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Further analysis of the unintentional discharge of firearms in law enforcement

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ABSTRACT

Empirical analysis of the contexts in which UDs occur in law enforcement have only recently begun to emerge. We analyzed a novel sample of UD reports ($N = 171$) that occurred between 1992 and 2016, collected from one non-U.S. and three U.S. law enforcement entities. Using an established antecedent-behavior-consequence (A-B-C) taxonomy, reports were analyzed by context, officer behavior, type of firearm, injuries, deaths, and property damages. This study is the first to empirically document reports of UDs caused by the startle response and the first to analyze a substantial sample of UDs that involved handguns with a double-action only trigger mechanism. An expanded analysis of UD consequences suggested that deaths and injuries might be more prevalent than previously reported.

1. Introduction

An unintentional discharge (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" (O'Neill et al., 2017). The phenomenon presents difficultly in research because occurrences are relatively rare and comprise only a small fraction of firearm injuries and deaths (O'Neill, 2015). Some departments release annual firearm reports that contain information on UDs, but empirical research (e.g., interviews, officer field reports, experimental analysis) has been sparse. Because UDs can result from involuntary muscle contractions, some officers report being unaware of exactly how the event unfolded. Previously, authors utilized deductive analytic approaches to understand UDs by generalizing well established principles from physiology (Charles, 2000; Enoka, 2003; Hendrick et al., 2008). However, very little physiological research addressed UDs directly in the context of law enforcement.

For example, Enoka (2003) opined that UDs (to the exclusion of accidental discharges) occur because of involuntary contractions, regardless of context, and may occur during a loss of balance, contralateral contraction, or startle response. During a loss of balance, postural contractions can evoke involuntary contractions in hand muscles (Corna et al., 1996; Dietz et al., 1989; Marsden et al., 1983), which has the potential to engage a firearm trigger. The second form of involuntary contraction occurs while one limb is performing a forceful action causing muscle contractions in the other limb, also known as contralateral irradiation (Arányi and & Rösler, 2002; Mayston et al., 1999; Zijdewind and Kernell, 2001). Contractions caused by contralateral irradiation have been shown to be directly related to the magnitude of force generated by contralateral limbs (Shinohara et al., 2003) as well as psychological stress (Noteboom et al., 2001; Weinberg and Hunt, 1976; Williams and Barnes, 1989). The third form of involuntary contractions occur during the startle response (Landis and Hunt, 1939). The startle response has been shown to cause an early execution of planned motor responses (e.g., pulling the trigger) or temporarily inhibit muscle contractions (e.g., "freezing") depending on the individual and circumstances (Alibiglou and MacKinnon, 2012; Nonnekes et al., 2015; Valls-Solé et al., 2008). To date, UDs caused by the startle response have not been empirically documented or observed in law enforcement.

Hendrick et al. (2008) suggested UDs can occur over a broader range of circumstances related to the person and environment. In addition to concepts proposed by Enoka (2003), Hendrick et al. (2008) proposed a myriad of factors related to UDs, including stress, fatigue, divided attention, use of drugs or alcohol, memory impairments, lack of formal handgun safety training, and anthropomorphic variables (strength, perception, mental workload, physical size, response time, and negative transfer of training). Although these authors contributed pioneering work to the understanding of officer involved UDs, both relied on theory, general observations, and anecdotal evidence to support their claims.

Debate exists on whether muscle co-activations and startle induced

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involuntary contractions can independently cause UDs (Charles, 2000). For most UDs, the index finger ultimately engages the trigger. In theory, for muscle co-activation or startle induced involuntary contractions to discharge a firearm, the index finger must be positioned near or have direct contact with the trigger (Heim et al., 2006a,b). Law enforcement firearms training caters to this point, stipulating that the index finger must remain outside the trigger guard until the decision to fire (e.g., Illinois Law Enforcement Training and Standards Board, 2016).

Heim et al. (2006a,b) examined whether inappropriate finger placement on the trigger is a conscious decision. Results indicated that some officers contacted the trigger without realization. During a deadly force simulation, 34 officers reacted to a robbery suspect, where the use of a firearm was likely. At the end of the scenario, all officers reported that their finger remained above or on the trigger guard during the entire scenario. However, force sensors on the trigger detected one in five officers applied significant force for at least 1 s during the scenario. These results suggest that the index finger might be placed on or near the trigger without officer awareness.

Part two of the Heim et al. (2006a,b) study examined the effect of sub-maximal and maximal voluntary contractions (e.g., jumping, kicking, pushing a bar) while holding a firearm. Maximal force contractions caused participants to unintentionally grip their firearm with significantly more force, as compared to sub-maximal force contractions. During the leg contractions (the highest force action), the pressure exerted on the trigger was sufficient to discharge a cocked (> 4 lbs) firearm 20% of the time and an uncocked (> 10lbs) firearm 6% of the time. In addition, the authors demonstrated that voluntary contractions elicited muscle co-activation in other limbs. The effect of muscle co-activation following an unexpected loss of balance or startle response may have different effects on force applied to a trigger. However, a notable limitation to the study was that participants were students, not officers.

Recent research suggests a number of contextual and behavioral factors may predict and influence UDs (O'Neill et al., 2017). The authors analyzed 137 reports from seven law enforcement agencies across the United States from 1974 to 2015. UDs involved a broad range of factors related to the context (e.g., threat potential, location, and actions of others), the officer's behavior immediately preceding the UD (e.g., routine tasks vs. unfamiliar tasks), and the officer's equipment (e.g., firearm type, trigger action and weight, holster type, and clothing). Most of the reported UDs occurred during low threat contexts, not during stressful or forceful actions. Approximately 25% of UDs were attributed to muscle co-activation but nearly 75% of UDs occurred during routine tasks (e.g., clearing, function check/attempted dry fire, holstering/unholstering, maintenance, storing/moving) and unfamiliar tasks (e.g., arm/hand crossover, equipment re-location, using an unfamiliar firearm, non-dominate hand transfers, and using new holsters or belts). Inanimate objects contacting the firearm or trigger (e.g., trigger catches on a radio antenna or clothing hook), contributed to a small proportion of UDs. One limitation was the number of reports obtained from a relatively small number of law enforcement agencies. Only a small sample of double-action only handguns was available and the authors did not find sufficient evidence of a startle response. UDs influenced by the startle response have not been empirically documented in law enforcement. Additional research might substantiate the role of the startle response as well as the notion that UDs occur across different types of trigger action.

The purpose of the present study was to replicate the procedures employed by O'Neill et al. (2017) to validate the proposed antecedent-behavior-consequence (A-B-C) taxonomy. We analyzed novel UD reports from several law enforcement entities. The sample included handguns with a double-action only trigger mechanism and we conducted an expanded analysis of UD consequences.

2. Method

In line with the O'Neill et al. (2017) analysis, a 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 situations where a subject gains control of an officer's firearm and activates the trigger mechanism.

A request for information for pre-existing officer-involved UDs was distributed via Force Science® News. A total of 203 individual UD reports that occurred between 1992 and 2016 were collected from one non-U.S. and three U.S. law enforcement entities. Instances of UDs were provided in narrative form, redacted official documents, and raw spreadsheets. All other identifying information about the parties involved was withheld. Reports were coded following the procedures and definitions for UDs in law enforcement described in O'Neill et al. (2017). Data were included if the information provided was adequate for determining one or more category within the A-B-C taxonomy. Reports containing ambiguous information were coded as unspecified. Data were excluded if the information did not pertain to a law enforcement officer (n = 19), a UD (n = 6), or a single classification category (n = 7). These exclusions resulted in a sample size of 171. The law enforcement agencies provided approval for the confidential analysis and publication of the data in this report.

2.1. Procedures

2.1.1. Context

On-or off-duty status of the officer at the time of the UD was determined. Threat potential at the time of the UD was coded as either low stress (locker room, processing area, firearm storage room, firing range, office, hotel, private residence, business, court house, air plane, and situations not otherwise specified), elevated stress (in the staging area of an operation, clearing an area, preparing to conclude a call, and situations not otherwise specified), or high stress (detaining a suspect, felony traffic stop, searching for an armed suspect, providing cover for a fellow officer, exiting a vehicle to make an arrest, and chasing a suspect on foot).

2.1.2. Officer behavior

Behaviors of the officer at the time of the UD were coded into one or more of the following six categories; contact (inanimate object, animate object, officer apparel), medical condition (seizures, twitch/tremor), muscle co-activation (loss of balance, loss of grip, use of other finger(s), use of leg(s), use of an arm(s), use of other hand), routine firearm task (clearing, storing/moving, function check, unholstering/reholstering, firearm maintenance), startle response (auditory stimulus, visual stimulus, vestibular stimulus, somesthetic stimulus), and unfamiliar firearm task (firearm, hand transfer, holster/belt, equipment location, and arm/hand crossover).

2.1.3. Firearm

The involved firearm was categorized by type (semi-automatics, revolvers, rifles, shotguns) and trigger action (single only, double only, double/single, pre-set).

2.1.4. Damages, injuries, and deaths

Property damage that occurred as a direct result of the UD was identified. UD related injuries and deaths of either the officer, a partner, the subject, or a bystander were identified.

2.1.5. Inter-observer agreement (IOA)

A trained secondary coder reviewed 30% (n = 50) of the reports and resulted in a high level of IOA across variables (9393.0%). IOA was calculated using the following formula: total number of agreements divided by agreements plus disagreements, multiplied by 100%.

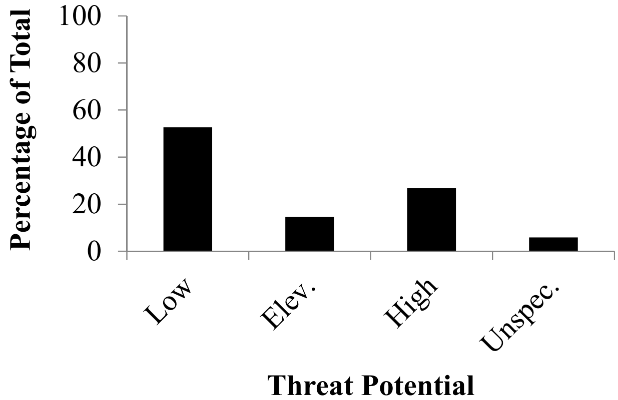

Fig. 1. Percentage of unintentional discharges by threat potential category.

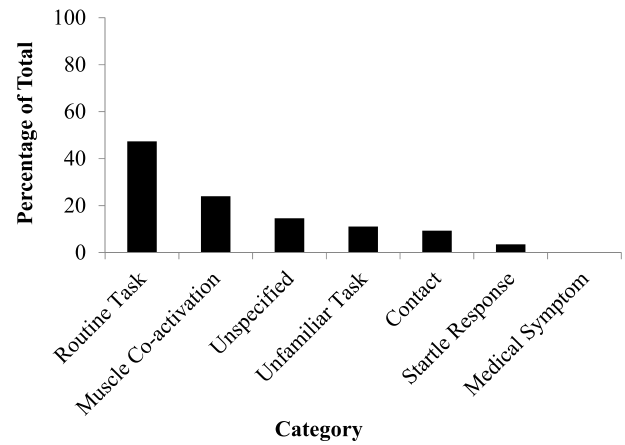

Fig. 2. Percentage of unintentional discharges by behavioral category.

3. Results

3.1. Context

UDs occurred on-duty (59.6%), off-duty (36.3%) and under unspecified (4.1%) circumstances. As displayed in Fig. 1, threat potential involved low (52.6%), elevated (14.6%), high (26.9%), and unspecified (5.8%) levels.

3.1.1. Threat potential

Total UDs per threat potential sub-categories are presented in Table 1. The following data represent within-category percentages relative to each mutually exclusive contextual sub-category. Within the low threat category ($n = 90$) 20.0% of UDs occurred in private residences, 17.8% in locker rooms/restrooms, 17.8% in firearm storage/cleaning rooms, 12.2% in department offices, 11.1% on a firing range, 7.8% not otherwise specified, 4.4% in parking lots, 2.2% in hotel rooms, 1.1% in processing areas, 1.1% in court rooms, and 1.1% on commercial aircrafts. Within the elevated threat category ($n = 25$), 68.0% of UDs occurred while clearing an area, 20.0% at the end of calls, and 4.0% in staging areas. Within the high threat category ($n = 46$), 39.1% of UDs occurred during traffic stops, 19.6% while searching for armed suspects, 15.2% while chasing suspects on foot, 13.0% while physically restraining suspects, 10.9% while providing cover, and 4.3% while aiming firearm at suspect.

Table 1
Number and percentage of unintentional discharges in contexts which involved low threat potential (routine), elevated threat potential (on a call), and high threat potential (use-of-force) situations. Categories are mutually exclusive. Total represents the overall UD sample size.

Threat Potential	Sub-category	n	%
Low	Firearm storage/cleaning room	18	10.5
	Locker room/restroom	16	9.4
	Private Residence	16	9.4
	Firing range/training facility	10	5.8
	Dept. office	11	6.4
	Not otherwise specified	7	4.1
	Parking lot	4	2.3
	Hotel room	2	1.2
	Processing area	1	0.6
	Court house	1	0.6
	Air plane	1	0.6
	Public business	0	0.0
Elev.	Clearing an area	17	9.9
	End of a call	5	2.9
	Staging area	1	2.2
	Not otherwise specified	0	0.0
High	Traffic stop	18	10.5
	Searching for armed suspect	9	5.3
	Chasing suspect on foot	7	4.1
	Physical restraint	6	3.5
	Providing cover	5	2.9
	Aimed firearm at threat	2	1.2
	Not otherwise specified	0	0.0
Unspecified	Not applicable	10	5.8
Total		171	100.0

3.2. Officer behavior

Fig. 2 displays percentages of UD within the main behavioral categories. UDs occurred during routine tasks 47.4% of the time, 24.0% occurred during muscle co-activation, 14.6% for unspecified behaviors, 11.1% during unfamiliar tasks, and 9.4% during contact, and 3.5% during the startle response. No UDs occurred as the result of a medical condition in this sample.

3.2.1. Behavioral sub-categories

Table 2 displays the number and percentage of total UDs per behavioral sub-category (not mutually exclusive). Data for within-

Table 2
Number and percentage of unintentional discharges by response category and sub-category. Categories are not mutually exclusive. Total represents the overall UD sample size.

Behavior	Sub-category	n	%
Routine Task	Clearing	28	16.4
	Function check	26	15.2
	(Un)Holstering	15	8.8
	Maintenance	8	4.7
	Storing/moving	4	2.3
Muscle Co-activation	Loss of balance	16	9.4
	Use of other hand	12	7.0
	Loss of grip	8	4.7
	Use of leg(s)	2	1.2
	Use of other finger(s)	2	1.2
	Use of arm(s)	1	0.6
Unspecified	Not Applicable	25	14.6
Unfamiliar Task	Firearm	11	6.4
	Hand transfer	4	2.3
	Arm/hand crossover	4	2.3
	Equipment location	2	1.2
	Holster/belt	1	0.6
Contact	Officer apparel	8	4.7
	Animate object	4	2.3
	Inanimate object	4	2.3
Startle Response	Visual	3	1.8
	Auditory	2	1.2
	Somesthetic	1	0.6
	Vestibular	0	0.0
Medical Symptom	Seizure	0	0.0
	Twitch/tremor	0	0.0
Total		171	100.0

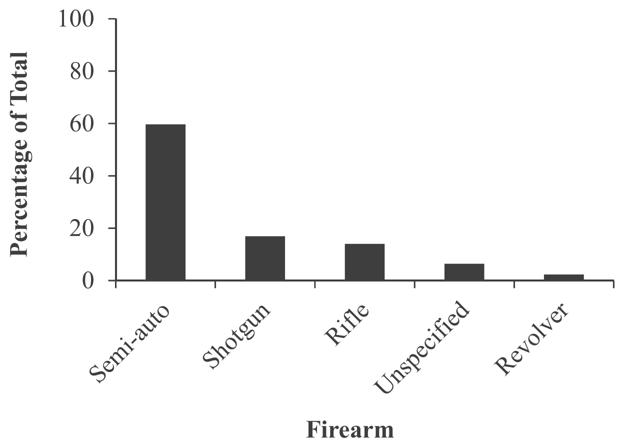

Fig. 3. Percentage of unintentional discharges by firearm category.

category percentages are as follows: Routine firearm tasks (n = 81) included clearing (34.6%), function checks (32.1%), holstering/unholstering (18.5%), conducting maintenance (9.9%), and storing/moving (4.9%). Muscle co-activation (n = 43) included a loss of balance (39.0%), use of the other hand (29.3%), a loss of grip (19.5%), the use of another finger (4.9%), use of a leg (4.9%), and use of other arm (2.4%). Unfamiliar firearm tasks (n = 19) included those involving unfamiliar firearms (57.9%), hand transfers (21.1%), arm/hand crossovers (21.1%), unfamiliar equipment location (10.5%), and holsters/belts (5.3%). Contact with objects (n = 16) included contact with the officer's apparel (50.0%), animate objects (25.0%), and inanimate objects (25.0%). Startle responses (n = 6) were induced by visual (50.0%), auditory (33.3%), and somesthetic (16.7%) stimuli. Vestibular-induced startle was not reported.

3.3. Firearm

A total of 46 models from 16 different firearm manufactures were reported. As displayed in Fig. 3, UDs involved semi-automatic handguns (63.4%), shotguns (18.0%), rifles (14.9%), revolvers (2.5%) and unspecified firearms (1.2%).

3.3.1. Trigger action

Table 3 contains the number and percentages of trigger action types relative to the total number of UDs. Within-category trigger action percentages are as follows: Semi-automatic handguns (n = 103) involved trigger actions that were double only (46.1%), pre-set (34.3%), double/single (9.8%), not otherwise specified (6.9%) and single only (2.9%); Shotgun (n = 29) and rifle (n = 24) trigger action was single only; Revolvers (n = 4) involved double only (50.0%) and not otherwise specified (50.0%). None of the reported revolvers contained a double/single trigger action.

Table 3
Number and percentage of unintentional discharges which involved each weapon type and associated trigger action. Total represents the overall UD sample size.

Firearm	Trigger Action	n	%
Semi-auto	Double only	47	27.5
	Pre-set	35	20.5
	Double/single	10	5.8
	Not otherwise specified	8	4.1
	Single only	3	1.8
Shotgun	Single only	29	17.0
Rifle	Single only	21	12.3
	Not otherwise specified	3	1.8
Revolver	Double only	2	1.2
	Not otherwise specified	2	1.2
	Double/single	0	0.0
Unspecified	Not applicable	11	6.4
Total		171	100.0

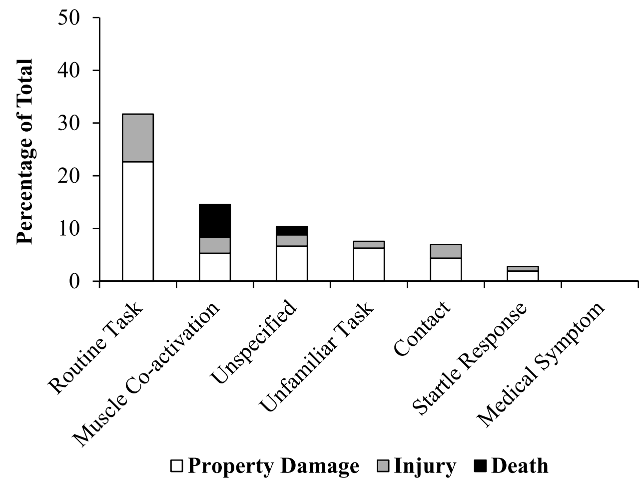

Fig. 4. Percentage of unintentional discharges resulting in property damage, injury, or death by behavioral sub-category.

3.4. Consequences: property damage, injury, and death

Fig. 4 displays the percentage of unintentional discharges resulting in property damage, injury, or death by behavioral sub-category. Property damage was reported in 52.3% of reports. Within these 79 cases, officer behaviors were routine firearm tasks (49.4%), not otherwise specified (14.5%), unfamiliar tasks (13.7%), muscle co-activation (11.6%), contact (inanimate, animate, or officer apparel) (9.5%), and the startle response (4.2%).

Injuries were reported in 19.9% of reports. Individuals injured included the officer (75%), the suspect (12.5%), and another officer (12.5%). Within these 30 cases, officer behaviors were routine firearm tasks (47.5%), muscle co-activation (15.9%), contact with an object (inanimate, animate, or officer apparel) (13.6%), not otherwise specified (11.3%), unfamiliar tasks (6.8%), and a startle response (4.5%).

Deaths were reported in 7.9% of reports and included the suspect (84.6%) and a fellow officer (15.4%). Within these 12 cases, officer behaviors included muscle co-activation (80.0%) and not otherwise specified (20.0%). No reported deaths occurred during routine firearm tasks, contact (inanimate, animate, or officer apparel), unfamiliar tasks, or a startle response. No officers died as a result of a UD with their own firearm.

4. Discussion

This study extends the systematic examination of officer-involved UD reports by context, officer behavior, consequences, and firearm characteristics. The A-B-C taxonomy proposed by O'Neill et al. (2017) successfully encompassed the conditions and behavioral categories reported in the present study, yet novel findings emerged. This study is the first to empirically document reports of UDs caused by the startle response. In fact, a double UD report demonstrated the potential for unexpected gunfire to evoke a startle response. This study was also the first to analyze a substantial sample of UDs that involved handguns with a double-action only trigger mechanism and expanded the analysis of UD consequences by finding a higher prevalence of injuries and deaths as compared to the previous study.

The results also compliment many of the findings reported in the O'Neill et al. (2017) study. The largest number of UDs occurred while performing highly routine activities (e.g., clearing, storing/moving, holstering/unholstering, function check, and maintenance) in familiar contexts with low threat potential (e.g., firearm storages/cleaning rooms, officer's home, department offices, locker rooms, etc.). Muscle co-activation was the second most common behavioral category, consistent with O'Neill et al. (2017). In both samples, routine task UDs were double that of the number of UDs related to muscle co-activation. This finding is in contrast with Enoka's (2003) assertion that UDs, which are not "accidental," are the result of involuntary contractions. According to our operational definition of a UD and resulting data, the majority of UDs were not caused by involuntary contractions but by routine tasks involving low threat potential. This suggests many UDs fit within the Generic Error Modelling System outlined by Reason (1990).

Some of the officers in our sample acknowledged that they had mistakenly placed a finger on the trigger prior to the UD. However, most officers did not specify this information, which aligns with previous research (Heim et al., 2006a,b).

4.1. Startle response

Others have suggested that some UDs may be caused by involuntary contractions associated with the startle response (Enoka, 2003; Hendrick et al., 2008). Our data provides the first known empirical support for UDs caused by the startle response. In fact, we found evidence of multiple startle modalities including auditory (e.g., an unexpected gunshot), somesthetic (e.g., a door unexpectedly swings into officer's back), and visual stimuli (e.g., an object unexpectedly swinging across the officer's field of view). Similar to muscle co-activation, startle responses might result in a UD if a finger is inside or near the trigger guard. However, unlike muscle co-activation, the startle response is modulated by emotional state; amplified by negative emotions (e.g., fear) and attenuated by positive emotions (e.g., energetic) (Vrana et al., 1988; Vrana and Lang, 1990). In the present study, all six cases of the startle response occurred during elevated or high threat potentials. Heightened stress during an incident can result in continued manifestation of physical symptoms for several hours, prolonging sensitivity to potential startle stimuli (Charmandari et al., 2005). Future research might extend psychological stress training to firearms-related procedures. While training programs already emphasize proper finger indexing, some evidence suggests individuals can be taught to minimize involuntary contractions through the use of anticipatory postural adjustment techniques (Horak, 2006).

We observed a particularly unique UD report which involved two individual UDs, a muscle co-activation response and a startle response. An officer and his partner were completing a call, during which the first officer carried a shotgun and jumped over a small ditch. The officer lost their balance, fell, and unintentionally discharged the shotgun. Nearby, the partner officer was holding a .22 caliber rifle and was startled by the unexpected shotgun blast, causing him to unintentionally discharge his rifle. While Enoka (2003) and Henderick et al. (2008) do not specifically address gunshots as a startle stimulus, the original investigations into startle response phenomenon used .22 caliber revolvers as an auditory startle stimuli (Hunt, 1936; Hunt and Landis, 1936; Landis and Hunt, 1939).

4.2. Double-action trigger mechanism

The relationship between firearm models and UDs was not specifically examined in this study, as experimental control was not possible. One notable difference in the present sample was the significantly higher prevalence of double-action only handguns (26.7%) compared to the O'Neill et al. (2017) study (0.7%). It is important to point out double-action only triggers typically have heavier trigger weights compared to single or single/double-action triggers (Kinard, 2003). Conventional wisdom suggests heavier trigger weights reduce the chances of a UD. For example, some advocate for the heavier weight New York trigger for Glocks claiming, "Accidental discharges, sometimes with tragic and fatal results, have been clearly and convincingly related to very light trigger pulls over the years by countless police departments" (Ayoob, 2012). However, Heim (2006a,b) demonstrated that the force exerted on the trigger was sufficient to overcome heavier trigger weights (i.e., 10 lbs). Important questions regarding finger positioning, indexing awareness, and trigger weight across officer behaviors and contexts should be experimentally tested in future research. The present data substantiate the claim that UDs occur across firearm types, trigger actions, and trigger weights.

4.3. Injuries and deaths

A greater number of injuries and deaths were reported in the present sample as compared to the O'Neill et al. (2017) study. Twelve UDs resulted in deaths, whereas only a single fatality was reported in the previous sample. Routine tasks were the most common officer behavior that resulted in injuries in both studies. Differences may reflect characteristics of the districts where the law enforcement agencies are located. Most reported deaths were suspects and occurred due to muscle co-activation while the officer restrained or chased a suspect.

4.4. Limitations

The present study provided novel findings in an area lacking empirical support, but is not without limitations. There are inherent limitations to self-reported data (e.g., memory accuracy) and yet there are no practical alternatives currently available to examine *in situ* UDs. Reports were officially documented at law enforcement departments or legal proceedings, which are held to a high standard as legally binding evidence. An experimental manipulation was not performed given the infrequency and difficulty of measurement. However, this study offers social validity as actual cases were analyzed and organized into an established taxonomy.

5. Conclusion

UDs can be conceptualized as a series of behavior-environment interactions that lead to a dangerous outcome. During low threat potential, most UDs result from skill-based (unintentionally pulling the trigger) and rule-based errors (knowingly pulling the trigger) in combination with muscle co-activation, unfamiliar tasks, or startle-induced involuntary contractions. Teaching awareness, strong habits, and error management are recommended strategies related to the Principle of Specificity, by which skills are performed best in a similar environment to that in which they were learned (i.e., the training environment) (Enoka, 2003).

A large number of UDs occurred because officers falsely assumed the firearm was unloaded. A critical step in firearm operation is to confirm an empty chamber before completing a dry-fire or disassembly. Firearm clearance can be taught in a variety of circumstances (e.g., locker room, range, high stress stimulations) that might foster generalization to real-world settings. The installation and use of firearm clearing barrels and traps in locker rooms and cleaning areas may also reinforce the training stipulation that firearms should be cleared in a safe manner. It is important, when possible, to point the firearm in a safe direction (e.g., low-ready position) until the decision to shoot is made. Maintaining a safe stance until the intent to shoot will not prevent UDs, rather it reduces the chance of injury or death. The majority of deaths reported in our sample occured when an officer pointed their firearm at a person, did not intend to shoot, but experienced muscle co-activation that resulted in a UD.

Finger indexing may benefit from practice during high stress and dynamic simulations. The perspective of detached intentions (Reason, 1990) suggests that routine range practice may facilitate a strong but wrong response of positioning the finger on the trigger immediately after the firearm is drawn. Trainers may consider instruction of officers to index before shooting on the range and to practice indexing during various conditions (e.g., static, dynamic, high and low stress). Dynamic conditions could incorporate novel situations which promote the development of problem-solving strategies and planning on the part of the officer. Regardless, the operation of firearms involves the potential for human error and the possibility of a UD. Teaching and practicing safe handling procedures (i.e., assume the firearm is loaded, point firearm in a safe direction, indexing) under a variety of conditions may aid in the reduction of UDs and their associated consequences. This line of research highlighted important variables that might aid in the design of proactive firearms training as well as re-training and re-qualification procedures.

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