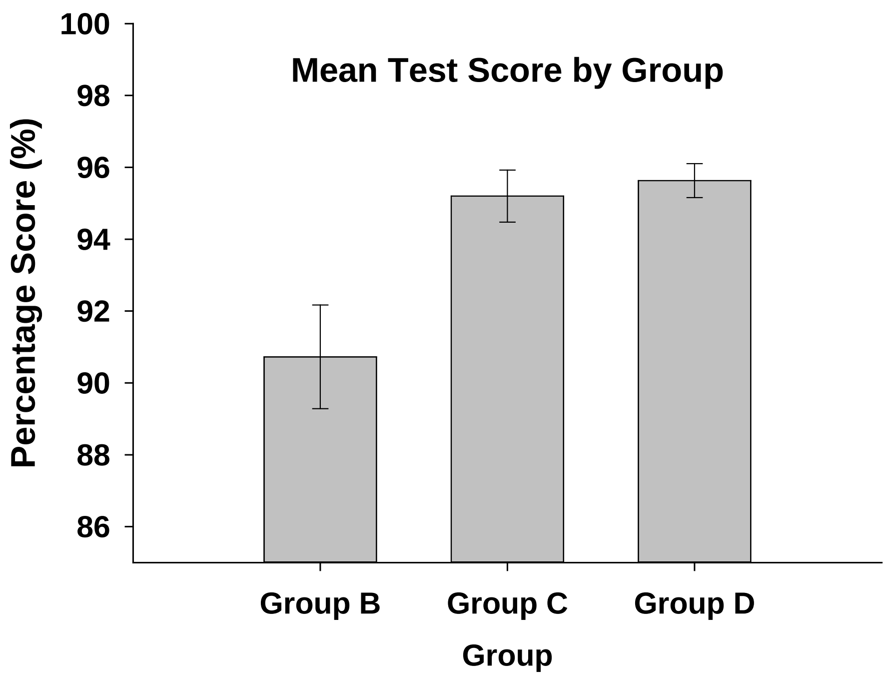


Figure 7.
Note. Group B (over 9 sessions) was used to compare test scores between Group C (over 18 sessions), as the overall number of trials was similar. Comparisons were also made with Group D, which had the same number of sessions as Group C but double the trials. Error bars ±1.96 SE=95%CI

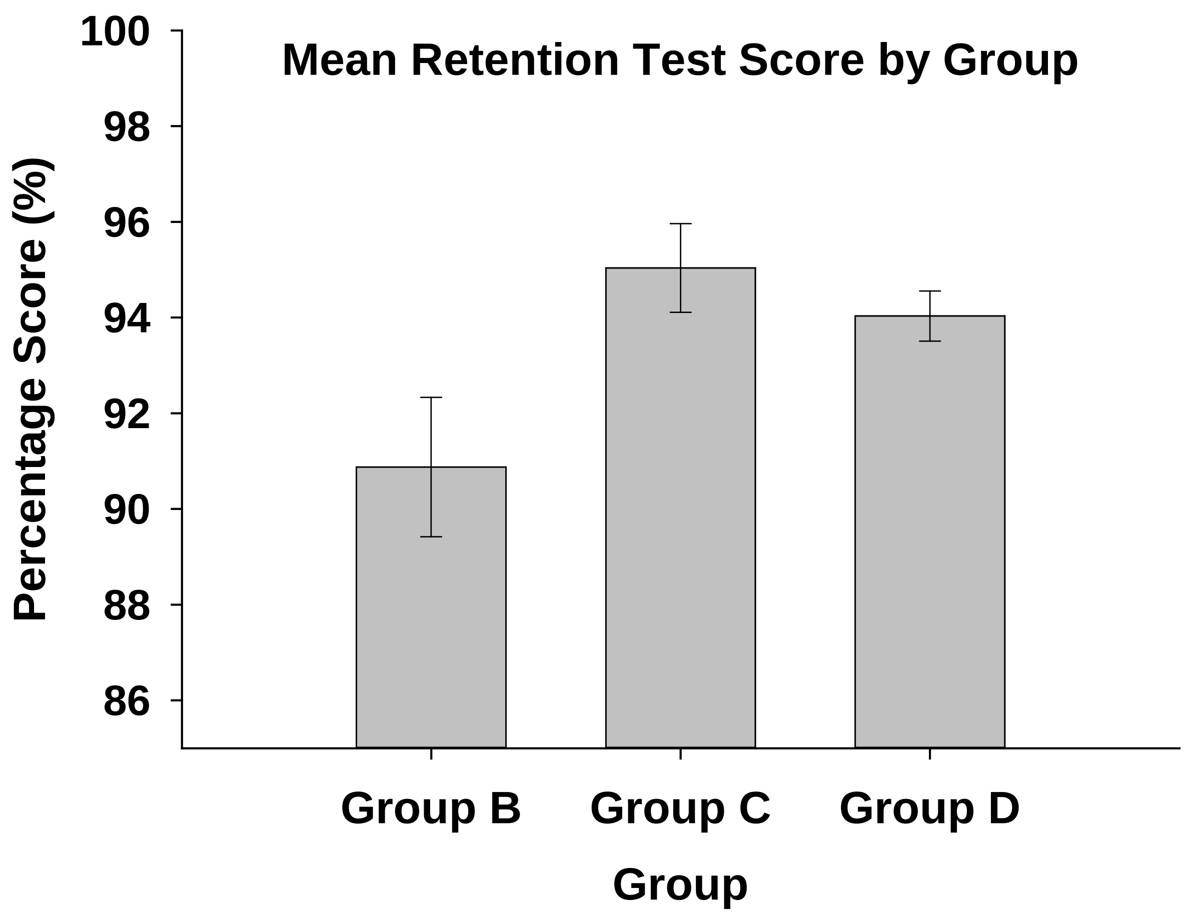


Figure 8.
Note. Group B (over 9 sessions) was used to compare retention test scores between Group C (over 18 sessions), as the overall number of trials was similar. Comparisons were also made with Group D, which had the same number of sessions as Group C but double the trials. Error bars ±1.96 SE=95%CI

II.D.i Overlearning Overlearning was defined as when criterion was achieved in at least one of the first four stages of the test (i.e., a score of 100 percent). Stage 5 was not included in this determination because 67 (78.8%) of the participants achieved 100% on this stage. Thus overlearning was coded based on how many stages that criterion was achieved (i.e., 0 = no overlearning, 1 = criterion achieved on one stage, 2 = criterion achieved on two stages, 3 = criterion achieved on three stages, 4 = criterion achieved on 4 stages). Inspection of the data revealed that overlearning on the first four stages was achieved by only one participant and this participant was thus excluded from this analysis. As a result, the overlearning analysis was based on data for those participants who achieved criterion on 0 – 3 stages. A One-way ANOVA of Retention Test scores by 4 levels of Overlearning (0, 1, 2, 3) was conducted to determine if overlearning influenced skill retention (Figure 9). This analysis was significant, $F(3,79) = 5.03$, $p = .003$. Retention test scores were lowest when no overlearning was observed (0 overlearning = 86.50% vs. 1 overlearning = 92.71% vs. 2 overlearning = 93.77%, 3 overlearning = 93.10%; see Figure 10). Bonferroni Post Hoc Tests indicated that the only significant differences were between participants who had 0 instances of overlearning and all other values of overlearning (92.71% - 93.77%).

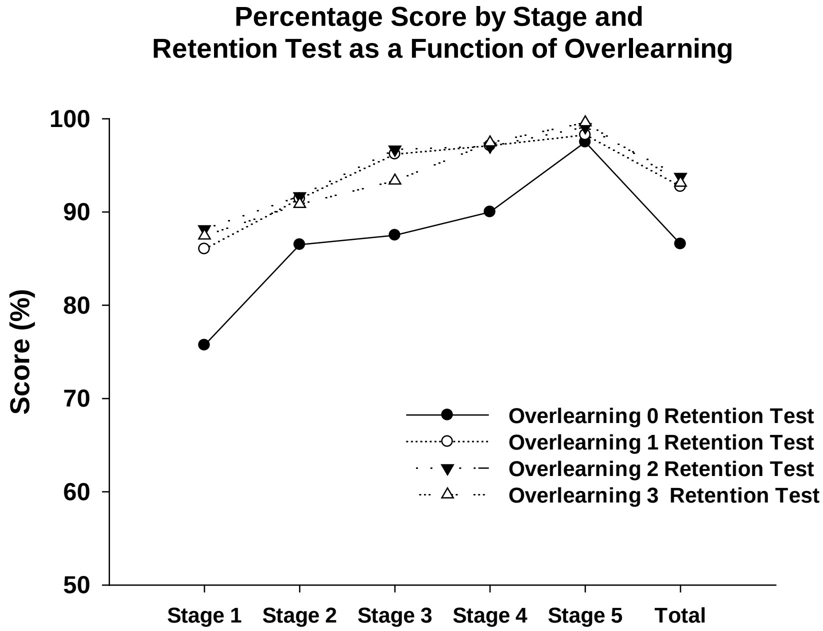


Figure 9. Note. Although overlearning is relevant only to retention test scores, test scores are included to enable examination of retention based on learning achievement.

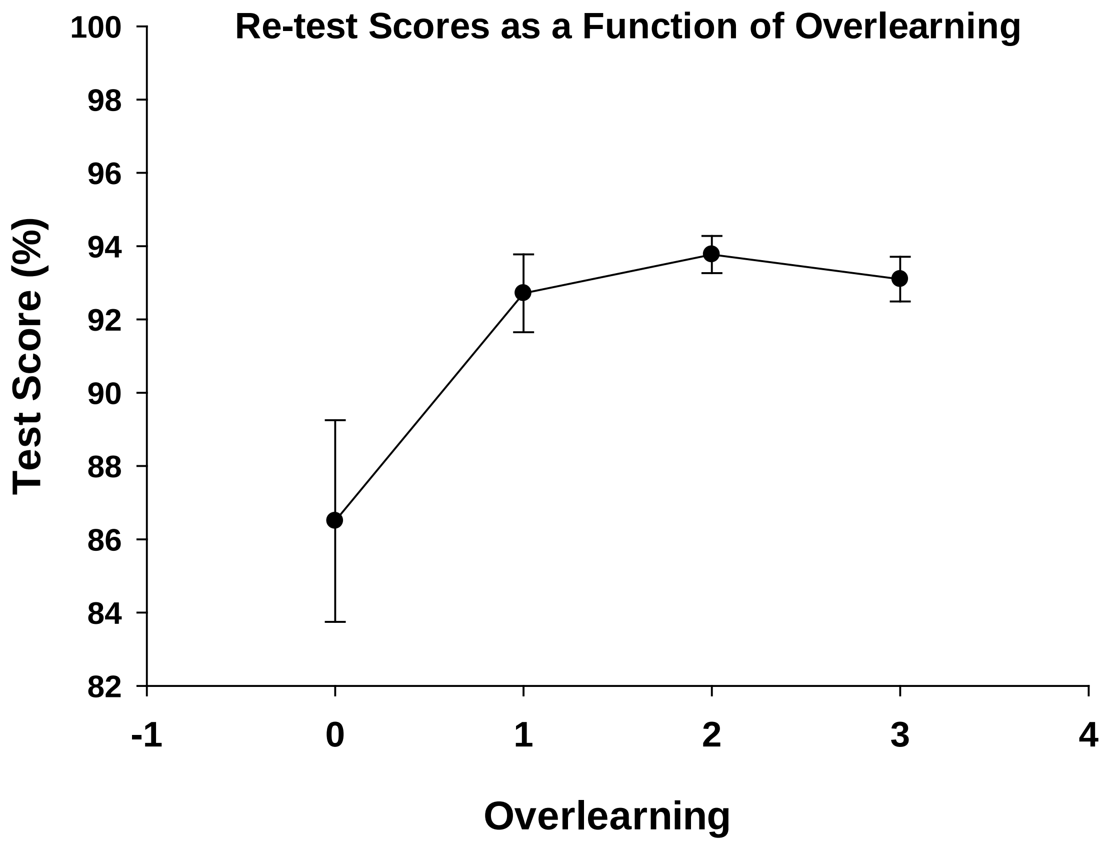
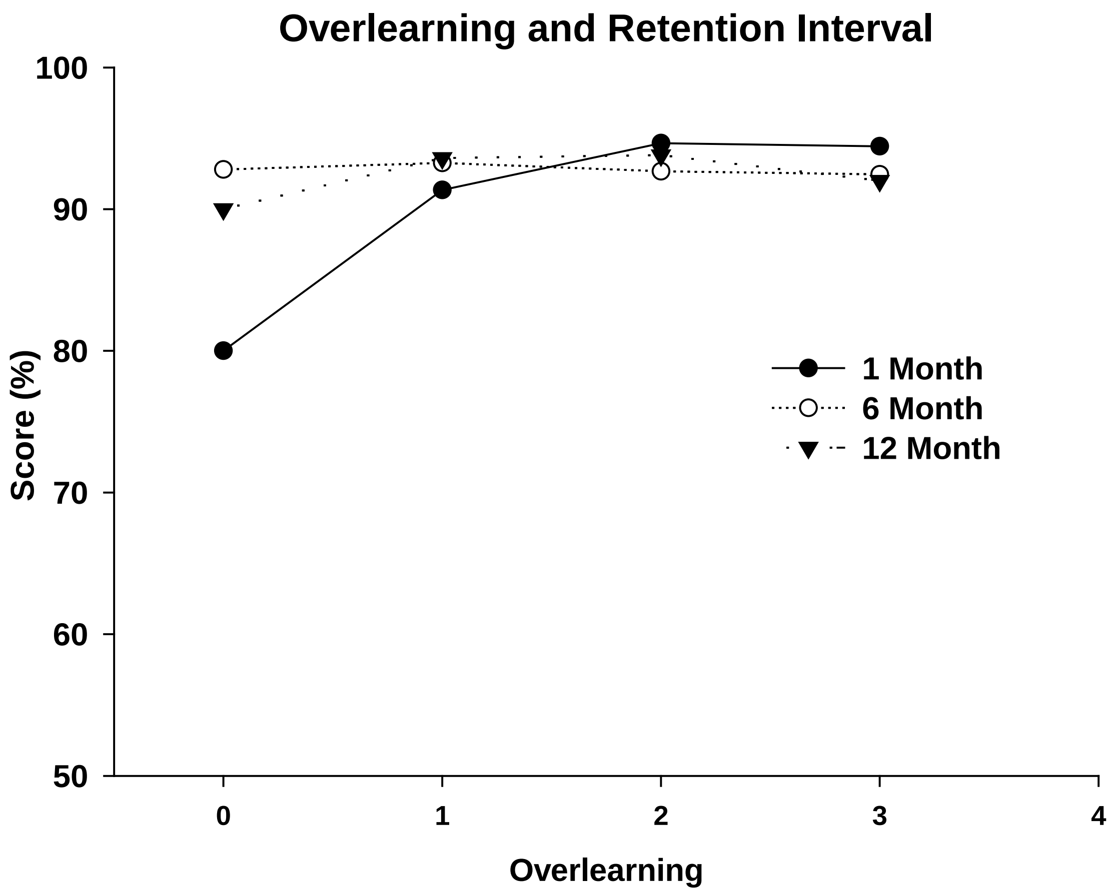


Figure 10.
Note. 0 = Overlearning not achieved, 1 = Overlearning achieved on 1 stage, 2 = Overlearning achieved on 2 stages, 3 = Overlearning achieved on 3 stages. Error bars ±1.96 SE=95%CI

Overlearning and Retention

The key purpose of this study was to examine whether skill retention is influenced jointly by overlearning and retention interval. Thus a 4 (Overlearning; 0, 1, 2, 3) x 3 (Retention Interval; 1 month, 6 months, 12 months) ANOVA was conducted with retention test scores as the dependant variable. This analysis indicated a main effect of overlearning with retention test scores lower for those where no overlearning was observed, $F(4,68) = 3.27$, $p = .016$, as in the analysis above. There was an overlearning x retention interval interaction, with retention $F(7,68) = 2.33$, $p = .034$ (Figure 11).

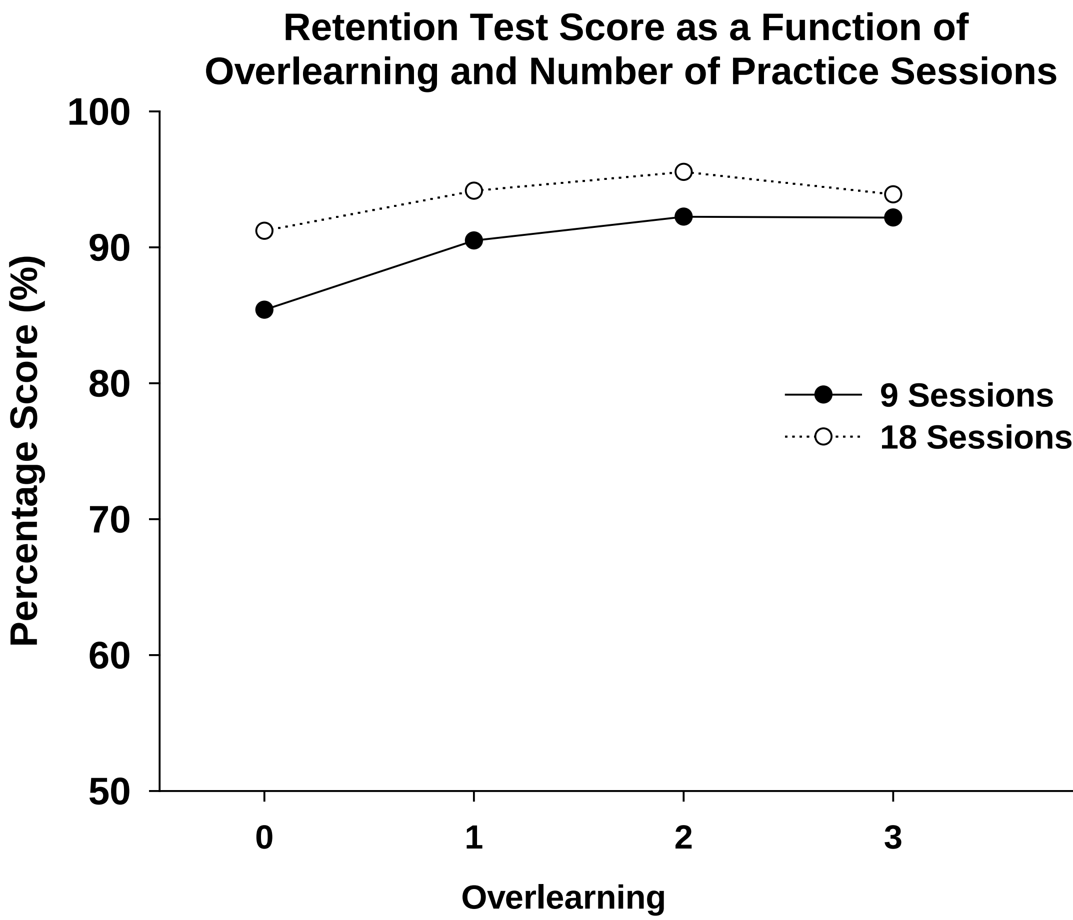


$R^2 = .332$, Adjusted $R^2 = .205$

Figure 11.

Note. 0 = Overlearning not achieved, 1 = Overlearning achieved on 1 stage, 2 = Overlearning achieved on 2 stages, 3 = Overlearning achieved on 3 stages.

Given the significant influence of distributed learning, Retention test scores were examined using a 2 (Session; 9 sessions, 18 sessions) x 4 (Overlearning; 0, 1, 2, 3) ANOVA. As in previous analyses, a main effect of overlearning was observed with retention test scores increasing as the number of instances of overlearning increased, $F(4,73) = 2.66$, $p = .039$, no other differences were observed ($p > .05$; Figure 12).



$R^2 = .310$, Adjusted $R^2 = .235$

Figure 12.

Note. 0 = Overlearning not achieved, 1 = Overlearning achieved on 1 stage, 2 = Overlearning achieved on 2 stages, 3 = Overlearning achieved on 3 stages.

II.D.ii Skill Durability Skill durability was calculated using the Reliable Change Index (RCI; Jacobson & Truax 1991; Maassen, 2004). Jacobson and Truax (1991) posit that effects which are found when statistical comparisons are made between mean changes between a treatment and control group, can be problematic. Jacobson and Truax (1991) argue that when standard statistical procedure were used that clinical treatments appear less effective when RCI is employed. Positive scores indicated lower durability (i.e., retention test scores lower than test scores), whereas negative scores indicated higher durability (i.e., retention test scores higher than test scores). A 3 (retention interval; 1, 6, 12 months) x 2 (Session; 9 Sessions, 18 Sessions) ANOVA was conducted with durability as the dependant variable and no significant results were observed; however, durability nominally decreased as the retention interval increased for both the 9 session and 18 session groups.

A 4 (Overlearning; 0, 1, 2, 3), one-way ANOVA of durability scores was conducted to investigate the effects of overlearning on skill durability. A main effect was observed, $F(4,77) = 3.04$, $p = .013$ indicating that overlearning did influence durability. The means indicated a linear increase in durability with increasing overlearning (0 Overlearning = .593 vs. 1 Overlearning = .000 vs. 2 Overlearning = -.123 vs. 3 Overlearning = -.723; (Figure 13).

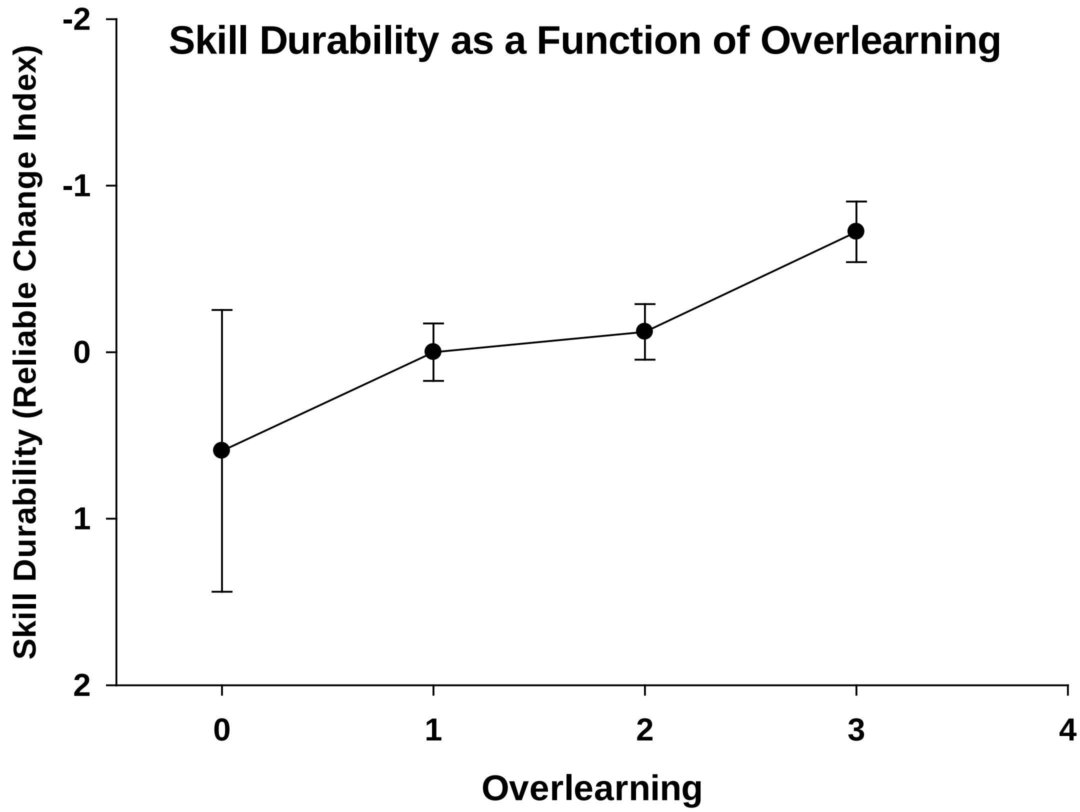


Figure 13.
Note. Positive scores = lower durability, negative scores = greater durability, 0 = Overlearning not achieved, 1 = Overlearning achieved on 1 stage, 2 = Overlearning achieved on 2 stages, 3 = Overlearning achieved on 3 stages; Durability scores 0.001 to 6 = Retention test scores lower than test scores; Durability scores -.001 to -10 = Retention test scores higher than test scores. Error bars ±1.96 SE=95%CI

II.D.iii Correlations Demographic information was collected (i.e., age, handedness, eyesight, previous firearms experience, videogame experience, sex,) and correlations were calculated between these variables, design factors, and Test and retention test score performance (see Table 3). Age and Eyesight were positively correlated (r = .269, p = .013). Test scores were correlated with the average number of hours spent playing Videogames (r = .270, p = .013); however, the number of Videogame hours and Retention test scores were not correlated (p = .102). Sex (M = 1, F = 0) and

Test scores were positively correlated (r = .253, p = .021) as were Sex and Retention test scores (r = .265, p = .016). Consistent with the ANOVA analyses, number of Sessions were positively correlated with both Test (r = .345, p = .001) and Retention test (r = .406, p < .001) scores. Test scores and Retention test scores were also correlated (r = .508, p < .001).

Table 3. Pearson's Correlations

	Age	Hand	Eye	Fire	Video	Sex	Session	Test	Retention Test
Age	--								
Hand	.196								
Eye	.269*	-.058							
Firearms	-.038	-.030	.021						
Video	-.142	-.012	-.013	.061					
Sex	.003	.013	.080	.075	.049				
Session	.266*	-.217*	.199	-.246*	.089	.141			
Test	-.158	-.165	-.027	.027	.270*	.253*	.345*		
Retention Test	-.083	-.244*	.124	-.088	.211	.265*	.406**	.508**	--

* p < .05; ** p < .001
Note. Hand = Handedness (1 = left, 2 = right, 3 = ambidextrous); Eye = Eyesight (0 = not corrected, 1 = corrected with glasses, 2 = corrected with contacts); Fire = Firearms Experience (0 = none, 1 = less than 20 rounds, 2 = hunter); Video = Average Hours per week Playing Video Games.

At the beginning of the experiment, each participant completed four questionnaires designed to measure personal engagement and motivation. Pearson's Correlations were conducted between these self-report measures and Test, Retention test, and Durability scores. The motivation scale included 7 subscales (Intrinsic-know, Intrinsic-accomplish, Intrinsic-experience, Identified, Introjected, External, Amotivation). Intrinsic-know was negatively correlated with durability, r = -.313, p = .004, and positively correlated with test, $r = .239$, $p = .030$. Motivation to participate was negatively correlated with durability, $r = -.287$, $p = .009$, and positively correlated with test, $r = .280$, $p = .011$. Engagement questionnaire scores were positively correlated with durability, $r = .230$, $p = .038$, and negatively correlated with test, $r = -.235$, $p = .032$.

II.E Discussion

In most professions, employees are required to complete tasks in a timely and accurate fashion. Consider, for example, a cashier at a grocery store. For novices, learning the functions of the cash register, or discovering that there is more than one type of apple for sale, can result in extra time being required to process a customer’s order than would be evidenced with a cashier who had been there for several years (which may be why novice cashiers often wear a badge indicating that they are in training). Over time, as the cashier continues the repetitive nature of the job, their errors decrease and the speed in which they perform their job increases, and they are performing at or near criterion during each shift. However, what happens if an infrequently used skill is needed without the benefit of practice, but performance errors can mean the difference between life and death? This is the case when police officers are called upon to use their pistol.

Police agencies the world over conduct training in a variety of domains (e.g., fitness, interviewing, shooting); yet, for the most part their approach to training is primarily based on best practices, tradition, policy, or court decisions, instead of using a scientific approach. Although North American agencies lag behind their European colleagues, law enforcement agencies in Canada have recently begun to solicit assistance from academia. Although many police agencies have long employed scientific experts in areas such as forensics, explosives, or behavioural analysis, as well as statisticians who analyze crime data, it is only recently that senior management in some police agencies have turned to science to help provide with them with evidence to direct policy decisions or enhance training. It is in the area of induction training (i.e., skills and knowledge acquisition), or ongoing training and re-certification (e.g., police driver training, or firearms re-qualification) that science has most often been overlooked. It is these areas that have traditionally been guided by best practices, policy, court decisions, or the frequently heard "we have always done it that way."

This last statement is particularity salient as police firearms training has remained largely unchanged (e.g., revolver to semi-automatic pistol, target image change) over the past 100 years (Charles & Copay, 2002; Morrison & Vila, 1998; Rotek, Kaminski, Smith, & Scheer, 2007). In fact the amount of time spent on pistol training varies greatly between police forces (Marion, 1998), a finding that is problematic considering that there is no empirical evidence guiding police educators on the optimal amount of training that is required to 1) acquire a skill, and 2) to retain the skill when proficiency needs to be demonstrated in an use-of-force setting (Morrison & Vila, 1998). With increasing public scrutiny (e.g., use-of-force instances), budgetary pressures (e.g., training costs), and environmental concerns (e.g., lead abatement) there is now growing interest amongst police leaders and educators to re-evaluate training to ensure that police are optimally trained to perform their duties in the field.

The present research was developed using a police-training model, a model which does not have a standardized approach to the acquisition of skills. Regardless of the length or content of training, most police officers must obtain a minimum level of proficiency in a number of areas including police driving, law, defence, and shooting. The paucity of scientific evidence that indicates whether training duration, content, and measurement criteria are empirically sound, instead of being informed by economic policy, best practices, or other factors, may severely hamper the effectiveness of long-term police performance.

One tool that has historically remained a constant for most police officers is the handgun (i.e., revolver or pistol); however, the amount of training that a police officer receives varies greatly. For example municipal police officers in Illinois are trained over a 10-14 week period, whereas the Illinois State police are trained over 26 weeks. In Canada this disparity is also evident. Saskatchewan mandates 16 weeks of training for their municipal police officers, Ontario requires 12 weeks, and Manitoba requires 37 weeks. Members of the Royal Canadian Mounted Police complete 24 weeks of training, while police in many European countries complete their training as part of their University education over a four year period. The Federal Law Enforcement Training Center (FLETC) in the United States receives an industry average of approximately 10 hours of on-range pistol training, whereas the Royal Canadian Mounted Police (RCMP) receive an industry high of approximately 24 hours of on-range instruction. These findings suggest that the number of hours spent training (1 vs. 2) are less important than the number of sessions (e.g., nine 2-hour sessions vs. eighteen 1-hour sessions).

While the amount of initial training is varied, the retention interval used for pistol re-qualification (skill durability) is also disparate. General Duty officers in the RCMP have a mandated retention interval of 12 months, as do police officers in Illinois, whereas Federal US Marshals and New York City Police officers have a retention interval of 6 months, and there are examples of retention intervals of 1 to 24 months (or longer) documented for other police agencies. In fact in some jurisdictions, the government is the authority that determines the retention interval (e.g., Ontario Ministry of Community Safety and Correctional Services). This inconsistency in training duration and retention interval highlights the need to investigate pistol skill acquisition and retention. An extensive review of the literature revealed no scientific evidence to support how much training was needed to acquire pistol shooting skills, nor what the retention interval should be based on the amount of training received. The results of this research have provided some of the first empirical data in the area of skill acquisition and retention and the effects of overlearning.

The results of the present study indicate that longer periods of training (18 weeks) resulted in better retention of motor skills than did training of shorter duration (9 weeks), independent of the number of practice trials achieved during training sessions. Whether skill can be increased with even longer distributions of training (e.g., 24 or 37 weeks) remains to be investigated. These results also suggest that the retention interval prior to re-certification has little impact on skill durability, but that overlearning during initial training does.

Pear (1928) argued that most motor skill acquisition was dependent on habit. In other words, attempting a task only once would not normally result in proficiency in performing that task. Although the focus of this research was to investigate skill acquisition and retention, how skills are acquired and the significance of criterion is often overlooked in applied research. For example, employment training programs are set at pre-determined lengths, and can consist of a number of areas in which the employee needs to demonstrate a minimum level of knowledge or proficiency. Although this is not the case for all careers (e.g., I am not sure that anyone would want a physician performing surgery after demonstrating only some knowledge of the task), it is true for those jobs that require minimal training time, the expectation is that performance increases will occur as the task is repeatedly completed after employment has been obtained.

In the present study, participants were trained to complete the Royal Canadian Mounted Police (RCMP) pistol Course-of-Fire (CoF) in one of four conditions (i.e., 9 sessions =1154 trials, 9 sessions double the trials = 2308 trials, 18 sessions = 2504 trials, 18 sessions double the trials = 5008 trials). Although this is not a true factorial design, it is ecologically valid as these are the options that are most representative of what would be expected during the RCMP pistol CoF. Following the conclusion of the research, performance curves were plotted for all four groups (Figures 1 & 2). After an obvious increase, performance appeared to asymptote around the 9th session of training, regardless of the training condition. This finding is similar to what is observed with RCMP cadets as they progress through training (Figure 3). On the basis of this evidence, the temptation is to cease training at this point as it seems intuitive that if performance increases are negligible after 50 percent of the training has been completed, then perhaps training could conclude at this point. While this may be appealing to managers who are responsible for their respective budgets, the results of the present study suggest that ending training at the 9th session asymptote would be a mistake for skill durability.

The analyses of sessions and retention interval indicated that participants who trained over 18 sessions performed better than those who trained over 9 sessions. This was true even for those who received a similar number of trials (Group B vs. Group C). These results suggest that the number of trials alone does not predict performance, a finding that partially supports early work in this area by Ruch (1928). The findings of the present research appear to support this argument. Although Ruch's research was conducted almost 100 years ago, there has been a vast amount of distributed practice research conducted since (e.g., Cepeda, Pashler, Vul, Wixted, & Roher, 2006) illustrating the effects of both massed and distributed practice on retention.

Comparison of less (Group B) and more distributed practice (Group C) with a similar number of trials found that both the initial test and retention scores were significantly higher when practice was distributed over 18 sessions. Similarly, doubling the number of trials within 18 sessions (Group C vs. Group D) showed no differences at test or retention. This finding suggests that although providing distributed practice during the initial stages of practice does affect both scores during the initial test and at retention, a massed practice approach over the same number of sessions (doubling trials) does not impact the overall scores either negatively or positively during either the test or retention. These results suggest that using a distributed practice approach (with or without overlearning) to acquiring and retaining pistol shooting skills can be used over 18 sessions. While it may be appealing to reduce the number of training sessions, these results suggest that reducing the overall number of training sessions has a negative effect on both acquisition and retention. This finding provides some evidence that is needed to dissuade reducing the number of training sessions that RCMP cadets receive during their pistol training, despite the apparent asymptote of learning observed at the 9-session mark. Further research is necessary to determine whether distributing training even further (e.g., 37 weeks in Manitoba) further improves learning.

Just as training duration has not been studied, the RCMP and a host of other police forces use a retention interval before recertification that has not been empirically validated. For this reason, the current study measured skill retention across 1, 6 and 12 month retention intervals. The results indicated that retention interval had no impact on scores. Across all retention intervals, those who trained for 9 sessions performed more poorly than those who trained for 18 sessions (1 month 90.23 vs. 95.67; 6 months 92.40 vs. 95.05; 12 months 91.16 vs. 96.09). Training over 9 vs. 18 sessions resulted in 3 to 5 percentage point difference in scores, a difference that could ultimately mean that a threat is either stopped or not stopped. Thus, the important issue for firearms accuracy is training duration, not retention interval between re-certifications.

Rawson and Dunlosky (2011) found that very few studies investigated how durability and learning could be maximized through practice. Although researchers have been investigating durability and learning, very few scientists have examined these together, let alone attempt to answer how much practice is needed to both acquire and retain a skill. Kornell and Bork (2007), Bahrick and Hall (2005), and Karpicke (2009) are among many researchers who have investigated the effects on cognitive performance after criterion has been achieved (e.g., one errorless trial), yet it is surprising that criterion was never manipulated to determine the effects on performance after a period of delay, nor were there studies that manipulated both criterion and retention interval. For cognitive tasks, Nelson, Leonesio, Shimamura, Landwehr, & Narens (1982), and Rawson and Dunlosky (2001) found that performance accuracy increased when criterion increased from one errorless trial to 10 errorless trials over a 4 week retention interval.

The results of the current study indicate that motor skill performance improved when overlearning increased from 0 to 4 (see Figure 10 and Figure 11), tested over much longer (4 – 52 weeks) retention intervals. As indicated earlier, there is a paucity of longitudinal research with retention intervals longer than 4 weeks, and no literature was found that manipulated overlearning with retention intervals of 26 or 52 weeks. The results of this research demonstrate that while overlearning was a quasi-experimental factor, there was an impact on test and re-test performance, with those participants who did not achieve criterion on at least one stage performing significantly worse on both the test and retention portions of the study. While the results suggest that those participants who received training over 18 sessions performed better than those who received training over 9 sessions, skill durability was best for those participants who had achieved criterion on at least 1 of the stages, regardless of the number of training sessions received. This last finding is particularly important, because many professions consider only the amount of training that they allow for new employees or students, instead of whether the employees or students can achieve criterion. This should also be an important consideration when proficient use of the skill is required after a period of delay, or for skills that are infrequently used (e.g., police using their pistol).

Motivation and engagement by the participant were also measured during the study, and while approximately half were university students who were participating for a reward, the other half were recruited from the general population. Performance was correlated with a few motivation and engagement scores, but these factors were not central findings of this study. It was clear that most of the participants in this study wanted to perform well and learn how to shoot. When this research first began, it was unclear how much attrition would occur over the life of the project, as the retention intervals ranged between 1 and 12 months, and while it was difficult finding articles that had retention intervals of longer than 4 weeks, it can be argued that research with longer retention intervals must be conducted. The fact that the overwhelming majority of participants returned for the critical retention test portion of the research is suggestive that the participants were highly motivated to complete the study. Thus, perhaps designing research with personal relevance or interest may be a viable solution to lowering attrition rates for research in excess of 4 weeks.

This study, the first to investigate skill training and durability features in pistol training, revealed several important results that, if replicated, will greatly improve pistol training efficiency. Specifically, the conditions of learning seem to be more important for skill durability than retention interval. Distributed training and overlearning greatly improve skill durability; however, this research also demonstrated that there is a point of diminishing returns with overlearning when it comes to the initial test and that more than

2 errorless trials does not translate into higher test scores. These findings are consistent with the results of Rawson and Dunlosky (2011) for cognitive tasks, suggesting that the same learning processes are relevant for both cognitive and motor skill learning. Where overlearning had the greatest return in the present study is when durability was measured, and as the number of errorless trials increased, so too did skill durability. The overlearning results indicated that having learners achieve at least one perfect score during training effectively eliminated loss of learning over retention intervals of 1 year. Implementing the two features of overlearning and distributed practice into training programs may greatly enhance the competence of police officers' pistol skills. Conversely, decreasing the duration of recertification would apparently have little effect.

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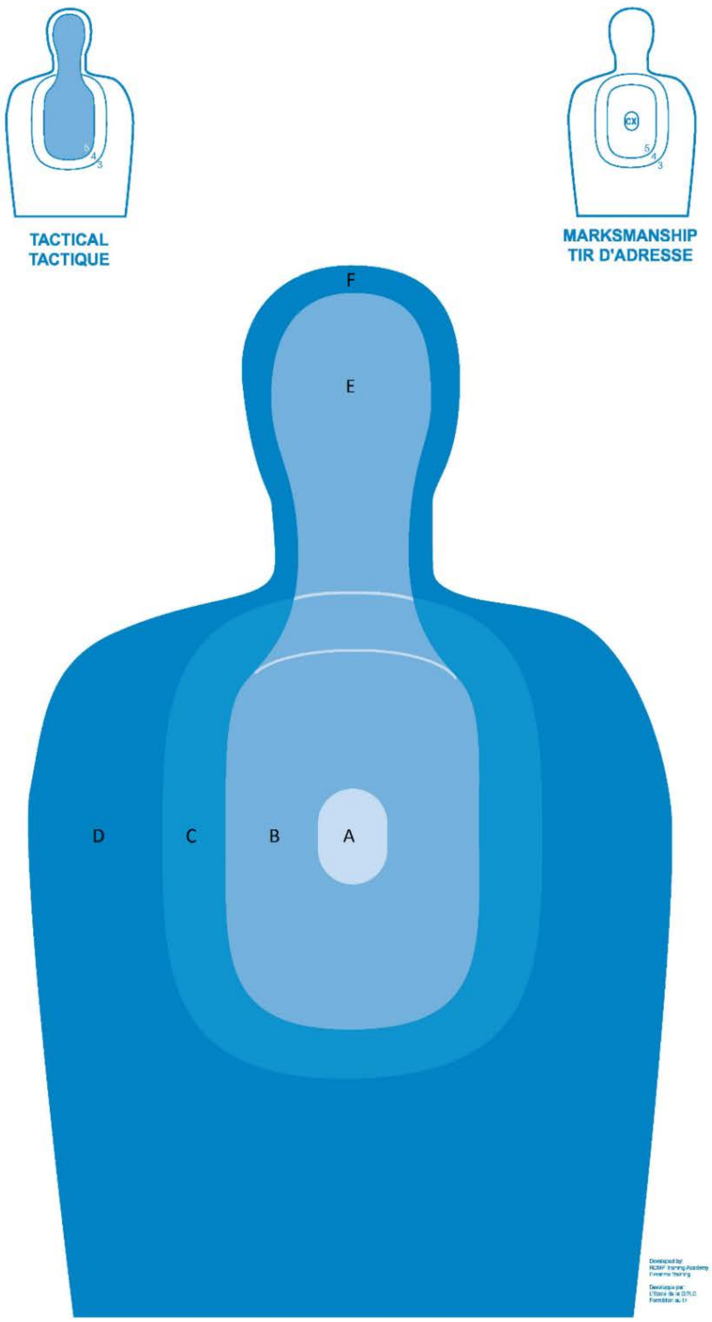
IV Illustration 1



V Appendix A

RCMP Pistol Evaluation Criterion

Evaluation	Minimum Total Score		Skill Description
BMK1	75/90		18 rds dominant hand no barricade Reload
BMK2	168/210	Stage 1	5 rds standing with barricade (dominant hand) 2 rds standing with barricade (non-dominant hand) 5 rds kneeling with barricade (non-dominant hand) Reload 2 rds prone
		Stage 2	4 rds standing without barricade (dominant hand) 4 rds kneeling without barricade (dominant hand)
		Stage 3	Begin far right of lane in low ready position 2 rds shift left then low ready 2 rds shift right then low ready 2 rds shift left then low ready 2 rds shift right then low ready Reload and reholster
		Stage 4	2 rds in center of target and 1 to head (5 s) X 4
FQ	200/250	Stage 1	5 rds standing with barricade (dominant hand) 2 rds standing with barricade (non-dominant hand) 5 rds kneeling with barricade (non-dominant hand) Reload 2 rds prone
		Stage 2	4 rds standing without barricade (dominant hand) 4 rds kneeling without barricade (dominant hand)
		Stage 3	Begin far right of lane in low ready position 2 rds shift left then low ready 2 rds shift right then low ready 2 rds shift left then low ready 2 rds shift right then low ready Reload and reholster
		Stage 4	2 rds in center of target and 1 to head (5 s) x 4 4 rds dominant hand only reload
		Stage 5	4 rds non-dominant hand only reload and reholster

RCMP Pistol Evaluation Criterion.
BMK1 = Benchmark 1, BMK2 = Benchmark 2, FQ = Final Qualification. Scoring based on 5 points for the centre ring, 3 points for the middle ring, and 2 points for the outer ring, no points are awarded for shots outside of the target area, rds = rounds.

Appendix B

Demographics Questionnaire

Participant Number		
Group #		
Age		
Sex		
Previous Fire-arms Experience	Yes/No	Type and how much
Handedness (Circle one)	Left / Right / Ambidextrous	
Eyesight (Circle one)	Glasses / Contacts / None	Prescription (Self Report)
Colour-blindness	Yes	No
Video Game Experience (Avg Number of hours per week)		
Video Game Experience (Type of games played)		
Video Game Experience (Type of controller used, e.g., mouse, joystick)		

Appendix C

Motivation to Participate Questionnaire

1. Were you motivated by the course credit to sign-up for this study?

1----------------2----------------3----------------4----------------5----------------6----------------7

Strongly Agree	*Neutral*	*Strongly Disagree*

2. Were you motivated to participate in this study by the skills you would be taught?

1----------------2----------------3----------------4----------------5----------------6----------------7

Strongly Agree	*Neutral*	*Strongly Disagree*

Appendix D

Engagement Questionnaire

Instructions: Listed below are statements about your experience during the training session. Using the scale provided, please circle the number that corresponds with your experience during the **current** session.

1. During this session I asked the instructor a question.

1----------------2----------------3----------------4----------------5----------------6----------------7

Strongly Agree *Neutral* *Strongly Disagree*

2. During this session I asked the instructor for feedback about some aspect of my skill.

1----------------2----------------3----------------4----------------5----------------6----------------7

Strongly Agree *Neutral* *Strongly Disagree*

3. During this session when the instructor offered me feedback, I made sure I understood their point.

1----------------2----------------3----------------4----------------5----------------6----------------7

Strongly Agree *Neutral* *Strongly Disagree*

4. During this session I was distracted by the performance of other students in the group.

1----------------2----------------3----------------4----------------5----------------6----------------7

Strongly Agree *Neutral* *Strongly Disagree*

5. During this session I showed one of the other students how to do something.

1----------------2----------------3----------------4----------------5----------------6----------------7

Strongly Agree *Neutral* *Strongly Disagree*

6. During this session I was distracted by something else happening in my day.

1----------------2----------------3----------------4----------------5----------------6----------------7

Strongly *Neutral* *Strongly*
Agree *Disagree*

7. During this session I discovered something that helped me solve a problem with my skill.

1----------------2----------------3----------------4----------------5----------------6----------------7

Strongly *Neutral* *Strongly*
Agree *Disagree*

8. Before each practice shot, I reviewed my performance from the previous trial, and attempted to change something in order to improve on the next trial.

1----------------2----------------3----------------4----------------5----------------6----------------7

Strongly *Neutral* *Strongly*
Agree *Disagree*

9. Over the training session I became more and more aware of the processes necessary for success.

1----------------2----------------3----------------4----------------5----------------6----------------7

Strongly *Neutral* *Strongly*
Agree *Disagree*

10. Over the training session I became better able to control my muscles to achieve my goal.

1----------------2----------------3----------------4----------------5----------------6----------------7

Strongly *Neutral* *Strongly*
Agree *Disagree*

11. Over the training session this task is familiar to something you had done the previous week.

1----------------2----------------3----------------4----------------5----------------6----------------7

Strongly *Neutral* *Strongly*
Agree *Disagree*

12. Between sessions, I practiced one or more of the movements.

1----------------2----------------3----------------4----------------5----------------6----------------7

Strongly *Neutral* *Strongly*
Agree *Disagree*

13. I was engaged in this task 100% of the time.

1----------------2----------------3----------------4----------------5----------------6----------------7

Strongly *Neutral* *Strongly*
Agree *Disagree*

Appendix E

Motivation Scale*

Using the scale below, indicate to what extent each of the following items presently corresponds to one of the reasons why you decided to take part in the learning associated with this study.

1. Because I experience pleasure and satisfaction while learning new things.

1.

Does not correspond at all		**Corresponds a little**	**Corresponds moderately**	**Corresponds a lot**		**Corresponds exactly**
1	**2**	**3**	**4**	**5**	**6**	**7**

2. Because I think that the skills I learn in the study will help me better prepare for the career I have chosen.

Does not correspond at all		**Corresponds a little**	**Corresponds moderately**	**Corresponds a lot**		**Corresponds exactly**
1	**2**	**3**	**4**	**5**	**6**	**7**

3. For the pleasure I experience while surpassing myself in learning a skill.

Does not correspond at all		**Corresponds a little**	**Corresponds moderately**	**Corresponds a lot**		**Corresponds exactly**
1	**2**	**3**	**4**	**5**	**6**	**7**

4. To prove to myself that I am capable of learning these skills.

Does not correspond at all		**Corresponds a little**	**Corresponds moderately**	**Corresponds a lot**		**Corresponds exactly**
1	**2**	**3**	**4**	**5**	**6**	**7**

5. For the pleasure I experience when I do new things I've never done before.

Does not correspond at all		**Corresponds a little**	**Corresponds moderately**	**Corresponds a lot**		**Corresponds exactly**
1	**2**	**3**	**4**	**5**	**6**	**7**

6. Because eventually these skills will enable me to enter the job market in a field that I like.

Does not correspond at all		**Corresponds a little**	**Corresponds moderately**	**Corresponds a lot**		**Corresponds exactly**
1	**2**	**3**	**4**	**5**	**6**	**7**

7. For the pleasure that I experience while I am surpassing myself in one of my personal accomplishments.

Does not correspond at all		**Corresponds a little**	**Corresponds moderately**	**Corresponds a lot**		**Corresponds exactly**
1	**2**	**3**	**4**	**5**	**6**	**7**

8. For the pleasure that I experience when I feel completely absorbed by an activity.

Does not correspond at all		**Corresponds a little**	**Corresponds moderately**	**Corresponds a lot**		**Corresponds exactly**
1	**2**	**3**	**4**	**5**	**6**	**7**

9. To show myself that I am a successful person.

Does not correspond at all		**Corresponds a little**	**Corresponds moderately**	**Corresponds a lot**		**Corresponds exactly**
1	**2**	**3**	**4**	**5**	**6**	**7**

10. For the "high" feeling that I experience while learning to do a skill.

Does not correspond at all		**Corresponds a little**	**Corresponds moderately**	**Corresponds a lot**		**Corresponds exactly**
1	**2**	**3**	**4**	**5**	**6**	**7**

11. Because people with these skills can receive a better salary.

Does not correspond at all		**Corresponds a little**	**Corresponds moderately**	**Corresponds a lot**		**Corresponds exactly**
1	**2**	**3**	**4**	**5**	**6**	**7**

12. Because this experience will help me gain entry into my chosen career.

Does not correspond at all		**Corresponds a little**	**Corresponds moderately**	**Corresponds a lot**		**Corresponds exactly**
1	**2**	**3**	**4**	**5**	**6**	**7**

13. Honestly, I don't know; I really feel that I am wasting my time.

Does not correspond at all		**Corresponds a little**	**Corresponds moderately**	**Corresponds a lot**		**Corresponds exactly**
1	**2**	**3**	**4**	**5**	**6**	**7**

14. I thought it would be interesting, but now I wonder whether I should continue.

Does not correspond at all		**Corresponds a little**	**Corresponds moderately**	**Corresponds a lot**		**Corresponds exactly**
1	**2**	**3**	**4**	**5**	**6**	**7**

15. For the pleasure I experience when I discover new things I have never tried before.

Does not correspond at all		Corresponds a little	Corresponds moderately	Corresponds a lot		Corresponds exactly
1	2	3	4	5	6	7

16. For the pleasure I experience when while surpassing myself in my abilities.

Does not correspond at all		Corresponds a little	Corresponds moderately	Corresponds a lot		Corresponds exactly
1	2	3	4	5	6	7

17. For the intense feelings I experience when I am displaying my abilities to others.

Does not correspond at all		Corresponds a little	Corresponds moderately	Corresponds a lot		Corresponds exactly
1	2	3	4	5	6	7

18. This experience will improve my overall competence.

Does not correspond at all		Corresponds a little	Corresponds moderately	Corresponds a lot		Corresponds exactly
1	2	3	4	5	6	7

19. To show myself that I am an intelligent person.

Does not correspond at all		Corresponds a little	Corresponds moderately	Corresponds a lot		Corresponds exactly
1	2	3	4	5	6	7

20. I don’t know, I can’t understand why I am doing this training.

Does not correspond at all		Corresponds a little	Corresponds moderately	Corresponds a lot		Corresponds exactly
1	2	3	4	5	6	7

21. Anything I can do to make me more competitive in the future

Does not correspond at all		Corresponds a little	Corresponds moderately	Corresponds a lot		Corresponds exactly
1	2	3	4	5	6	7

Appendix F

Training Assessment Questionnaire

1. I found the instructor easy to understand.

1----------------2----------------3----------------4----------------5----------------6----------------7

Strongly *Neutral* *Strongly*
Agree *Disagree*

2. I found the instructor's feedback useful to improving my skill.

1----------------2----------------3----------------4----------------5----------------6----------------7

Strongly *Neutral* *Strongly*
Agree *Disagree*

3. The things I have learned in this study will help me acquire a job.

1----------------2----------------3----------------4----------------5----------------6----------------7

Strongly *Neutral* *Strongly*
Agree *Disagree*

Appendix G

University of Regina

OFFICE OF RESEARCH SERVICES
MEMORANDUM

DATE: June 2, 2011

TO: Gregory P. Kratzig
Psychology (Campion)

FROM: Dr. Bruce Plouffe
Chair, Research Ethics Board

Re: **Skill Retention: A Test of the Effects of Overlearning and Retention Interval on Maintenance of Infrequently Used Complex Skills (File #95S1011)**

Please be advised that the University of Regina Research Ethics Board has reviewed your proposal and found it to be:

☑ 1. APPROVED AS SUBMITTED. Only applicants with this designation have ethical approval to proceed with their research as described in their applications. For research lasting more than one year (Section 1F). **ETHICAL APPROVAL MUST BE RENEWED BY SUBMITTING A BRIEF STATUS REPORT EVERY TWELVE MONTHS.** Approval will be revoked unless a satisfactory status report is received. Any substantive changes in methodology or instrumentation must also be approved prior to their implementation.

☐ 2. ACCEPTABLE SUBJECT TO MINOR CHANGES AND PRECAUTIONS (SEE ATTACHED). Changes must be submitted to the REB and approved prior to beginning research. Please submit a supplementary memo addressing the concerns to the Chair of the REB.** <u>Do not submit a new application</u>. Once changes are deemed acceptable, ethical approval will be granted.

☐ 3. ACCEPTABLE SUBJECT TO CHANGES AND PRECAUTIONS (SEE ATTACHED). Changes must be submitted to the REB and approved prior to beginning research. Please submit a supplementary memo addressing the concerns to the Chair of the REB.** <u>Do not submit a new application</u>. Once changes are deemed acceptable, ethical approval will be granted.

☐ 4. UNACCEPTABLE AS SUBMITTED. The proposal requires substantial additions or redesign. Please contact the Chair of the REB for advice on how the project proposal might be revised.

O. Bruce Plouffe

Dr. Bruce Plouffe

cc: Dr. Katharine Arbuthnott – Psychology, Campion College

** supplementary memo should be forwarded to the Chair of the Research Ethics Board at the Office of Research Services (Research and Innovation Centre, Room 109) or by e-mail to research.ethics@uregina.ca

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