Toward a Taxonomy of the Unintentional Discharge of Firearms in Law Enforcement

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Abstract

An unintentional discharge (UD) is an activation of the trigger mechanism that results in an unplanned discharge that is outside of the firearm's prescribed use. UDs can result in injury or death, yet have been understudied in scientific literature. Pre-existing (1974 to 2015) UD reports (N = 137) from seven law enforcement agencies in the United States of America were analyzed by context, officer behavior, type of firearm, and injuries. Over 50% of UDs occurred in contexts with low threat potential while engaged in routine firearm tasks. The remaining UDs occurred in contexts with elevated to high threat potential during muscle co-activation, unfamiliar firearm tasks, contact with inanimate objects, and a medical condition. An antecedent-behavior-consequence (A-B-C) taxonomy as well as a standardized reporting form, based on the current findings and the existing literature, are offered as tools for identifying the conditions under which UDs may be likely to occur.

Keywords: firearm; gun; law enforcement; police; unintentional discharge

1. Introduction

The unintentional discharge (UD) of a firearm poses a potentially deadly threat not only to the officer involved but also to bystanders such as colleagues and civilians. For example, the New York City Police Department (NYPD) Annual Firearms Discharge Report (Bratton, 2014) documented a total of 499 UDs during an 18-year period (i.e., 1996 to 2013). Of the total UDs reported, 166 resulted in an injury and 14 resulted in a death. These reports suggest that one in three UDs reported by the NYPD resulted in an injury. The NYPD reports define UD as "an incident in which an officer discharges a firearm without intent, regardless of the circumstance." Although lack of intent is the hallmark feature for classifying a firearm discharge as unintentional, it is important to also understand the circumstances under which UDs occur in order to decrease the likelihood of their occurrence in the future.

Upon review of literature relevant to the physiological basis for UDs, Enoka (2003) identified three situations that can result in a UD: (1) a *sympathetic contraction*, (2) a *loss of balance*, and (3) a *startle reaction*. A *sympathetic contraction* occurs when contraction of muscles on one side of the body (i.e., ipsilateral) results in the contraction of the muscles in the other (i.e., contralateral). For example, intentionally squeezing a flashlight with the left hand and, as a result, making a fist with the right hand. As noted by Enoka, the term *sympathetic contraction* does not have a basis in scientific literature, but has been adopted by some in law enforcement nomenclature. The effect has been referred to in physiology literature as *mirror movement* (Arányi & Rösler, 2002; Mayston, Harrison, & Stephens, 1999;), *contralateral irradiation* (Zijdewind & Kernell, 2001), and *contralateral contraction* (Post, Bakels, & Zijdewind, 2009). The term *motor overflow* has also been used as a more general term for muscle contractions that occur in one limb (e.g., an arm or a leg) that lead to increased activity in the

muscles used to hold a firearm (Heim, Schmidtbleicher, & Niebergall, 2006a, 2006b). It has been demonstrated that the force of a contralateral contraction depends on the intensity (Shinohara, Keenan, & Enoka, 2003) and direction of force in space (Post et al., 2009) exerted by the dominant muscle, the level of stress associated with the task (Noteboom, Barnholt, & Enoka, 2001; Weinburg & Hunt, 1976; Williams & Barnes, 1989), and even the ability to see the contralateral limb (Carson & Ruddy, 2012). From this point forth, we refer to any use of a muscle that results in the contraction of the muscles in the trigger finger, as *muscle co-activation*.

A *loss of balance* can result in the contraction of muscles necessary to return the body to a state of equilibrium. Research has suggested that the specific muscle contractions that occur can vary depending on the environment in which the loss of balance occurs (Cordo & Nashner, 1982; Elger, Wing, & Gilles, 1999; McIlroy & Maki, 1995; Schieppati & Nardone, 1995). For example, tripping on a step or uneven ground will result in contraction of the leg muscles as the body attempts to regain balance and may be accompanied by contraction of the arm muscles in order to grasp a railing or another object. Furthermore, it is possible for loss of balance in one limb to promote contractions in the other (Corna, Galante, Grasso, Nardone, & Schieppati, 1996; Dietz, Horstmann, & Berger, 1989; Marsden, Merton, & Morton, 1983). This means that an officer who trips and reaches for a railing with their left hand might experience a contraction of the muscles in their right hand.

The *startle reaction* is a total-body response to auditory, visual, vestibular, or somesthetic stimuli (Bisdorff, Bronstein, & Gresty, 1994; Bisdorff et al., 1999; Hawk & Cook, 1997). It starts with an eye blink and extends to the neck, trunk and shoulders, elbows, fingers, and legs (Brown, 1995; Landis & Hunt, 1939) and may be moderated by fear and arousal (Davis, 1984). For example, if an officer is holding a suspect at gun point and suddenly hears a loud noise such as

the blast of an automobile's horn, the startle response may cause a contraction of the hand muscles. Enoka (2003) suggests two strategies to address the factors involved in a sympathetic contraction, loss of balance, and startle reaction: (1) training on a handling procedure that requires the positioning of the index finger outside of the trigger guard along the barrel of the firearm (i.e., *indexing*) and (2) training to reduce the frequency and intensity of responses. Firearm safety trainings typically highlight the need to keep one's index finger outside the trigger guard except when firing the firearm.

Heim, Schmidtbleicher, and Niebergall (2006a) tested the application of this procedure in an experiment using a pistol fitted with a sensor to register any pressure exerted on the trigger. Forty-six police officers, who had been trained to index their trigger finger participated in a simulated scenario involving an armed robbery suspect. Thirty-four of the officers removed their firearm from its holster and 20% of those officers placed their index finger on the trigger for longer than 1s during the scenario. None of the officers reported being aware of any contact with the trigger. In support of Enoka's (2003) primary suggestion, these results suggest that regulations may not be sufficient to promote indexing behavior in some contexts; therefore, specific training on the technique under various levels of stress may be warranted. Given evidence to suggest that officers may contact the trigger of a firearm in some contexts, Heim et al. (2006a; 2006b) investigated the extent to which muscle co-activation could contribute to UDs. Twenty-five students with various sporting histories and between 21 and 39 years of age participated in five strenuous activities involving both upper and lower limbs (e.g., jumping, pulling/pushing bars and pulleys, kicking, and destabilization) at maximum and sub-maximum intensity for a total of 144 trials across 13 conditions. The authors reported that, on average, muscle co-activation reached maximum force within 200ms of trial onset and that the force

exceeded the trigger weight of an uncocked firearm (8 to 12 pounds) in 6.25% of trials and a cocked firearm (4 to 6 pounds) in 20% of the total 144 trials. The results suggested that UDs might be likely to occur during strenuous use of the lower limbs and suggest that officers use extreme caution when engaging in forceful actions involving their legs (e.g. kicking a door or jumping). Furthermore, some support was provided for Enoka's (2003) proposal that a loss of balance could result in a UD. One third of the sample that participated in the balance condition (n=12) exerted force on the back of the firearm's hand stock that exceeded the trigger weight of a cocked firearm. With preliminary evidence for the effects of muscle co-activation and loss of balance, it has been proposed that a host of human factors might contribute to UDs.

Hendrick, Paradis, and Hornick (2008) considered the additional physiological effects of stress (e.g., bodily trembling), fatigue (e.g., decreased eye-hand coordination), and drugs (e.g., general impairment of motor functioning) in a chapter on the human factors associated with UDs. The authors also pointed to complacency (e.g., a shift in attention), human error (e.g., skipping a safety step), firearm design (e.g., single vs. double action triggers), and insufficient training (e.g., lack of skill transfer to the real world) as potential factors in the frequency of UDs. In fact, Reason's (1990) generic error-modeling system (GEMS) suggests that errors at the *skill-based level* might be remedied through training. This type of error precedes the detection of a problem (i.e., the unintentional discharge of a firearm) and is unlikely to be affected by any rule or problem-solving strategy in the moment. According to Reason (1990), skill-based *slips and lapses* occur when "actions deviate from the current intention due to execution failures…" (Reason, 1990, p. 53) and can be *strong-but-wrong* in that the error "is more in keeping with past practice than the current circumstances demand" (Reason, 1990, p.54). For example, an officer

who does not intentionally practice indexing at the firing range, is unlikely to engage in the behavior during a use-of-force when their attention is directed toward a threat.

There are myriad contexts in which the UD of a firearm can occur.. However, all UDs will have the following properties in common: (a) an antecedent (i.e., a stimulus or environmental change) that precedes and sets the occasion for a behavior; (b) a behavior (i.e., flexion of the finger muscles) that follows the environmental change; and (c) a consequence (i.e., firearm discharge) that follows said behavior. An antecedent-behavior-consequence (A-B-C) model allows for a pragmatic examination of UDs in terms of identifying the conditions under which UDs may be more likely to occur. The primary purpose of this analysis was to extend previous research on UDs by identifying the context, officer behavior, and types of firearm involved. A secondary purpose was the conceptualization of an A-B-C taxonomy of UDs that might inform the development of proactive strategies to prevent or minimize their occurrence as well as a standardized reporting form that may yield a systematic means to collect information. Data might also inform departmental policies and procedures surrounding the issues related to UDs.

2. Method

UD was operationally defined as *an activation of the trigger mechanism that results in an unplanned discharge that is outside of the firearm's prescribed use*. Prescribed use refers to departmental policies and laws related to the operation of firearms. This excludes a situation where a subject gains control of an officer's firearm and activates the trigger mechanism. A request for information was distributed via Force Science® News. Seven law enforcement agencies in the United States of America provided pre-existing (1974 to 2015) descriptive information on a total of 137 individual reports of UDs. Currently, there is no standardized

procedure for reporting UDs in law enforcement. In fact, some agencies do not require the tracking of ammunition counts or off-duty incidents. Instances of UDs were submitted in narrative form, redacted official documents, and raw spreadsheets, from which the experimenters were able to parse details about: (a) *the context*: a brief description of the situation in which the UD occurred; (b) *the officer's behavior*: a brief description of the action that resulted in the UD; (c) *the firearm*: specifications such as manufacturer and model; and (d) *injuries*: whether or not any involved parties required medical attention. A number of reports contained ambiguous information in one or more of the aforementioned categories. These data are reported as *unspecified*. All other identifying information about the parties involved was withheld. The law enforcement agencies provided approval for the confidential analysis and publication of the data contained in this report.

2.1. Procedures

Categories and subcategories were developed in accordance with the existing literature on UDs as well as the information gleaned from the present reports.

2.1.1. Context. First, a determination was made as to the on- or off-duty status of the officer at the time of the UD. Next, an approximation of the potential for encountering a threat during the incident was made. According to the Federal Bureau of Investigation's (FBI's) Law Enforcement Officers Killed and Assaulted data, officers are most likely to be attacked while conducting investigations, searches, attempting arrests, or serving summonses and least likely to be attacked while on office duty (FBI, 2014). *Low threat potential* was defined as a UD that occurred during any situation that did not involve a response to a call (i.e., routine tasks). Eight subcategories of the low threat potential context were identified: department parking lots/vehicle, firing ranges, locker rooms, residences, offices, public businesses, hotel rooms, and situations not

otherwise specified. *Elevated threat potential* was defined as a UD that occurred during an officer's response to a call (i.e., on a call). Four subcategories of the elevated threat potential context were identified: in the staging area of an operation, clearing an area, preparing to conclude a call, and situations not otherwise specified. *High threat potential* was defined as a UD that occurred during an officer's response to a call when the officer was likely to become or was already engaged with a suspect (i.e., higher likelihood for the use-of-force). Use-of-force refers to the continuum recognized by the National Institute of Justice (2009), in which officer behavior ranges between mere officer presence, use of verbal commands, empty-hand control, less-lethal methods, and lethal force. Six subcategories of the high threat potential context were identified: detaining a suspect, felony traffic stop, search for an armed suspect, providing cover for a fellow officer, exiting a vehicle to make an arrest, and chasing a suspect on foot.

[insert Table 1 here]

2.1.2. Officer behavior. Reports were then categorized according to the behaviors that officers were engaged in at the time of UD. Table 1 contains definitions and examples for each category and subcategory of officer response. Six distinct categories emerged: *Contact* was defined as an event in which the firearm was positioned such that the trigger mechanism is activated by someone or something other than the officer in possession of the firearm. *Medical Condition* was defined as any event that includes a symptom of a disease or disorder. Two subcategories of medical condition were identified: seizures and twitch/tremor. *Muscle Co-activation* was defined as an event in which muscle activity unrelated to the firearm's trigger was associated with a contraction of the muscles in the finger positioned on the firearm trigger. This includes using any part of the body to climb, jump, kick, punch, pull, push, run, squeeze (cf. contralateral contraction), or otherwise engage in an activity unrelated to the firearm's trigger.

Six subcategories of co-activation were identified: a loss of balance, a loss of grip, use of other finger(s), use of leg(s), use of an arm(s), and use of other hand. *Routine Firearm Task* was defined as a manipulation of a firearm, on- or off-duty, which did not involve a response to a call. Five subcategories of routine firearm tasks were identified: clearing, storing or moving, function check, unholstering/reholstering, and conducting firearm maintenance; *Startle Response* was defined as any event in which the officer is exposed to a sudden change in environmental stimuli and reacts with total-body muscle contractions. This includes responses to loud sounds, fast-approaching objects, and sensations of cold, heat, pain, pressure, and touch. Four subcategories of startle stimuli were identified: auditory stimulus, visual stimulus, vestibular stimulus, or somesthetic stimulus. *Unfamiliar Firearm Task* was defined as any event that includes use of the non-dominant hand or manipulation of a new, novel, or recently modified piece of equipment related to the firearm. Five subcategories of unfamiliarity were identified: firearm, hand transfer, holster/belt, equipment location, and arm/hand crossover.

2.1.3. Firearm. Four categories of firearm were reported. *Semi-automatic* was defined as a handgun that uses the energy of a discharge to cycle the action of the firearm and advance the next available cartridge into the firing position. *Revolver* was defined as a handgun that uses a revolving cylinder with multiple cartridge chambers. *Rifle* was defined as a firearm designed by the manufacturer to fire a bullet from the shoulder position. *Shotgun* was defined as a firearm designed by the manufacturer to fire a slug or the contents of a shotgun shell from the shoulder position.

2.1.3.1. Trigger action. Four types of trigger action were identified. *Single only* was defined as a trigger that performs only the action of releasing a hammer/striker. *Double only* was defined as a trigger that performs both the action of fully cocking and releasing a hammer/striker

for every discharge. *Double/single* was defined as a trigger that performs both the action of cocking and releasing a hammer/striker on the first shot but only the action of releasing a hammer/striker on subsequent discharges. *Pre-set* was defined as a trigger that performs the action of completing the cocking cycle and releasing a partially cocked hammer/striker.

2.1.4. Injury. An injury was defined as an event in which any involved parties required medical attention or were struck by the firearm's projectile as a result of the UD. Reports were categorized as either yes or no.

2.1.5. Inter-observer Agreement (IOA). A trained secondary coder reviewed 30% (n = 41) of the reports resulting in a high level of IOA across variables (90.2%). IOA was calculated using the following formula: total number of agreements divided by agreements plus disagreements, multiplied by 100%.

3. Results

UDs (N = 137) occurred in sixteen discriminable contexts, involved fifteen officer behaviors, four general types of firearm, and resulted in injuries ranging from flesh wounds to fatality.

3.1. Context

UDs occurred on-duty (70.8%), off-duty (16.1%), and under unspecified (13.1%) circumstances. As displayed in Figure 1, contexts involved low (50.4%), elevated (23.4%), high (15.3%), and unspecified (10.9%) threat potential.

[insert Figure 1 here]

3.1.1. Threat potential. The following data represent *within-category* percentages. Table 2 contains the number and percentage of *total* UDs per mutually exclusive contextual sub-category. The low threat potential category (n = 69) contains UDs that occurred on a firing range

(21.7%), in departmental parking lots (20.3%), in a locker room (17.4%), not otherwise specified (15.9%), at the officer's place of residence (10.1%), in a departmental office (8.7%), a public place of business (2.9%), and in officer's hotel rooms (2.9%). The elevated threat potential category (n = 32) contains UDs that occurred during a response to a call while clearing an area (65.6%), at the end of a call (18.8%), not otherwise specified (12.5%), and in a staging area (3.1%). The high threat potential category (n = 21) contains UDs that occurred while conducting a felony traffic stop (28.6%), searching for an armed suspect (28.6%), not otherwise specified (14.3%), providing cover (14.3%), using physical restraint (9.5%), and chasing a suspect on foot (4.8%).

[insert Table 2 here]

3.2. Officer Behavior

As displayed in Figure 2, officers were engaged in routine firearm task (59.1%), muscle co-activation (24.1%), unfamiliar firearm tasks (10.9%), contact with objects (7.3%), unspecified behaviors (3.6%), and/or experiencing medical condition (0.7%).

[insert Figure 2 here]

3.2.1. Behavioral subcategories. The following data represent *within-category* percentages; the number and percentage of *total* UDs per behavioral sub-category (not mutually exclusive) can be located in Table 3. Routine firearm tasks (n = 81) included clearing (33.3%), storing/moving (23.5%), holstering/unholstering (17.3%), function checks (16.0%), and conducting maintenance (9.9%). Muscle co-activation (n = 33) included the use of another finger (36.4%), a loss of grip (21.2%), use of a leg (18.2%), a loss of balance (15.2%), and use of the other hand (9.1%). Use of another arm was not reported. Unfamiliar firearm tasks (n = 15) included those involving hand transfers (40.0%), unfamiliar firearms (33.3%), and holsters/belts

(26.7%). Equipment locations and arm/hand crossovers were not reported. Contact with objects (*n* = 10) only involved inanimate objects. Animate objects were not reported. Medical conditions (*n* = 1) involved one instance of a seizure. Twitches/tremors were not reported. None of the reports were indicative of a startle response.

[insert Table 3 here]

3.3. Firearm

In all, 23 models from 11 firearm manufacturers were reported. As displayed in Figure 3, UDs involved semi-automatic handguns (59.9%), unspecified firearms (17.5%), shotguns (12.4%), rifles (6.6%), and revolvers (3.6%).

[insert Figure 3 here]

3.3.1. Trigger action. The following data represent *within-category* percentages, whereas Table 4 contains the number and percentage of *total* UDs per mutually exclusive firearm sub-category. Semi-automatic handguns (*n* = 82) involved trigger actions that were preset (73.2%), not otherwise specified (12.2%), double/single (11.0%), single only (2.4%), and double only (1.2%). Shotgun (*n* = 17) and rifle (*n* = 9) trigger action was single only. Revolvers (*n* = 5) involved double/single (40.0%), not otherwise specified (40.0%), and double only (20.0%).

[insert Table 4 here]

3.4. Injuries

Injuries (*n* = 21) were reported in 15.3% of reports, 10.9% reported no injuries, and 73.7% were unspecified. Within cases that resulted in injury, officer behaviors were routine firearm tasks (*n* = 15), unspecified (*n* = 5), contact with an inanimate object (*n* = 3), unfamiliar tasks (*n* = 1), a medical symptom (*n*=1), and a muscle co-activation (*n* = 1). Injuries occurred in

contexts with low (n = 16), elevated (n = 1), high (n = 3), and unspecified (n = 1) threat potential. One UD resulted in an officer fatality.

4. Discussion

4.1. Contextual Factors

Nearly three quarters of all UDs occurred in contexts with low to elevated threat potential. This might be expected given the relatively short duration of high threat potential activities as well as the low frequency of activities that result in the unholstering of a duty weapon. That is to say, officers spend a very small proportion of their time engaged in use-of-force encounters that extend beyond officer presence or verbal commands (Eith & Durose, 2011).

4.1.1. Low threat potential. Over half of the total UDs occurred in contexts with low threat potential. Departmental parking lots, firing ranges, and locker rooms made up over half of UDs that occurred in contexts with a low threat potential. One explanation might be that this percentage is proportional to the amount of time officers spend in contexts with low threat potential. An alternative explanation is that officer complacency with regards to handling firearms is more common in contexts with low threat potential. In addition to complying with range protocols, these data suggest that officers should be mindful of their firearm handling outside of calls. It seems likely that officers spend a considerable portion of time in locker rooms and departmental parking lots at the beginning and end of their shifts.

4.1.2. Elevated threat potential. Roughly one quarter of the total UDs occurred in contexts with elevated threat potential and nearly two thirds of those UDs took place while officers were in the process of clearing an area (e.g., a room or lot) during a call. The remaining UDs specified in this category occurred at either the beginning or end of a call and suggest that officers should be vigilant when preparing to respond and maintain special vigilance for a period

following a call until the firearm is secure. Future research might seek to determine appropriate procedures for such a period.

4.1.3. High threat potential. Approximately one sixth of the total UDs occurred in contexts with high threat potential. Detaining a suspect and conducting felony traffic stops each accounted for over a quarter of the UDs in the category. One explanation for this might be that this percentage is proportional to the amount of time officers spend in contexts with high threat potential. If so, officers who have received firearm training that simulates a context with high threat potential might be less likely to experience UDs when placed in similar real-world situations. Future research might examine firearm manipulation in dynamic scenarios with exposure to various degrees of simulated threat that require use of other limbs, startle stimuli, or unfamiliar firearm tasks, situations, or equipment.

4.2. Officer Behavior

4.2.1. Routine firearm tasks. More than half of the total UDs occurred during routine manipulation with clearing a firearm accounting for more than double that of any other sub-category. UDs can occur during clearing when there is a round loaded in the chamber of a firearm and the slide is released in a forceful manner. UDs can occur during function checks when officers intentionally pulled the trigger of their firearm but were under the assumption that it was not loaded (i.e., dry-fire). In fact, three such UDs occurred while officers were practicing a quick-draw procedure. For these reasons, officers should always handle firearms with the assumption that they are loaded, even during routine manipulation. Indexing the trigger finger along the slide or trigger guard of the firearm might have prevented UDs that occurred during storing/moving, holstering/unholstering, and maintenance of firearms. However, some firearms require that the operator pull the trigger in order to disassemble the firearm. In these cases,

officers should use visual and tactile inspection to ensure that the chamber is empty before engaging the trigger.

4.2.2. Muscle co-activation. One quarter of the total UDs involved muscle co-activation, with use of another finger accounting for over a third of the category. This type of UD occurred when the officer attempted to activate a weapon-mounted device such as a flashlight or laser with the middle finger of the hand holding the firearm. In support of Heim, Schmidtbleicher, and Niebergall (2006a; 2006b), UDs involved the use of a leg to kick, jump, or step up onto an object as well as use of the other hand to push or pull an object (e.g. a door). It is possible that some UDs involved contralateral contractions but none of the reports contained sufficient detail to make a definitive conclusion. However, further support was provided for Enoka's (2003) proposal that a loss of balance might result in a UD. In this study, officers reported falling or stumbling and reaching out to catch their balance as a UD occurred. In addition to the situations outlined by Heim et al. (2006a; 2006b) and Enoka (2003), the present analysis suggests that a loss of grip on the firearm can result in a UD. These occurred as the officers attempted to regain control in order to avoid dropping their firearm. This type of UD may be more common in concealed carry firearms that have a relatively short hand stock in comparison to various other stock sizes. Future research might replicate and extend the works of Heim et al. (2006a; 2006b) by analyzing the effect of stock size. Overall, these data provide support for the recommendation for officers to train in scenarios designed to elicit muscle co-activation.

4.2.3. Unfamiliar firearm tasks. UDs involving unfamiliar firearm tasks were involved in approximately one tenth of the total reports. These included the manipulation of someone else's firearm, holstering/unholstering with a new or different holster, and transferring a firearm to or from the non-dominant hand. These data suggest that, when possible, officers should

exercise caution when handling any firearm that is not their own. Additionally, officers should engage in regular practice handling/indexing with their non-dominant hand and practice with any new/unfamiliar equipment.

4.2.4. Contact. Ten UDs involved a firearm coming in contact with some sort of inanimate object. Reports indicated that the firearm triggers might become entangled in the officer's radio antenna/cord or in a curtain or bed sheet while attempting to clear an area. Officers should be mindful of any object that has the potential to be inserted or become entangled within the trigger guard of their firearm. Contact with animate objects was not suggested in the present data set and hasn't been proposed in previous research, so it was not included in the taxonomy. Future research could examine the occurrence of UDs resulting from contact with animate objects, such as a subject attempting to gain control of an officer's firearm while grappling with an officer.

4.2.5. Medical conditions. One UD involved an officer who experienced a seizure. Officers should seek medical consultation and engage in strict adherence to medical regimen prescribed for all conditions that may impact work performance.

4.2.6. Startle responses. There was no evidence to suggest that any of the UDs involved a startle response. It is possible that some UDs involved a startle response but none of the reports contained sufficient detail to make a definitive conclusion. Future research might explore this phenomenon with respect to UDs by exposing officers to conditions that apply sudden changes in auditory somesthetic, vestibular (cf. loss of balance), and visual stimuli. Such data might provide support for Enoka's (2003) assertion that a startle response can result in a UD.

4.3. Firearms

The analysis of firearm type and trigger action serves to illuminate the fact that UDs can and do occur across a wide variety of manufacturers, models, and firearm types. Many law enforcement agencies use semi-automatic handguns with preset trigger mechanisms as their standard issue firearm. This fact might explain why such a large proportion of the UDs in the present sample involved semi-automatic handguns and preset triggers. It is possible that trigger poundage and pull length influenced the occurrence of UDs in certain contexts, and in relation to particular officer behaviors. However, this information should be interpreted with caution as the present sample was not counter-balanced in any fashion and so, an analysis of firearm design was not appropriate. According to manufacturer specifications retrieved online, triggers involved in this study had weights that fell within the range of 4 to 13 pounds.

A more parsimonious and alternative explanation for any increase in the occurrence of UDs might be found in an examination of standard issue transition-training. In the absence of training to fluency, a relative increase in UDs might be expected during any transition between standard issue firearms, regardless of poundage and pull length (e.g., Katz, 2015). Future research might extend the work of Heim et al. (2006a; 2006b) by comparing the frequency of UDs under similar conditions but incorporating various firearm designs.

4.4. Injuries

UDs can result in serious injury and death. For this reason alone, it is crucial that law enforcement continue to analyze the contexts, officer behavior, and firearm designs that contribute to UDs in order to inform qualification, remediation, and transition training, policies, and procedures.

4.5. Taxonomy

Figure 4 displays a taxonomy developed from the findings of this study and the previous literature concerning situations that can result in UDs. This taxonomy could provide the foundations for performance-based training that may minimize the occurrence of UDs. The taxonomy might inform trainers to target known contexts within which UDs occur during real-world training scenarios.

[insert Figure 4 here]

5. Conclusion

In line with Reason's (1990) GEMS, skill-based errors in the form of slips (e.g., pulling the trigger when intending to activate a weapon-mounted flashlight) and lapses (e.g., forgetting to clear the chamber) might account for many of the aforementioned UDs given that over half occurred during routine use and care of a firearm. Reason (1990) also suggests that *attentional capture* (i.e., distraction or preoccupation with something other than the routine task at hand) can lead to a shift in focus of attention and the intrusion of a strong habit. To build on the previous example, an officer who routinely practices without indexing at the firing range but does occasionally practice indexing during role-play scenarios, may unintentionally place their finger on the trigger during a use-of-force because indexing is not the stronger habit and their attention is preoccupied by a threat. It seems plausible that focus of attention may be the missing link between an officer's intent and the resulting unintentional action. As such, training areas that involve intentional practice and the development of strong habits are emphasized in order to minimize the potential for UDs.

5.1. Assume the Firearm is Loaded

Officers should handle firearms with the assumption that they are loaded until checked. Individuals operating firearms are encouraged to verify there is no ammunition in the chamber

before completing a dry-fire or disassembly with the barrel of the firearm pointed in a safe direction. If not already in practice, trainers are encouraged to consider crucial clearing steps in firearms disassembly that officers must perform in order to pass training, such as ejecting the magazine, racking the slide, and then performing visual/tactile inspection of the chamber. These steps should be trained in a variety of contexts (e.g., range and role-play scenarios) in order to promote generalization to other settings.

5.2. Practice Indexing

Indexing the trigger finger along the slide or trigger guard of the firearm should be a well-trained precaution and might have prevented many of the UDs reported in this study. Given that officers may not be aware of touching a trigger during simulated scenarios (Heim, Schmidtbleicher, & Niebergall, 2006a; 2006b), trainers may consider building the skill of indexing to fluency by executing the skill with speed and accuracy during dynamic training conditions. That is, officers may be able to demonstrate a skill on the range in a static position and under low stress conditions, but the same skill may not generalize to other contexts involving dynamic movements and higher physiological arousal.

5.3. Point the Firearm in a Safe Direction

Perhaps most important is the practice of pointing the firearm in a relatively safe direction (e.g. a low-ready position) until there is an intent to discharge the firearm. Although this precaution may not prevent a UD, actively predicting the outcome of a UD during practice might decrease the potential for injury to the officer and bystanders should a UD occur during or outside practice. Training to fluency of this and the aforementioned skills would also be beneficial in civilian concealed-carry training programs. Numerous agencies provided data that spanned several decades; however, a relatively small sample of 137 UDs was reported.

Departmental consequences ranged from informal to formal internal investigations, firearms re-training and re-qualification, to automatic termination. Officers may be more likely to report UDs if mandated, such as a policy to report ammunition count. However, a less stringent and less aversive approach may be remediation training without punitive repercussions (such as unpaid leave or termination) where appropriate. Such an approach might result in an increase in reported UDs but will ultimately serve to inform policies and procedures for the safe handling and operation of firearms.

It should be noted that although there are limitations inherent in departmental self-reporting, in-situ data collection would be impractical given the infrequency of UDs. Analyzing UDs using an A-B-C approach might aid in clarifying the conditions under which UDs are likely to occur. The proposed taxonomy herein could provide the foundations for procedures and skill-based training aimed at minimizing the occurrence of UDs and increasing the safe handling and operation of firearms. Trainers are encouraged to compare and contrast the current findings with UDs that have occurred within their own agency (see Appendix I for a reporting form) in order to develop idiosyncratic training targets in an attempt to emphasize those contexts that involve an increased risk of UDs.

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Table 1. Behavioral categories and subcategories of UDs with definitions and examples.

Category	Definition	Sub-category	Examples
Contact	An event in which the firearm is positioned such that the trigger mechanism is activated by something other than the officer in possession of the firearm.	**Inanimate Object** - A non-living thing.	Firearm trigger catches on a radio antenna or a bathroom stall clothing hook.
Medical Symptom	An event that involves a symptom of a disease or disorder or a medication side effect.	**Seizure** - An event that involves convulsions during which the body shakes rapidly and uncontrollably due to abnormal brain activity.	An officer forgets to take his/her anticonvulsant medication.
		Twitch/Tremor - An involuntary quivering or shaking movement	An officer has been under an excessive amount of stress.
Muscle Co-activation	Activity in muscles not associated with the trigger mechanism leads to a significant increase in the force exerted on the trigger by the trigger finger, which results in enough pressure to overcome the trigger pull.	**Loss of Balance** - A rapid involuntary contractions occur due to loss of balance or disturbance in posture in an effort to return the body to a position of equilibrium.	An officer slips on a wet surface and attempts to regain control of their body.
		Loss of Grip - An event in which force is exerted against a part of the body or firearm that results in a loss of control over the firearm.	A golf bag falls on the gun hand causing the officer to lose grip on firearm and subsequently, attempt to regain control.
		Use of Arm(s) - Co-activation of muscles wherein an involuntary contraction may occur in the muscles of the hand when muscles in either arm are performing a forceful action.	Using the elbow to forcefully push open or close a door.
		Use of Leg(s) - Co-activation of muscles wherein an involuntary contraction may occur in the muscles of the hand when muscles in either leg are performing a forceful action.	Jumping over a barrier, running, climbing up stairs, or kicking a door open.
		Use of Other Finger(s) - Co-activation of muscles wherein an involuntary contraction may occur in the muscles of the index finger when muscles in other fingers are performing a forceful action.	Officer attempts to depress the frame-mounted light switch with his/her middle finger and simultaneously squeezes the index finger.
		Use of Other Hand - A contralateral contraction wherein involuntary contraction may occur in the muscles of one hand when the same muscles in the other hand are performing a forceful action.	Using the non-firearm hand to forcefully push or pull a door handle.
Routine Firearm Task	Manipulation of a firearm, on- or off-duty that does not involve a response to a call.	**Clearing** - Manipulating the slide of a firearm outside of a use of force encounter or potential use of force encounter	Releasing the slide; attempting to render a weapon safe at a range or at home.
		Function Check - Attempting to dry-fire or otherwise check the trigger mechanism of a firearm.	Officer believes the firearm to be empty and practices drawing and firing.

		Holstering/Unholstering - Manipulating the duty firearm into or out of the standard holster outside of a use of force encounter	Moving the gun into or out of the holster outside of a call (in a hallway or parking lot)
		Maintenance - Cleaning, breaking down, or otherwise maintaining a firearm.	Changing a part; firearm requires the trigger to be pulled for disassembly.
		Storing/Moving - Transferring a firearm with or without other equipment into or out of a storage location.	Moving/loading the firearm into a locker, out of storage, out of a bag, checking the firearm into or out of evidence.
Startle Response	A whole-body response that involves rapid involuntary contractions that begins with the blink of an eye and spread to all muscles throughout the body and leads to individuals clenching their fists.	**Auditory Stimulus** - An energy change that affects an organism through the auditory system.	A loud and unexpected fire alarm.
		Somesthetic Stimulus - An energy change that affects an organism through pain, pressure, temperature, or touch.	Someone suddenly and unexpectedly bumps into the officer.
		Vestibular Stimulus - An energy change that affects an organism through equilibrium, motion, or orientation.	A sudden and unexpected free fall from a floor that gives way.
		Visual Stimulus - An energy change that affects an organism through the visual system.	A sudden and unexpected movement.
Unfamiliar Firearm Task	An event that involves use of the non-dominant hand or manipulation of a new, novel, or recently modified piece of equipment.	**Arm/Hand Crossover** - Placing one hand over the other so that the right hand is on the left side and the left hand is on the right side.	Officer uses his/her non-dominant hand to brace the firearm hand from below while pointing a handheld flashlight.
		Equipment Location - Manipulating a firearm that is in an unpracticed location.	Officer's firearm is in a location that is typically occupied by other equipment.
		Firearm - Manipulating a firearm other than the officer's own duty firearm.	Officer is manipulating a firearm obtained from a suspect or another officer.
		Hand Transfer - Manipulating a firearm with the non-dominant hand.	Officer has not practiced passing a firearm from one hand to the other.
		Holster/Belt - Manipulating a firearm into or out of a new/different holster or belt.	Officer has been issued a new holster and has not sufficiently practiced with the new equipment.

Table 2. Number and percentage of UDs in contexts that involved low threat potential (routine), elevated threat potential (responding to a call), and high threat potential (likely use-of-force) situations. Sub-categories are mutually exclusive.

Threat Potential	Sub-category	n	%
Low (outside of a call)	Firing range	15	10.9
	Dept. parking lot	14	10.2
	Locker room/restroom	12	8.8
	Not otherwise specified	11	8.0
	Residence (of the officer)	7	5.1
	Dept. office	6	4.4
	Public business	2	1.5
	Hotel room	2	1.5
Elevated (responding to a call)	Clearing an area	21	15.3
	End of a call	6	4.4
	Not otherwise specified	4	2.9
	Staging area	1	0.7
High (likely use-of-force)	Felony traffic stop	6	4.4
	Searching for armed suspect	6	4.4
	Not otherwise specified	3	2.2
	Providing cover	3	2.2
	Physical restraint	2	1.5
	Chasing suspect on foot	1	0.7
Unspecified	Not applicable	15	10.9
Total		137	100.0

Table 3. Number and percentage of total UDs by behavioral sub-category and organized according to parent category totals. Sub-categories are not mutually exclusive.

Behavior	Sub-category	n	%
Routine Firearm Task	Clearing	27	19.7
	Storing/moving	19	13.9
	(Un)Holstering	14	10.2
	Function check	13	9.5
	Maintenance	8	5.8
Muscle Co-activation	Use of other finger(s)	12	8.8
	Loss of grip	7	5.1
	Use of leg(s)	6	4.4
	Loss of balance	5	3.6
	Use of other hand	3	2.2
	Use of arm(s)	0	0.0
Unfamiliar Firearm Task	Hand transfer	6	4.4
	Firearm	5	3.6
	Holster/belt	4	2.9
	Equipment location	0	0.0
	Arm/hand crossover	0	0.0
Contact	Inanimate object	10	7.3
Unspecified	Not Applicable	5	3.6
Medical Symptom	Seizure	1	0.7
	Twitch/tremor	0	0.0
Startle Response	Auditory	0	0.0
	Somesthetic	0	0.0
	Vestibular	0	0.0
	Visual	0	0.0
Total		137	100.0

Table 4. Number and percentage of total UDs by firearm categories. Categories and sub-categories are mutually exclusive.

Firearm	Trigger Action	n	%
Semi-auto	Preset	60	43.8
	Not otherwise specified	10	7.3
	Double/single	9	6.6
	Single only	2	1.5
	Double only	1	0.7
Unspecified	Not applicable	24	17.5
Shotgun	Single only	17	12.4
Rifle	Single only	9	6.6
Revolver	Double/single	2	1.5
	Not otherwise specified	2	1.5
	Double only	1	0.7
Total		137	100.0

Figure 1. Percentage of UDs by threat potential category.

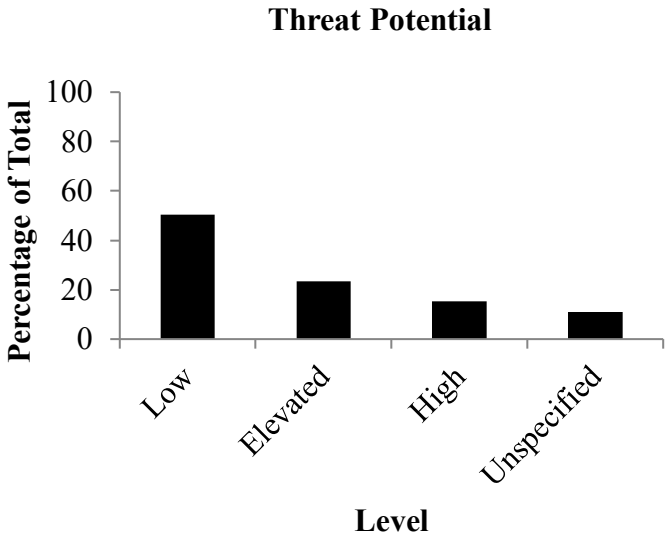


Figure 2. Percentage of UDs by behavioral category.

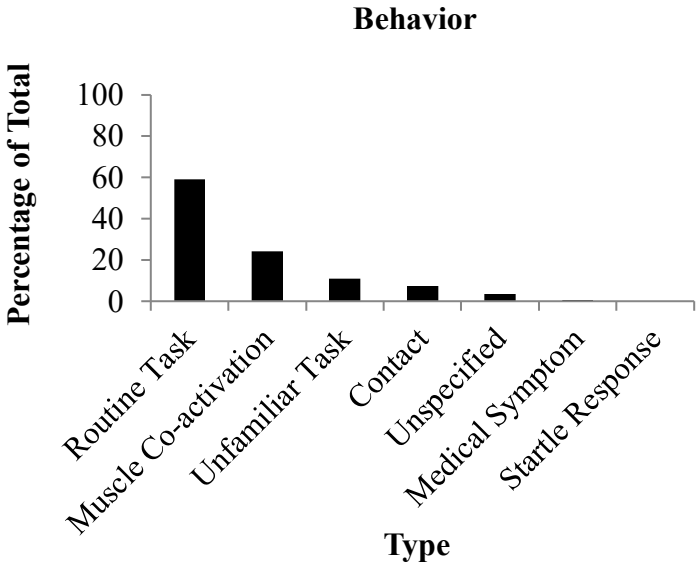


Figure 3. Percentage of UDs by firearm category.

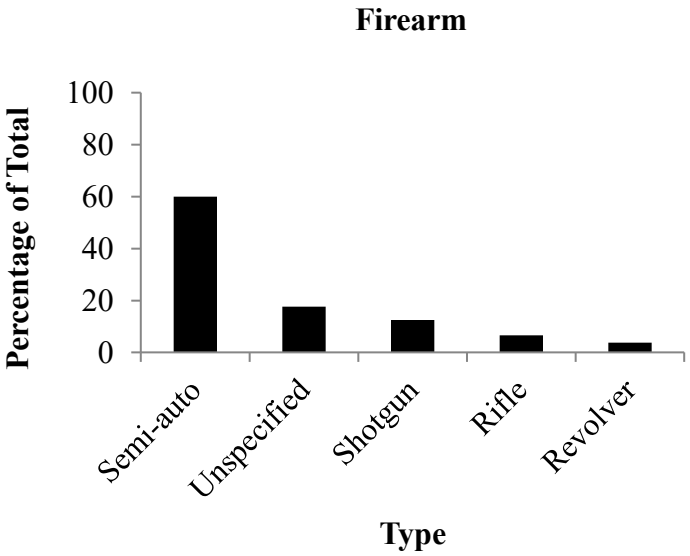
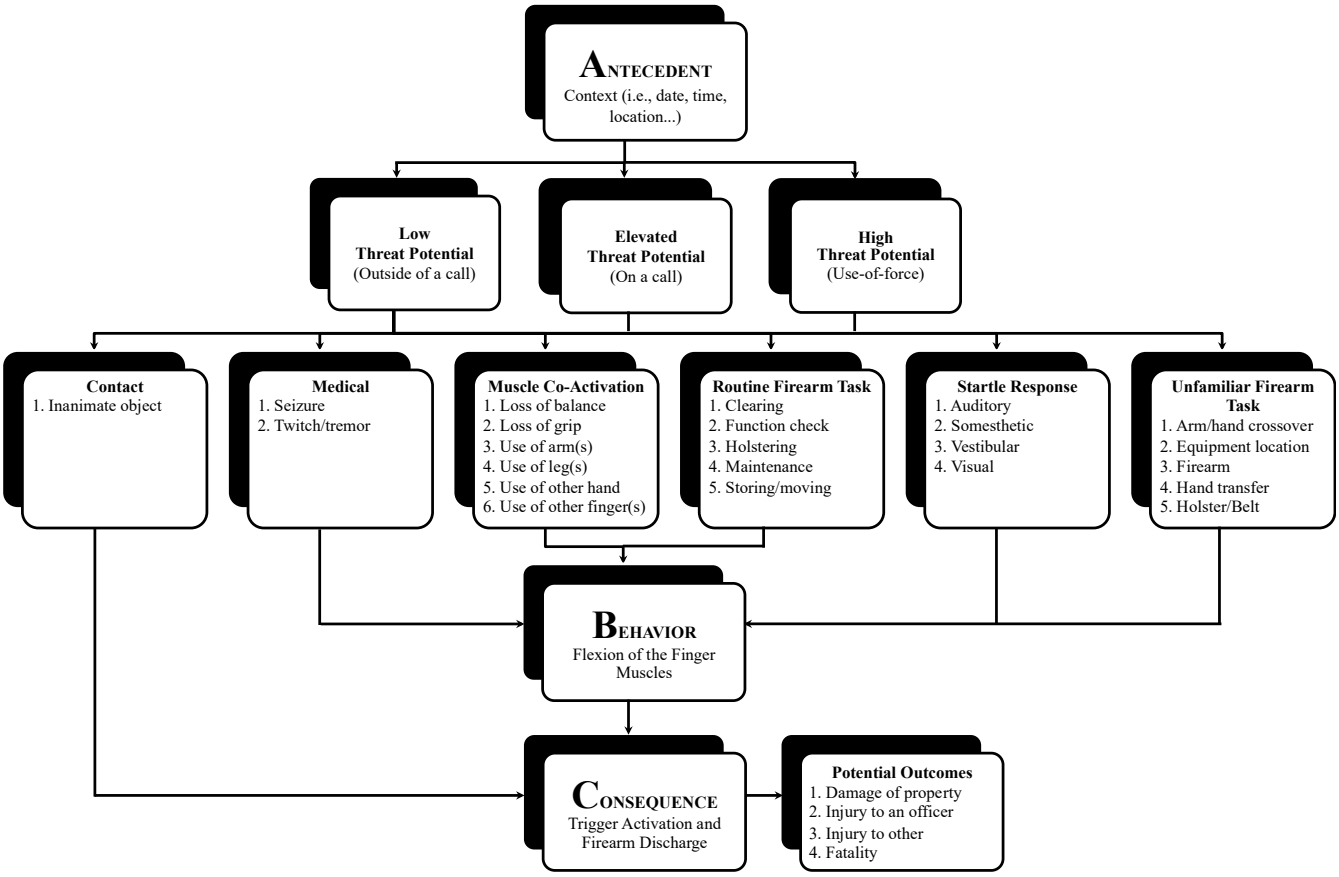


Figure 4. Antecedent-behavior-consequence (A-B-C) taxonomy of UDs.



APPENDIX I.

Unintentional Discharge (UD) Tracking Form (Front)

Officer involved: **Date of UD:** **Time of UD:**

On- or off-duty: ☐ On-duty ☐ Off-duty
If on-duty, for how many hours?
_____

Threat potential: ☐ Low (outside of a call) ☐ Elevated (responding to a call) ☐ High (likely use-of-force)
Describe the location in which the UD occurred:
_____

Officer Behavior: ☐ Contact with an inanimate object ☐ Medical Symptom ☐ Muscle Co-activation
☐ Routine Task ☐ Startle Response ☐ Unfamiliar Task (see reverse for definitions)
Describe what the officer was doing immediately before the UD:
_____
_____
_____
_____

Firearm involved: ☐ Semi-automatic ☐ Revolver ☐ Rifle ☐ Shotgun
Manufacturer: _____ Model: _____
Trigger function: ☐ Double only ☐ Double/single ☐ Preset ☐ Single only

Injuries/Damages: ☐ Officer ☐ Subject ☐ Bystander ☐ Property
Describe any injuries/damages or additional details:
_____
_____
_____
_____

Unintentional Discharge (UD) Tracking Form (Back)
Behavioral Definitions

Contact: An event in which the firearm is positioned such that the trigger mechanism is activated by something other than the officer in possession of the firearm.

Medical Symptom: An event that involves a symptom of a disease or disorder or a medication side effect.

Muscle Co-activation: Activity in muscles not associated with the trigger mechanism leads to a significant increase in the force exerted on the trigger by the trigger finger, which results in enough pressure to overcome the trigger pull.

Routine Firearm Task: Manipulation of a firearm, on- or off-duty that does not involve a response to a call.

Startle Response: A whole-body response that involves rapid involuntary contractions that begins with the blink of an eye and spread to all muscles throughout the body and leads to individuals clenching their fists.

Unfamiliar Firearm Task: An event that involves use of the non-dominant hand or manipulation of a new, novel, or recently modified piece of equipment.