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Police officer involved shootings – retrospective study of situational characteristics

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Abstract

The study analyzed the situational characteristics of 112 incidents where police used firearms to handle high threat situations. Most shooting incidents emanated from usually uneventful tasks, e.g., handling burglaries or disturbances. The assailants were commonly armed with firearms (26%), sharp (27%) or blunt objects (10%). The incidents were regularly short-lasting (in 39% were shots fired ≤ 3 s from threat emerged) and occurred at short distances (in 42% at distances ≤ 3 m). Predominantly, the first responders had to address the situation and did so with warning shots or, equally common, with fire-for-effect shots (40%) or a combination thereof. Psychological stress was manifested as feelings of panic at some point and as motor skill alterations, e.g., firing without using sights and with one hand only. Analysis of these incidents shows that all field duty police officers should receive training in handling potentially life-threatening, sudden, close-range attacks.

Keywords

Police use of force; officer involved shootings; firearms; psychomotor; motor control

Introduction

The most forceful method for a police officer to contain an imminently high threat situation is to use a firearm. Ideally, threatening situations and violence should never reach this state but be contained through conflict management and tactics (Klinger, 2005). However, as the present study will illustrate, sometimes the series of events play out so fast or come without warning so that those present at the scene can't prepare before they face a life-or-death situation. The practices and regulations for police officers use of firearms vary between countries, and sometimes even within countries (Mistry, Minnaar, Redpath, & Dhlamini, 2001; Sarre, 1993). The Swedish police can use firearms against humans in two different situations; (1) to arrest suspects of grave felonies and (2) to protect themselves or others from ongoing or imminent threat of aggravated assault with risk for life or severe bodily harm. This is similar to the legislation developed in many western countries including Australia (Sarre, 1993). Swedish police rarely shoot to arrest and, if so, it is then predominately in the form of warning shots. If the firearm is used for arrest, fire-for-effect (FFE) shots aimed at the legs or warning shots are legal. For comparison, in USA warning shots are not an accepted practice and practically not allowed due to the risk of ricochets or stray bullets (Bratton, 2014). In Sweden, firing warning shots are legal and regularly trained. However, warning shots are only allowed if the situation also allows FFE shots.

In shooting incidents, the stakes are often very high, not only for the police officers involved, but also for the persons in need of protection or rescue, for bystanders at the site and the assailants. However, police officers often have no previous in-field experience of tackling these situations so they need to rely on recalling taught behaviors (Linsdell, 2012). A suddenly emerging threat or assault from short distance may overwhelm the officer because

certain time durations are needed to perceive the scenario contexts, select the appropriate action (Mather & Lighthall, 2012), produce the selected response and for the selected response to take effect on the assailant, all of which take time. Additionally, psychological stress, which is undoubtedly present, affects the ability to use well-trained skills but the level of effects depend on whether the skill involves fine, complex or gross motor control (Grossman, 1995; Siddle, 1995; Yerkes & Dodson, 1908) and how the skill has been acquired and trained (Masters, 1992; Maxwell, Masters, Kerr, & Weedon, 2001). One approach to address these problems might be to adapt and extend the regular training to include handling high threat incidents (Atkins & Norris, 2004; Bertilsson et al., 2013; Murray, 2004; Schmidt & Lee, 2011).

Literature review

In spite of the attention and focus on large scale killings in the media, they are not common (Greenberg, 2007). Still, one single event with one shooter could result in mass fatalities; producing more fatalities than all the murders over several years in the region, as illustrated by the event in Utoya, Norway in 2011. This is due to a rapid kill rate (Greenberg, 2007) and slow police intervention. Thus, to postpone intervention, like in Utoya, until a well-trained special unit or special weapons and tactics team arrives, can have dire consequences (Greenberg, 2007). The alternative is that the first responders intervene in the active threat event as fast as possible. When studying the active shooter scenarios in USA between 2000 and 2010 the first responder reached the scene before the situation had ended in about 51% of the incidents, out of which the perpetrator then was stopped by the first responders in 51%, committed suicide in 35% and surrendered in 14% (Blair, Nichols, Burns, & Curnutt, 2013). In an active threat situation personal grudge, mental illness, criminal intent, political or religious terroristic convictions guiding the perpetrators behavior are often unknown, and thus, the first responders' initial focus needs to be on stopping the behavior regardless of the perpetrator's frame-of-mind (Kelly et al., 2011). However, less common but more difficult risks for the immediately intervening first responders to handle are to be spotted early, hidden explosives or be faced with a superior number of well-armed trained perpetrators. A regular field duty patrol officer is the most likely unit to face the very strenuous active threat situations, including having to handle a threat or an attack that would be most suited for a special unit (Bertilsson et al., 2013). Few detailed data and research studies are to date available about situational characteristics from officer involved shootings (OISs) (Aveni, 2003), as can be exemplified by the OIS information data-set collected by the Indianapolis Metropolitan Police Department, (e.g., Occurred Date, Division, District, Shift, Resident Race, Resident Sex, Resident Age, Officer Race, ...). However, information data sets of this kind can be of great interest from a criminological perspective and for studies regarding characteristics of the persons involved. Moreover, such data can serve a role for operative policing in determining where current dangerous hotspots are.

A research study by Artwohl has examined what police officers experience during incidents, documenting effects of stress primarily on perception and memory, and post-incident experiences (Artwohl, 2002). However, apart from basic overviews on the effects of stress on perception, memory and cognition like decision-making during OIS (Mather & Lighthall, 2012), most research studies lack the detail or data to drive tactical, training, equipment and even future legislation change (Bertilsson & Fredriksson, 2014; Bertilsson, Fredriksson, Piledahl, Magnusson, & Fransson, 2014). Other sources may provide more detailed data that can be useful for closer analyses, like the OIS statistics presented by the Los Angeles Police Department (LAPD) (MacArthur et al., 2013). The New York City Police Department (NYPD) collects and evaluates also more detailed situational characteristics data from their OISs in their Annual Firearms Discharge Reports (Aveni, 2003; Bratton, 2014).

The NYPD states that their detailed OIS data serves to adapt tactics, training and equipment (Bratton, 2014).

The study objective was to perform a systematic evaluation of the situational characteristics during high threat shooting incidents and the police officer's actions taken to handle them. By collecting and incorporating the experiences of the people that have been involved in real-life incidents, one may find more effective operative tactics to approach these incidents and better methods to improve the skills trained so police officers can address these rare but extreme situations safer. Here, we present the first detailed analysis of situational characteristics from standardized shooting incident reports. Empirical data about situational characteristics such as time, distance, threat properties including the performance of the assailant and police officers in the real life situations was collected. We also analyzed signs of human physical and psychological limitations while performing policing tasks during high threat incidents.

Methods

Population, violent crime rates and police force within the investigated county

The scenario conditions of OIS incidents were monitored in the then Skane (Scania) County Police Department, Sweden, from 1984 to 2012. During the period investigated, the county population was about 1.2 million and the Skane County Police Department had on average 1320 police officers employed performing active field duty service, detached to a number of subunits including a SWAT team, patrol units, recon units, traffic units, drug units and so forth, with somewhat different armament and training. The county police department handled on average 230,000 policing tasks per year during the investigated period. The reported violent crimes (including categories; murder, forcible rape, robbery and aggravated assaults) increased during the period investigated by about 120%, reaching an average of 259 per 100,000 citizens in 2012. In comparison, the violent crime rate was 639 per 100,000 citizens in 2012 in New York, USA.

Police equipment and training

Swedish police officers assigned to field duty work in pairs following occupational safety regulations, to diminish risk of injury when assaulted compared to single patrol (Wilson, Brunk, & Meyer, 1990). Initially, the standard sidearm was the Walther Arms® 7.65 mm Walther PP®. However, due to repeated incidents where attackers were not incapacitated within acceptable time frames, even after several bullet hits, became this weapon gradually replaced from 1987 with different models/sizes of the 9 mm SigSauer® (J. P. Sauer & Sohn GmbH®). From 1991, all shootings with sidearms were with SigSauer®. Both Walther PP® and SigSauer® have safety mechanisms designed to make the trigger force 5–6 kg if the hammer is placed in passive position. The semiautomatic design makes the pistol reload after each round fired and place the hammer in active position. In this active state, firing the pistol requires a trigger force of about 1.8 kg. During the investigated period, a safety regulation stated that the pistol should be carried with rounds in the magazine but not in the chamber.

Supportive weaponry was available to the SWAT-team and other assigned officers in case of high threat situations. The Swedish Armed Forces 9 mm submachine gun m/45B, in a police version m/45BE, was initially used, but was gradually replaced starting in the 1980s with the 9 mm submachine gun, MP5 (Heckler & Koch®). All shootings with two-hand weapons from 1998 are with MP5. The assignment to use submachine guns was restricted to police officers that had passed a three day course and participated in training once every year. All police officers could apply to attend the submachine gun course but patrol officers were given priority to the limited positions on the courses. Once a year, the police officers had to pass a shooting test requiring them to hit 4 of 5 shots within a 12.5 cm radius circle from 7 m.

Between 2006 and 2008, police officers in field service received firearms training about twice a year and more irregularly offered training in various tactics and arrest/self-defense skills. From 2009 till 2012, training was provided twice a year in integrated tactics, firearms and arrest/self-defense skills.

Collected situational characteristics information

Data about the shooting incidents were collected by detailed interviews of all police officers that had used their firearm in line of duty. The information collected partly adhered to the New York City Police Department OIS Data-set, for details see below. The same person (UP) performed all but a few interviews with the police officers using a predesigned questionnaire. The interviews were performed after the legality of the shooting incident was determined, usually within a few days. The kind of information collected during the interview adhered to the study objective of performing a systematic evaluation of the relevant situational characteristics during high threat shooting incidents and of the police officer's actions taken to handle them. This approach enabled using more objective scales when, e.g., rating the levels of threat or the time frame available for the police officer to determine how to respond and perform response. Data collection by means of interviews were chosen based on that it minimized the possibility that the police officers involved in the shootings diverged in answers because of misinterpreting any written questions.

The incident information collected during the interview and analyzed were:

- *Assailant and police officer profiles*: (1) Age; gender and armament of the assailant; (2) Age; gender; work experience of the police officer and kind of police unit involved.
- *Scenario conditions*: (3) Perceived time from threat emerged till shots fired (police); (4) perceived distance to assailant when shots were fired and relationships between shooting distance and assailant armament. (5) Assailant actions; (6) Police officer actions; (7) Police force on site and active in the incident; (8) Incident locations, risks for bystanders and ricochets; (9) Visual conditions.
- *Other incident details*: (10) Initial police assignment; (11) Initial encounter phase; (12) Implications of affected motor skills from psychological stress; (13) Circumstances at accidental shots.

Statistical analyses

Shapiro-Wilks test of data distribution profiles revealed that some data sets did not have normal distribution. Hence, non-parametric statistical methods designed to handle this kind of data distributions were used in the statistical evaluation. The collected data was analyzed using the non-parametric Spearman's correlation test to determine the presence and strength of systematic cause-effect relationships. In the analysis, p values < 0.05 were considered statistically significant. All statistical tests were performed using SPSS 21.0 software (SPSS Inc., Chicago, IL, USA).

Results

The Skane County Police officers used their firearms 132 times in 112 separate incidents from 1985 to 2012. Of these 132 shootings were 10 accidental, whereof 9 during policing actions and one during training. In 14 of the 112 shooting incidents, police officers were harmed themselves, thereof 11 officers got light to moderate lesions and 3 received gunshot wounds. Among the known outcome cases, 12% of the assailants were killed (6 humans and 8 canines), 7% were severely wounded (e.g., chest shot lesions), 12% were moderately

wounded (e.g., leg shot lesions), 12% were lightly wounded and 57% of the assailants were unharmed after the incidents.

Assailant and police officer profiles

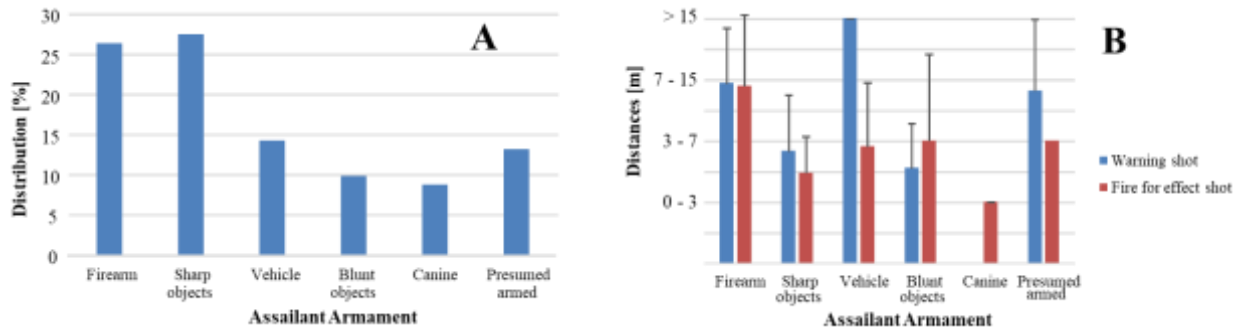


Figure 1. (A) Armaments of shooting incident assailant. (B) Illustration of at what distances (mean (SD)) actions were taken for each of the different assailant armaments and whether the officer responded to the threat with warning shots or fire-for-effect shots.

(1) Assailant profile

The typical assailant was on average a 30.0 (SD 10.0) year old male. Proportionally, in the known cases, 76% of the attacks were made by one male person; 1% was by one female, 14% were by a crowd of people and in 9% the attacker was a canine. The most common assailant armament was firearms (26%) and sharp objects such as knives (27%), see Figure 1(A). Vehicles were also fairly commonly used (14%) as means for attack, whereas attacks with blunt objects (10%) or by dogs (9%) occurred more rarely. In 13% of the cases the subjects were presumed armed, e.g., from information and/or behavior combined with that the assailant's hands were not visible. The officers fired at shorter ranges when the assailant was armed with perceived close or contact range weapons, see Figure 1(B).

(2) Police responder profile using the firearm

The typical police officer was on average 35.0 years old (SD 6.1) with a work experience of 10.4 years (SD 6.5). The police officer was commonly male (93%). The gender distribution followed well the gender distribution among police officers working in field service during the assessed time period. Most incidents (82%) occurred with officers in uniform. The most common police unit operating in field service, the patrol unit, also dominated among those involved in the shooting incidents by 60%. The SWAT-team, was involved in 17% of the incidents whereas the recon units were involved in 15%. Less often involved were the traffic units (4%) and the K9 units (4%).

Situational characteristics

(3) Duration of shooting incidents

A marked property for the shooting encounters was the short time frame during which the event took place, see Figure 2(A). In 39% of the cases, the threat was regarded so imminent that a shot was fired within ≤ 3 s from it emerged. In 27% of the cases, the time frame between emerged threat and response was estimated between 3 and 10 s. The emerged threat was

regarded in 13% requiring a reaction between 10 and 30 s afterwards, whereas in 21% of the cases the threat resulted in a shooting after more than 30 s.

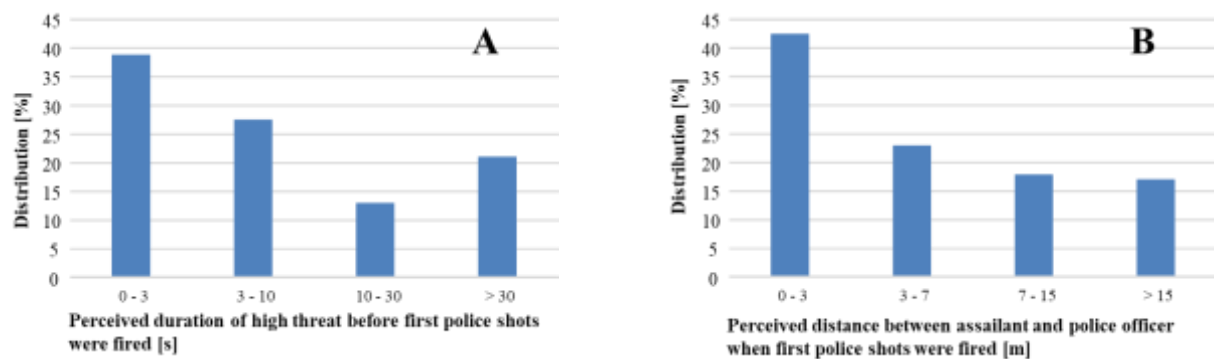


Figure 2. (A) Perceived duration of high threat before first police shots were fired. (B) Perceived distance between police officer and the assailant when the first police shots were fired.

(4) Perceived distances between assailant and the police officer shooting

Another marked circumstance was the perceived short distances between the police officer and the assailant at the time of the shooting, see Figure 2(B). In 42% of the cases the distance was estimated to be ≤ 3 m and in 65% of the cases ≤ 7 m.

(5) Assailant actions

The assailant was in motion during 76% of the shooting encounters. The attacker moved towards the police officer in 52% of the cases, moved away from the officer in 8% of the cases, moved in parallel to the officer in 16% and the attacker was standing still in 24% of the encounters. In the 27 shooting incidents where the attacker was standing still, 4 shots were accidental, 15 times the attacker had firearms, 3 times the attacker had a sharp object and in the last 5 cases the attacker was presumed to be armed, which was addressed with warning shots. In the 9 shooting incidents where the attacker was in motion away from the police officer, one shot was accidental, 4 times the attacker had firearms, 2 times sharp objects and 2 times was the attacker presumed to be armed, which was addressed with warning shots.

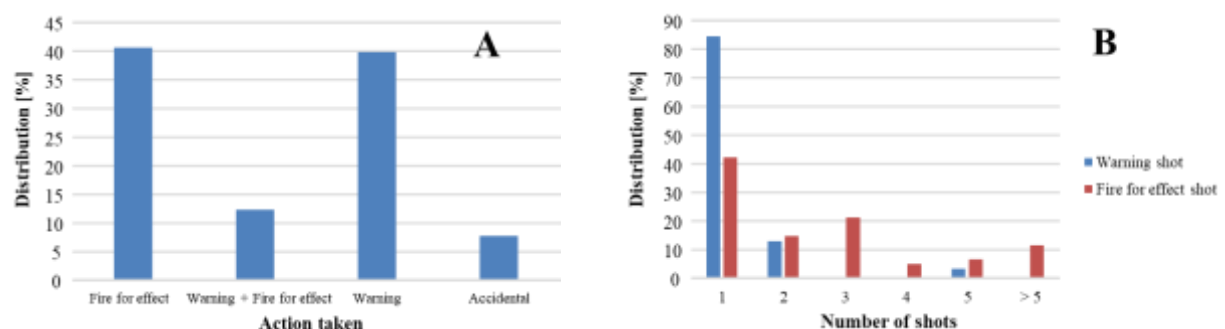


Figure 3. (A) Distribution of action taken during the incidents. (B) Distribution of number of warning shots and FFE shots fired during the incidents.

(6) Police officer actions

The police officer responded in 40% of the cases with FFE shots (aimed or pointed); in 12% with a combination of FFE shots and warning shots; in 40% with warning shots and in 8% with an accidental shot, see Figure 3(A). The police officer was in motion during 27% of

the warning shots fired and during 33% of the FFE shots fired. When the firearm was used for warning, in 83% of the cases one shot was fired and in 96% two shots or less (mean 1.2 shots (SD 0.8)). The warning shots were directed up in the air in 78% of the cases, beside the assailant in 7% of the cases and toward the ground in 15% of the cases. When aimed or pointed shots for effect were fired, two or less shots were fired in 57% of the cases and three or less shots were fired in 78% of the cases (mean 2.8 shots (SD 3.3)), see Figure 3(B). A large number of shots were fired when the police officers were using MP5 in three long-range confrontations with robbers armed with firearms and in one incident shooting an aggressive dog with a pistol.

The hit rate could to some extent be estimated for 39 of the 69 FFE shootings performed during the investigated period. The estimated hit rate was about 72% for pistols whereas about 6% for submachine gun (MP5). Of note, the accurateness of the hit rate values presented here are likely low, e.g., warning shots might have been missed FFE shots. Moreover, when comparing the hit rates for pistols and submachine guns, one should regard that pistols were used at short distances whereas the submachine guns were used in incidents confronting assailants armed with firearms positioned more than 40 m away.

(7) Police force on site

When the shootings occurred, the number of police officers present were in 24% of the cases one officer; in 37% two officers; in 10% three officers and in 29% of the cases four or more officers (mean 3.3 officers (SD 3.1)). In 86% of the incidents one police officer used the firearm and in 98% of the incidents two officers or less used the firearm, whereas three and four shooters occurred in 1% each of the incidents (mean 1.2 shooters (SD 0.5)).

(8) Incident locations, risks for bystanders and risks for ricochets

Most shooting events, 84%, occurred in urban or densely built-up areas whereas the remaining 16% happened in the less populated countryside. In 85% of the investigated cases, the shooting took place outdoors. Of the indoor shootings (18 out of 131), 33% occurred in stairwells, 33% in corridors and 33% inside apartments, shopping malls and at a gas station. In 47% of the cases, the police officers did report presence of bystanders and in several cases the presence of bystanders raised concern about how to solve the situation in a safe way. The risks for ricochets were regarded as elevated at 82% of the shooting sites, medium at 10% of the sites and low at 8% of the sites. In 6 of the 112 shooting cases, bystanders or other police officers got harmed while resolving the incidents. However, no bystander was injured by the police officer's projectiles.

(9) Visual conditions during the incidents

The incidents predominantly (60%) occurred during the dark hours of the day whereas 32% occurred during daylight. The intermediate lighting states of dawn and dusk accounted for 4% each. A possibly confounding factor for the difficulties to identify armament could be visibility problems while dark. The number of cases of 'perceived armed' was somewhat more frequent for the dark encounters, but followed roughly the same distribution as for all encounters. A flashlight was used in 6% of the encounters occurring during the dark hours.

Other incident details

(10) Initial police assignment

The initially stated reason for the policing intervention rarely gave indications that the event could evolve into a shooting incident. About 70% of the initially given assignments concerned tasks usually performed un-dramatically on daily basis such as house search warrants, handling brawls, burglaries or handling mentally ill subjects. The remaining 30% of

the cases concerned more serious offences such as handling robbery, pursuit of criminals and kidnapping.

(11) Initial encounter phase

The police officers using their firearms were in 80% of the cases the first to arrive at the scene. In 63% of the incidents, the police officers approached the scene with their weapon drawn and loaded. Still, 54% of the officers reported being mentally prepared for that the incident would become difficult and violent and in 36% of the cases it was reported that the events included elements of panic. In 77% of the cases the time and/or options to handle the situation was limited or there was no protection close enough for cover. Other issues encountered were that the vegetation offered poor protection and that the ballistic shields used offered poor capacity to protect from the firearms or the long sharp objects the attacks were performed with.

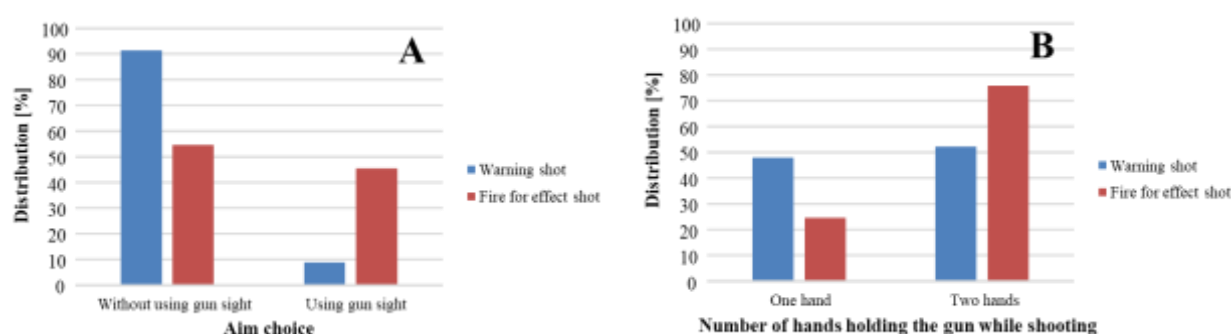


Figure 4. (A) Distribution of use of sights while firing for effect and while firing warning shots. (B) Distribution of use of support hand when firing the gun.

Note: The police officers were trained to stand still while firing, use sights and to hold the firearm with two hands.

(12) Implications of affected motor skills from psychological stress

Partly opposing the training received, the police officers fired in 91% of the cases warning shots without using gun sights and in 55% of the cases FFE shots without using gun sights (Figure 4(A)). Moreover, when firing warning shots the police officer held the gun with one hand in 48% of the cases, whereas while firing FFE shots the gun was held with one hand in 24% of the cases (Figure 4(B)). Listed below are findings made when, based on correlation analysis, determining whether there were cause-effect relationships between incident factors likely causing an autonomous hormonal stress response and how the police officers handled physical tasks and their equipment.

Warning shots

During warnings shots had police officers that were in motion while shooting significantly more often emotions of panic ($p = 0.004$, $R = 0.406$). Moreover, police officers took actions at longer distances when the assailant was armed with more obvious lethal weapons (e.g., firearm, sharp objects ($p = 0.017$, $R = -0.412$) and they also took actions at longer distances when they were mentally prepared for the incident ($p = 0.031$, $R = -0.315$). Furthermore, when allowed to be mentally prepared the risk for feeling panic during some part of the event decreased ($p = 0.012$, $R = -0.361$). Noteworthy, the officers tended to feel more mentally prepared ($p = 0.079$, $R = 0.305$) and feel less panic ($p = 0.065$, $R = -0.320$) when the assailant was armed with more obvious lethal weapons. Two motor and performance skill alterations noted was that the two-hand grip tended to be used more often when the assailant was armed

with more obvious lethal weapons (e.g., firearm, sharp objects ($p = 0.054$, $R = -0.333$) and the sights tended to be used more often with two-handed grip ($p = 0.057$, $R = 0.283$).

FFE shots

During FFE shots did the police officers take actions at longer distances when the assailant was armed with more obvious lethal weapons (e.g., firearm, sharp objects ($p < 0.001$, $R = -0.511$)). Moreover, the sights were used more often when firing at longer distances ($p = 0.011$, $R = 0.382$). Noteworthy, the officer felt more mentally prepared ($p = 0.014$, $R = 0.369$) when the assailant was armed with more obvious lethal weapons. Two motor and performance skill alterations noted was that when the police officers were in motion, more shots tended to be fired without using sights ($p = 0.075$, $R = 0.271$). Moreover, a two-handed grip on the pistol tended to be used more often when using sights ($p = 0.068$, $R = 0.277$).

(13) Circumstances at accidental shots

About 8% of all shootings events were accidental shots. In 80% of the cases reported, shots were fired during motion e.g., walking. Other common conditions were that the hand holding the weapon was physically affected (e.g., squeezed in a door); that the other hand simultaneously was doing a task requiring large force, or that the officer came into close combat with an assailant while still holding the weapon. Noteworthy, in at least half of the incidents the firearm was in single-action with 1.8 kg trigger pressure.

Discussion

Police shooting incidents are rare in Sweden, averaging once per 57 500 policing events. However, being rare, it is likely that the police officers involved have not experienced such events before (Linsdell, 2012). This has raised questions about how to prepare a police force for these very rare events and how training should be designed to best prepare a police officer for the extremely high psychological stress levels experienced when facing malicious threats to life. This study showed that the local SWAT-team only handled 17% of the shooting incidents. However, several of these SWAT-team shootings recorded occurred while performing regular policing tasks since the SWAT-team performed also such tasks during first decade of the studied period. Most of the shooting events (70%) occurred while performing ordinary uneventful policing tasks, and where the phase of violence played out within a few minutes. Thus, the chances to act preemptive or wait for elite reinforcements were not an option. Most events (80%) had to be handled by the first responders at site, whoever they might be.

All shooting events analyzed involved addressing an armed or perceived armed assailant, whereof 26% were armed with long range weapons (i.e., firearms) and 61% with close to contact range weapons (i.e., knives). A recurring incident property was the short time frames and distances during which the event took place. In 66% of the cases, the threat was regarded so imminent that a shot was fired less than 10 s after it emerged, and in 42% of the cases at distances less than 3 m. Although most shooting incidents occurred in the urban areas with the higher violent crime rates, incidents occurred also in small villages and in the countryside.

Tactical application of firearms

The first responders were involved in most of the shooting situations (80%). The incident reports show that it was often hard or not possible to predict and prevent often sudden threats during regular patrol tasks. A SWAT-team or other special unit is commonly 30 min to an hour away if available. However, only 8% of the violent confrontation phases exceeded a minute in duration. Hence, the findings advocate that police officers in field service in general

should receive training in how to handle the documented most common incident properties during high threat scenarios. Such training is today mostly given to special units.

Commonly the sidearm was used on short distances, especially against assailants armed with sharp or blunt objects that are most dangerous on close to contact range. Also, the short time frames and the common lack of preemptive cues of imminent violence in many of the incidents suggest that the opportunity never appeared to apply any learned tactics or de-escalating techniques. When the assailant was armed with longer range weapons, e.g., firearms, the police officer commonly responded at a greater distance. Strikingly, in the most dangerous and stressful incidents, when an armed assailant/ threat was in motion toward the police officer from a distance of 0–3 m (20% of the incidents), 41% of the officers used only warning shots and 63% remained static and 33% did both. Several explanations are possible: The inherent true risks, e.g., of short distances and the lethal effects of different close or contact range weapons, may not be sufficiently known to the police officers. Some of the action taken, or lack thereof, may be an effect of that most humans are both subconsciously and consciously unwilling to use lethal force against other humans (Grossman, 1995; Swank & Marchand, 1946). Another culprit may be that the legal frame work is perceived as unclear about how a violent assailant armed with close/contact range weapons is allowed to be addressed. Furthermore, a firearms-training predominantly performed standing static and holding the firearm with two hands may also produce a more common static non-adaptive response. Moreover, psychological stress effects may delay/disturb the analysis of the scenario contexts and the selections of appropriate actions, on different subconscious as well as conscious levels. Finally, it requires a certain amount of time for the human subconscious perception to evaluate the situation in all its aspects and to reach a decisions about how to respond to the situation encountered. Moreover, the physical processes to produce a response takes time, thus, sometimes the available time maybe was too short to enable the police officer to respond differently. Whichever explanation or combinations of explanations that may be in effect, the way to improve the responses in these the most extreme objectively dangerous situations is likely through suitable open-skill stimulus-response-training including stress-inoculation (Bertilsson & Fredriksson, 2014). Specifically, it is important to include training to handle the factors common in real-life incidents, e.g., to respond to and fire at threats that are in motion, to respond and fire while in motion, to be able to shoot accurately without the use of sights and to perform these tasks in combination (Applegate, 1976; Bratton, 2014; Fairbairn & Sykes, 1942).

A country's legislation about when and how police officers are allowed to use firearms may pose restrictions on the operational options available when submitted to an imminently dangerous encounter. All deliberate police OISs investigated in this study was found legal and in line with Swedish legislation. However, as has been highlighted in recent court trials, the legal framework may still require retrospective updates and clarifications. Hence, the found signs of hesitation to take action early during a high threat incident, might be due to too limited juridical education of police officers or to an unclear legal framework. A clear and appropriate legal framework preemptively detailing how police officers are allowed to handle armed or unarmed assailants may markedly support designing better tactics, customize training and support design and introduction of suitable less-lethal weapons enabling safer interventions.

Role of psychological stress

Psychological stress repercussions affects the sensory systems and the CNS processing stages where the information of the environment is first subconsciously and then within tenths of a second partly consciously perceived, thus, stress is even subconsciously producing and affecting different responses or behaviors. These processes precede, often bypass and

sometimes overrun, the stage where our consciousness is allowed to weight and analyze the information, thus, our consciousness is initially and sometimes during a stressful event fed with disrupted perceptive information, which may make rational analysis of the event processes difficult, delayed or even inhibited. Because of the design of the neural pathways of information processing, one cannot consciously prevent an initially strong stress response if the stress stimulus is interpreted as catastrophic, unfamiliar, sudden or a combination of these three factors (LeDoux, 2000; Meyerhoff et al., 2004).

Noteworthy, an uncertain threat caused in the incidents more stress than a clear severe threat did, e.g., the discovery that the assailant had a firearm. This may partly be due to that taking action in this situation were more obviously justified morally as well as socially and legally. One conclusion is, thus, that regular shooting training should also include exposing the police officer while under stress to the common properties in real-life type-incidents. Such training should address the natural human strengths and, herein shown, limitations when under an autonomous and hormonal stress response. One training aim might then also be to avoid that hesitation, inexperience or slow scenario evaluations unnecessarily produces short range high threat encounters (0–3 m), where a determined attacker within less than a second can reach and lethally injure the police officer (Dysterheft, Lewinski, Seefeldt, & Pettitt, 2013).

An attacker can reach a person standing at 7 m distance within 1.5 s, meaning that knives and blunt objects pose an imminent life threat at this distance (Dysterheft et al., 2013). Backing is not a viable option to avoid being reached/attacked. It merely delays the attack with at best a few seconds. However, if the distance is >7 m to the attacker, estimations based on the data presented by (Dysterheft et al., 2013) and on data from our own assessments suggests that one might try to immediately turn and run if the assailant makes a sudden rush. This offers a long-term solution only if the one chased can run faster and have better stamina than the attacker and do not stumble or fall. However, it may delay contact for defenders and allow shots fired to have effect.

Stress effects on shooting and aiming

Typically, psychological stress that increases pulse rates above 115 BPM degrades fine motor control (Oudejans, 2008; Siddle, 1995), whereas stronger stress activation to pulse rates above 145 BPM start to degrade ability to perform complex motor control (Nieuwenhuys & Oudejans, 2010; Siddle, 1995). However, implicit learning appears to make fine and complex motor skills more robust to stress (Masters, 1992). At very strong stress activations both cognitive and physical performance degrades, resulting in ability to perform only simple gross motor skills (Grossman & Christensen, 2004; Siddle, 1995; Vonk, 2008). Thus, strong stress activation may render people unable to use equipment requiring fine motor skills or complex motor control (Oudejans & Nieuwenhuys, 2009). A common motor effect under extreme stress is that one squeezes the sidearm grip harder than otherwise physically possible. If the grip is poorly adjusted to the users hand (i.e., too large) or is held tilted sideways, even slightly, the hard squeeze may change the direction of the muzzle to such a degree that one misses large targets even from less than 2 m (Applegate, 1976; Fairbairn & Sykes, 1942).

Moreover, psychological stress will also affect the sensory systems and cognitive processes, and thus, our perception of the environment and of the ongoing events. A common perceptive stress distortion is tunnel vision, describing a reduction of the peripheral visual field produced by a strong visual fixation, dilated pupils and attentional locking on a threat, like the gun or knife in the hand of the perpetrator. The hearing may also be distorted or lost, e.g., one may not hear the shots when using the firearm (Artwohl, 2002). Noted physical manifestation of stress was that in spite of the training received, when forced to use their

firearm while being in motion, 87% used no sights and 49% used only one hand. Emotions of panic were more common when the police officer was in motion while firing (44%).

Role of police armament and ammunition

Typically, there are two means to obtain an almost instant movement incapacitating effect; (1) by causing neural damage or block neural communication by lesions (e.g., a hit affecting key central nervous system pathways) or by causing nerve blockades (e.g., use of conducted energy device or also more precisely referred to as electro-muscular incapacitation device (EID) less-lethal weapons) of vital movement control sites; or (2) by causing lesions to the stability-supportive skeletal structure (e.g., rupture the femur of the leg) (Fackler, 1996). Other, even lethal or severe, lesions may not per se be incapacitating on a seconds level scale, especially not so if the subject is affected by drugs or medication or is in a psychological state restricting sensations of pain. Thus, the physical demands on ammunition to be used for solving situations including imminent life threats are high, but also legal and ethical aspects set boundaries. The ideal ammunition should combine having a high incapacitating effect without causing lethal, substantial or permanent lesions. Furthermore, due to the above presented data of often short distances and time frames available during shooting incidents, a shot fired may need to cause an incapacitating effect within 1–2 s or the determined attacker will be able to come within reach to perform armed close/contact range attacks. Moreover, since most incidents occur in urban areas, care must be taken to reduce the risk for bystanders by that the ammunition should have limited penetrative power, i.e., not remain harmful after passing through targets and house walls, and should not produce harmful ricochet shrapnel when hitting hard surfaces. These series of demands are conflicting, thus, trade-offs has had to be made to balance beneficial and negative properties.

The 7.65 mm ammunition initially used during the period investigated had not the properties required to cause movement-incapacitation through rupture of relevant skeletal structures. The later change to a 9 mm weapon and ammunition provided this capacity and enabled effectuating a tactical approach where the first choice of action is to shoot to prevent assailant movement to reach the target of attack. This choice of equipment and ammunition adheres to what is presently used by several police forces in Europe including France, Belgium and Finland. Presently, it is under debate whether to introduce medium to long range less-lethal weapons, e.g., EID, as police armament. Noteworthy, the conditions in about 32% of the shooting incidents assessed, e.g., numerical superiority in combination with available time and no perceived firearms threat, might have allowed attempts to incapacitate assailants using medium to long range less-lethal weapons.

Accidental shots circumstances

The accidental shooting event reports suggest that two circumstances were common. One contributing factor was possibly the safety regulation in effect during the period. This regulation stated that a holstered pistol were not allowed to be loaded, meaning that when encountering a hazardous situation a two-step procedure had to be performed to make the weapon operational. Firearms instructors noticed though that the second step in the loading procedure, (de-cocking) setting the trigger force to 5–6 kg, commonly was forgotten under attention-demanding situations. Therefore, shots might have been fired due to an unexpectedly low trigger force setting. The position of the gun's hammer shows the trigger force in effect, but this is poorly discernible when the gun is viewed from straight behind and in a high threat situation where the visual focus is on a distant object, see Figure 5.

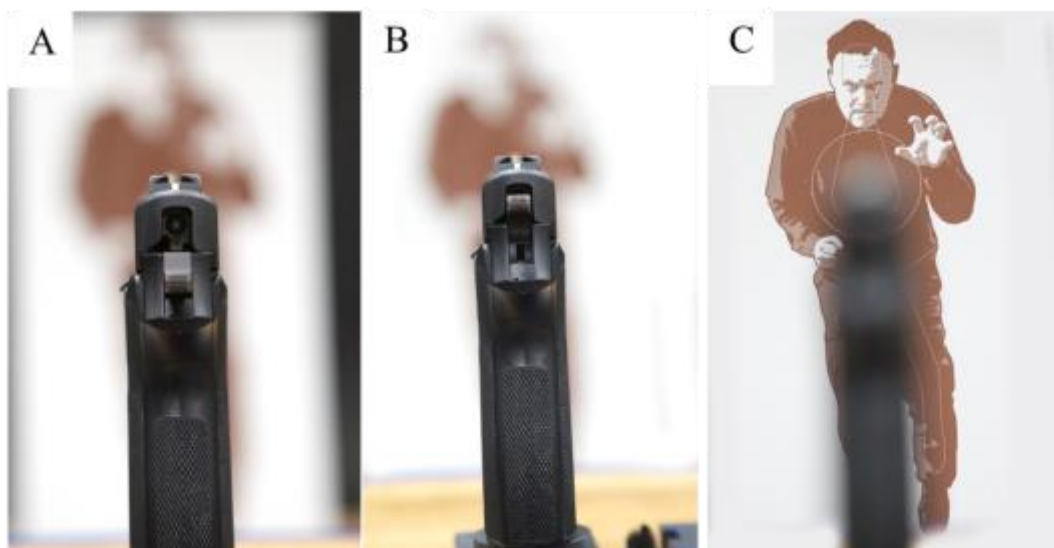


Figure 5. Visibility of the hammer position when viewing a SigSauer® pistol from behind and when the pistol is; (A) Set to low trigger force; (B) Set to high trigger force; (C) When the visual focus is locked on a threat about 5 m away.

Note: Dilated pupils due to stress will increase the poor visibility effect.

Another common factor was that accidental shots were fired when the event came to include physical elements, e.g., a physical confrontation with the assailant. A contributing element could then likely be involuntary clenching of the hand due to reflex responses on different neurological levels from when losing balance, of being startled or from motor errors due to mirror symmetrical movements caused by our human neural muscle homology (Daffertshofer, van den Berg, & Beek, 1999; Enoka, 2003; Heim, Schmidtbleicher, & Niebergall, 2006; Howard, Ingram, Kording, & Wolpert, 2009; McDowell & Wolff, 1997). Hence, when one hand is using extensive force the other hand may unintentionally mirror the movement and increase the force used, thus, may make the index finger slide inside the trigger guard and press the trigger with a force larger than the pistol's firing threshold.

Study limitations

A study limitation was that some parameters analyzed were based on subjective assessments made by the officers involved. This included parameters that are difficult to rate under psychological stress, e.g., time and distance. On the other hand, the data is based on at least 120 individually different observers, meaning that the reported values are likely representative for what was perceived by the police officers involved themselves. Moreover, the protocols used for reporting shooting incident details provided in some areas limited information. Development of a more extensive incident protocol may support more detailed research and of novel tactical procedures to address high threat events.

Conclusion

The study findings suggest that police officers in field service in general should receive high threat incident training. In 80% of the incidents, it was the first officers arriving to the site that addressed the situation and the incidents regularly played out so fast that a SWAT-team rarely was able to reach the site before the incident was over. Firearms training aimed to mimic real-life shooting incidents should include practicing firing at threats on various distances, various target areas, on threats that are in motion and include training to fire without using sights, using one hand and while in motion. The common practice to fire

warning shots in the air is hazardous, given that the bullet in most cases will have lethal velocity when it comes down again (Ordog et al., 1994). Warning shots should be avoided or fired with caution on suitable safe targets. The situational characteristics in many shooting incidents (32%), e.g., the numerical superiority, no firearm threat, available time and distance, might have allowed attempts to incapacitate assailants using medium to long range less-lethal weapons, e.g., EID.

A clear legal framework preemptively detailing how police officers are allowed to handle violent assailants with certain armaments may markedly support designing better tactics, customize training and support design and introduction of suitable less-lethal weapons able to address these situations. The concept of 'safe distance' is poorly viable to real-life scenarios, e.g., an assailant armed with close range weapons can from 10 m inflict no harm, but this can change from a rushed attack within 2 s. A concept of 'safe time', i.e., within what time frame is an assailant able to harm or kill someone, may add a more versatile measure of imminent risks to determine suitable tactics.

Disclosure statement

No potential conflict of interest was reported by the authors.

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