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Toward a taxonomy of the unintentional discharge of firearms in law enforcement

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A R T I C L E I N F O

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A B S T R A C T

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 (1974–2015) 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.

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* (Aranyi & Rösler, 2002; Mayston et al., 1999), *contralateral irradiation* (Zijdewind and Kernell, 2001), and *contralateral contraction* (Post et al., 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 and Niebergall, 2006a, 2006b). It has been demonstrated that the force of a contralateral contraction depends on the intensity (Shinohara et al., 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 et al., 2001; Weinburg and Hunt, 1976; Williams and Barnes, 1989), and even the ability to see the contralateral limb (Carson and 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 and Nashner, 1982; Elger et al., 1999; McIlroy and Maki,

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1995; Schieppati and 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 et al., 1996; Dietz et al., 1989; Marsden et al., 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 et al., 1994; Bisdorff et al., 1999; Hawk and Cook, 1997). It starts with an eye blink and extends to the neck, trunk and shoulders, elbows, fingers, and legs (Brown, 1995; Landis and 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 200 ms 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 et al. (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 (1974–2015) 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