


Lost in transition: The effects of transitioning between firearms and electronic control devices (ECDs) on perception-response times (PRTs)

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Abstract

The research described in this article tested the perception-response times for experienced police officers to transition from a firearm to a TASER and from a TASER to a firearm. The theoretical models and police training on use of force have largely ignored the temporal space between force modalities. Escalating through force modalities has by default been treated as equivalent, in task and timing, to deescalating through force modalities. This study employed a randomized controlled experiment using a police firearms training simulator and 139 active law enforcement officers. The average perception-response time for transition from a TASER to a firearm was 2.49 seconds for experienced police officers in response to an anticipated visual stimulus in a laboratory setting. The average perception-response time for transition from a firearm to a TASER was 4.7 seconds for experienced police officers in a response to an anticipated visual stimulus in a laboratory setting. 70% of the officers that participated in the study had never participated in department training that required them to transition between a firearm and a TASER. The findings demonstrate that moving from TASER to firearm and from firearm to TASER are not equivalent tasks. In the

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case of firearms and TASERS, it is significantly faster to move up the force continuum—from TASER to firearm—than it is to move down the force continuum. This research has implications for police training, tactics, policy, research, and post hoc investigations involving the use or potential use of force.

Keywords

Police, use of force, TASERS/electronic control devices, firearms, perception-response times

Introduction

The lawful capacity to use coercive force, up to and including deadly physical force, is a fundamental yet contentious aspect of the police role in modern society (Bittner, 1970; Klockars, 1985; Reiss, 1971). In fact, police use of force—and deadly force in particular—has become one of the most “visible and controversial” aspects of the United States criminal justice system (Klinger et al., 2015: p. 194). This public interest is reflected in an ever-expanding body of research and data collection initiatives focused on the topic. Yet, much of the academic effort has been concentrated on sociodemographic variables, which, according to Shane and Swenson (2019), “[D]o very little, if anything, to help understand the dynamics of a police shooting, or to help reduce use of force encounters, which should be the overriding goal of use of force research” (p. 56).

In addition, a large body of this research has attempted to isolate specific types of force. This is often accomplished by distilling use of force cases down to the highest level of force used during an encounter (e.g., Alpert and Dunham, 1997) or by simply counting the number of applications and case outcomes for particular force modalities (e.g., Brandl and Strohshine, 2017). This has resulted in a siloed literature made up largely of independent topics like deadly force (e.g., Fyfe, 1988; Jennings et al., 2019); less than lethal force (e.g., Hickman et al., 2008; Lawton, 2007); electronic control devices (ECDs)/TASER (e.g., White and Ready, 2007, 2010); and even de-escalation (e.g., Engel et al., 2019; Todak and James, 2018). These, somewhat ironically, closely resemble in both name and substance the silos found in modern police training programs (Hickman, 2005).

The problem with a siloed approach to both research and training on police use of force is the complex and dynamic nature of these events. As Klinger (1995) noted, “When officers [use] force of a given level of severity in an encounter, they almost invariably also [use] less severe types of force” (p. 184). A dramatic example of this can be found in police shootings involving unarmed people. In 2015, 84 unarmed people were shot and killed by law enforcement officers in the United States. In 27% ($n = 23$) of those cases, officers deployed a TASER before resorting to deadly force (Selby et al., 2016). According to Shane and Swenson (2019):

Once a threat has stopped, the officers must deescalate and assess the situation. If force against the officer escalates during the assessment period, then the officer can escalate his or

her force to meet that force with reasonable force; if the force against the officer stops, then the officer must stop his or her use of force. A single police-citizen encounter that begins with a mere inquiry may ripen into a deadly force situation in an instant... (p. 7).

By definition, de-escalation involves the movement of situations where there is a potential need for higher levels of force to a state in which lower levels of force or no force at all are adequate to resolve them. Actively adjusting to evolving situations necessitates the ability for officers to transition from one potential force modality to another.

To account for this dynamic nature, a substantial amount of ink has been spilled in the development of hierarchical models and continuums designed to define, categorize, and measure police use of force and to determine its appropriateness in relation to corresponding forms of citizen resistance and aggression (e.g., [Alpert and Dunham, 1997](#); [Garner et al., 1995](#); [Terrill, 2005](#); [Terrill and Paoline, 2013](#)). Yet, all of these models treat the spaces between force categories—which tend to be remarkably similar in name and content to the research and training silos—as equivalent or, perhaps more accurately, the spaces between force categories are ignored by these models altogether. In addition, moving up and down the continuum between the same two categories—for instance, moving from TASER to firearm and, conversely, from firearm to TASER—are by default presented as equivalent tasks. There are a number of reasons to believe these tasks, though they both involve the same tools, are different.

First, while there is a lot of variation in where officers carry their TASERs when they are not holding them, they are never carried in the same position as an officer's firearm and thus differ in the biomechanical manipulation needed to retrieve them. Second, and perhaps more important, there is a substantial training disparity between the two tools. Nationally, new police officers spend an average of 60 h on firearms and shooting skills during their initial academy training and much of this training is practical in nature ([Morrison, 2006b](#)). After the academy, firearms training continues to be emphasized throughout an officer's career through advanced officer and in-service training, often on an annual and in some cases a quarterly basis ([Morrison, 2006a](#)). TASER certification, on the other hand, is mostly classroom based and only requires officers to fire two practice rounds during the initial certification and two practice rounds for recertification every two years ([Axon, 2018](#)). The authors were not able to locate any research or law enforcement training on transitioning between firearms and TASERs.

We know that the tools and tasks people employ in the workplace tend to be systematically linked to their behaviors and the outcomes they create (e.g., [Dekker, 2014](#); [Lipsky, 2010](#); [Woods et al., 2010](#)). Research into the human factors involved in the operation of tools and equipment has been instrumental in improving both the safety ([Dekker, 2019](#)) and the post hoc forensic investigation ([Dekker, 2010](#)) of incidents in a wide array of other high-risk endeavors including medicine ([Dekker, 2011](#); [Institute of Medicine, 2000](#)), aviation ([Wise et al., 2016](#)), the military ([Snook, 2002](#)), and traffic safety ([Green, 2017](#)) to name a few. Understanding the time it takes for a driver to observe a changing traffic light and apply the brakes of a vehicle, for instance, has been instrumental in the design of safer intersections while, at the same time, improving the ability of investigators to reconstruct traffic accidents when they do occur (e.g., [Green,](#)

2000). This baseline information can inform both the safer operation of equipment and, in hindsight, the reasonableness of the actions taken by front-end operators.

Binder and Scharf (1980), argue that the decisions officers make; the behaviors they exhibit; and the tactics they employ in the early “phases” of a police-citizen encounter can influence whether or not the encounter results in a shooting. While Binder and Scharf did not explicitly explore the interactions of time, tools, and tactics on police decision-making; Taylor, 2020 found that the position in which experienced officers held their firearms and just fractions of a second in movement time could dramatically influence the accuracy of shoot/no shoot decision-making in a simulated environment. He writes that, “Rather than relying solely on an officer ability to predict and prevent a shooting in the earlier frames of a complex and dynamic situation, why not design tactics that assume human failure and provide some resilience against catastrophic outcomes?” (p. 6). We submit that in order to design and implement “resilient” tactics that take into account both the safety of the public and the involved-officer(s), it is critical understand the time it takes for an average officer to perceive a change in their environment and to manipulate the appropriate tool in response to that change.

While limited research of this kind has been conducted on individual levels of force—specifically limited to police use of handguns (e.g., Blair et al., 2011; Lewinski et al., 2014, 2015)—little to no research has been dedicated to understanding the time it takes to move between different levels of force and the implications this time might have for both the tactics officers employ and the post hoc analysis of use of force encounters. In an effort to start to address this deficit in the literature, the aim of this study was to examine the times and differences in time it takes experienced police officers to transition from a firearm to a TASER and from a TASER to a firearm in response to a visual stimulus. Given the emphasis of police training on firearms skills and the substantial difference in practical training time devoted to each tool, the researchers formed the following research and null hypotheses:

H_1 = Transitioning from TASER to firearm will be significantly faster than transitioning from firearm to TASER.

H_0 = There will be no significant time difference between transitioning from a TASER to a firearm and transitioning from a firearm to TASER.

Sample and method

To test these hypotheses, a randomized controlled experiment was devised utilizing an interactive police firearms training simulator. These types of simulators have been used to test police use of force decision making in a number of other studies (e.g., Blacker et al., 2020; Chaires, 2015; James et al., 2016; Taylor, 2019). While firearms training simulators cannot possibly reproduce the dynamic environments or elicit the same cognitive strain an officer is likely to contend with in the field, they do provide for standardized and realistic video scenarios in which the situated decision making of experienced officers with a full range of force options can be observed in a controlled and relatively safe environment. This makes simulators attractive for both law enforcement training and research purposes. In the present study, a VirTra brand V-300[®] simulator was used in conjunction with

modified Glock brand handguns and Axon (TASER) brand X-2 ECDs with simulator compliant laser firing cartridges. Both the VirTra handguns and the ECDs were physically and functionally identical to the actual weapons law enforcement officers carry, with the exception that they had been modified to fire laser pulses rather than bullets or probes.

Sample

The sample was composed of 139 active-duty law enforcement officers recruited from six different Arizona agencies. The participating agencies were diverse and included large, midsize, and small municipal police departments. Based on the collected demographic characteristics (see [Table 1](#)), other than an underrepresentation of female and Black officers, the resulting sample appears to be representative of the larger United States law enforcement population ([Walker and Katz, 2018](#)).

Participation in the study was voluntary and confidentiality was extended to both the officers and the agencies involved. The project received approval from both a university institutional review board and an executive officer from the sponsoring agency. Data for the study were collected during the month of June 2019 by the authors. To recruit officers, the sponsoring agency distributed an email both internally and to surrounding agencies. The email contained a copy of the informed consent document and invited officers to come to the sponsoring agency's training academy while the study was being conducted if they were interested in learning more or participating in the research. Each potential volunteer that came to the training academy was asked if they had reviewed the express consent form and if they had any questions. They were explicitly asked if they wanted to voluntarily participate in the study and, if they did, they were asked to sign the express consent form. Potential volunteers were told the study was focused on police decision-making and response times using a firearms training simulator. Each volunteer officer was asked not to divulge their experience with the study to other potential participants while the study was being conducted. It should be noted that all of the officers that came to the training center to learn more about the study ended up participating in the study.

Design

Volunteer participants were taken one at a time to a secluded study area, the simulator training room at the sponsoring agency's training academy, where they were given a simulator handgun and simulator-compliant X-2 TASER cartridges. Participants were asked to put the handgun and their duty TASER with the simulator cartridges into the carry systems (i.e., holster, vest pouch, etc.) and positions they regularly carried both on duty. The participants were then asked to stand in a designated location, eight feet from the simulator screen. Once in position, the participants were given the following instructions:

You will either be assigned to start with your firearm drawn and pointed at the screen or your TASER drawn and pointed at the screen. In front of you is a turning target, similar to the turning targets you might see on a shooting range. As soon as you see the target start to turn we want you to transition to the weapon that is not currently in your hands and fire at the

Table 1. Sample description (*N* = 139).

Variable	<i>N</i> (%)	Range	Mean	SD
Sex				
Male	129 (92.8)			
Female	10 (7.2)			
Age (in years)	139 (100)	21–67	37.69	9.413
Race				
Asian	2 (1.4)			
Black	2 (1.4)			
Hispanic	1 (0.7)			
Native American	29 (20.9)			
Pacific Islander	3 (2.2)			
White	102 (73.4)			
Total years of LE experience	139 (100)	1–35	11.06	8.501
Current assignment				
Administrative	20 (14.4)			
Investigative	15 (10.8)			
Patrol	81 (58.3)			
Tactical	23 (16.5)			
Last firearms training				
Today	8 (5.8)			
This week	48 (34.5)			
>1 week/< 1 month	25 (18)			
>1 month/< 3 months	51 (36.7)			
>3 months/< 6 months	6 (4.3)			
>6 months/< year	1 (0.7)			
Last TASER training				
Today	23 (16.5)			
>1 week/< 1 month	1 (0.7)			
>1 month/< 3 months	8 (5.8)			
>3 months/< 6 months	2 (1.4)			
>6 months/< 1 year	13 (9.4)			
>1 year/< 2 years	86 (61.9)			
>2 years	6 (4.3)			
Ever participated in transition training				
Yes	41 (29.5)			
No	98 (70.5)			

Note: LE = law enforcement; SD = standard deviation.

target as quickly as you can. For example, if your TASER is drawn, as soon as you see the target start to move, we want you to transition to your firearm and shoot the target as fast as you can. If your firearm is drawn, as soon as you see the target start to move, we want you to transition to your TASER and shoot the target as fast as you can. Do you have any questions?

The participants were then given a demonstration of the targets turning on the screen (see [Figure 1](#)).

After the instructions and demonstration were given, the participants were randomly assigned to one of two starting positions using a random number generator:

- Handgun drawn and pointed at the screen ($n = 71$)
- TASER drawn and pointed at the screen ($n = 68$)

The participants were told the starting position they should assume and were again asked if they had any questions. None of the officers that participated in the study had additional questions at this juncture.

Once the officers were in the assigned position, the simulation was started and the officers' transition times, as captured by the simulator, were recorded. The simulator calculated perception-response time as the time between the first frame of target movement and the time its sensors detected a laser strike from one of the simulated weapons. For the purposes of this study, this time included perception time—likely enhanced by anticipation, motor movement/manipulation time during the transition and firing, and laser travel time.

After completing the simulation, the officers were asked the demographic questions detailed in the sample section. They were also asked when they had last participated in firearms and TASER training and whether or not they had ever participated in training on transitioning between firearms and TASERS (see [Table 1](#) for details).

Results

For the purposes of analysis, an independent *t*-test was used to analyze the transition—perception-response—times in seconds. The results can be found in [Table 2](#) and indicate strong support for the research hypothesis.

Given the inherent problems with using “balance tests” in conjunction with experimental data (e.g., [Mutz et al., 2018](#)), no additional statistical analysis of the data was done.



Figure 1. Screen shot of turning targets on a VirTra brand simulator.

Table 2. Independent t-test comparison of transition (perception-response) times in seconds ($N = 139$).

Transition	<i>N</i>	<i>M</i>	<i>SD</i>	<i>Range (Min – Max)</i>
Firearm to TASER	71	4.70	1.353	2.475–9.354
TASER to firearm	68	2.49	1.226	0.811–6.865

$t(137) = 10.071, p = 0.000.$

Limitations

The experimental design of this study makes it vulnerable to the weaknesses of all experimental designs. Selection bias is always a potential issue with voluntary participation. For instance, there may have been some underlying difference in the group of officers that volunteered to participate in the study. Having said that, the sample appears to be compositionally (e.g., assignments and experience) representative of United States law enforcement organizations (Walker and Katz, 2018). Diffusion certainly cannot be ruled out. However, each participant was asked not to divulge the research protocol or their experience with the study to other potential participants. In addition, and perhaps most important, there is no reason to believe that prior knowledge of the experimental protocol would affect the speed with which an officer is able to transition between a TASER and a firearm.

The generalizability of the findings to other settings is likely the greatest concern given the stark contrast between the laboratory-like setting and strict controls needed for an experiment and the chaotic reality of a real world use of force encounter. From this, a number of potential issues arise. First, the officers knew they were being monitored and evaluated. Second, they were shown and were anticipating the stimulus that they were expected to respond to. As Olson (1989) pointed out:

When expectancies are violated, it requires a more potent stimulus and/or more information to reliably capture [an officer's] attention and communicate the essential data than would otherwise be the case. The result is that perception-response time may be increased, primarily because detection and/or identification intervals are lengthened. There are unfortunately, no data to provide guidance in determining how much longer perception-response time should be when expectancies are violated (p. 857).

Furthermore, the officers knew the expected behavior they should perform in response to the expected stimulus. Law enforcement officers facing a real-world use of force encounter have choices in both their level of response and the tools or techniques they apply. We have known for some time that eliminating the need to choose between alternatives will reliably decrease response times (Hick, 1952; Hyman, 1953). Finally, the officers knew that no physical harm was going to come to them while they were participating in the study and were not likely subject to the perceptual narrowing or hypervigilance that have been noted during police use of force encounters (Engel and Smith, 2009; Klinger, 2012; Klinger and Brunson, 2009).

In addition, a laser travels much faster than a bullet or a TASER probe and is not subject to the same ballistic constraints. This means that the measured time in the study is much closer to the initial trigger pull time than bullet or probe strike time would be. It would take slightly longer for a bullet or probe to strike a target than it did for a laser. However, the time difference between transitioning from a TASER to a firearm and a firearm to a TASER should not differ significantly.

As [Reiss \(1980\)](#) noted—similar to the difficulties encountered in trying to study how pilots behave during plane crashes or surgeons perform during rare and risky procedures—there are logistical, methodological, and ethical constraints to studying potential police use of force encounters in the real world. High fidelity simulators and scenarios offer a means of studying how professionals interact with the same tools and technology they use in the real world and the outcomes of their decision-making under a wide variety of circumstances. While there are certainly still limitations and caution should be taken with any laboratory finding, the results of simulator research have been used to improve the safety and efficiency of many other high-risk professions and should not be shunned by those who study police use of force encounters.

Discussion

When the perception-response times and the differences in perception-response times for experienced police officers transitioning from a firearm to a TASER ($M = 4.7$ s) versus a TASER to a firearm ($M = 2.49$ s) are examined, a number of important implications emerge.

First, these are not trivial timeframes in the context of potential use-of-force encounters, and they have implications for how officers respond to people who are armed or potentially armed with a handgun. As part of an experiment examining police shooting response times, [Blair et al. \(2011\)](#) examined the differences in time it took for a person to point a gun at an officer and fire when they started from a position with the gun pointed at the ground ($M = 0.36$ s) and when they started from a position with the gun pointed to their head ($M = 0.40$ s). [Lewinski, 2000](#) found that on average a person could produce a firearm from their waistband and shoot it without specifically aiming at a person or target in 0.23 s. In another study, [Lewinski et al. \(2014\)](#) found the average time between shots, when a person was pulling the trigger of a semiautomatic handgun as fast as possible, to be 0.28 s. If, for instance, an officer was to approach a person who had a gun to their head with a TASER drawn, on average the person could lower the gun and fire eight rounds at the officer or another person before the officer could transition to a firearm—and that is assuming the officer anticipates and perceives the changing threat as quickly as they did in a laboratory environment.

These transition times also have implications for how officers respond to people who are armed with a knife, a blunt instrument (e.g., baseball bat), or who are apparently unarmed. The TASER cartridge wire lengths—they come in 15, 21, 25, and 27 feet—and the increase of probe spread with distance both serve to restrict the effective range from which a TASER can be deployed. In fact, [White and Ready \(2007\)](#) found that the average distance, for a police TASER deployment in the field, was five feet. According to

Dysterheft et al. (2013), the average person starting from a standstill can cover 7.07 feet in 0.65 s; 15.6 feet in 1.16 s; and 25.72 feet in 1.67 s. Regardless of the TASER deployment distance, officers should be aware that they will not have time to transition to their firearms, should they need to, prior to the average person being able to close the distance to physical contact.

In a similar fashion, an officer who is pointing a firearm at an unarmed person or a person who becomes unarmed (e.g., drops a weapon) during the course of an encounter should be aware of the time it will take to transition to a TASER ($M = 4.7$ s). With this knowledge, an officer may choose to tactically retreat or position themselves behind a barrier in order to create more time for a transition rather than attempting to transition as an unarmed person closes the distance between them. These findings provide support for Shjarback et al. (2021) hypothesis that having a firearm in hand, can effectively “paint an officer into a corner”. If perception-response times have not been taken into consideration, officers could find themselves in positions in which they have no time to re-holster their firearms and/or transition to lesser levels of force. Human factors such as perception-response times should be taken into consideration as officers and departments develop and employ tactics that are more resilient to inevitable human fallibility (e.g., Taylor, 2020).

These findings also demonstrate that moving from TASER to firearm and from firearm to TASER are not equivalent tasks. In the case of firearms and TASERs, it is significantly faster to move up the force continuum—from TASER to firearm ($M = 2.49$ s)—than it is to move down the force continuum—from firearm to TASER ($M = 4.7$). While this certainly has implications for police training and tactics, as discussed above, it also has implications for the research and policy models that have ignored the temporal space between force modalities. This in turn has implications for the post hoc investigations and assessments of officer decision-making and any actions taken or not taken during realized or potential use of force encounters.

From a qualitative standpoint, the researchers noted that most of the officers that participated in the study did not appear comfortable with the process of transitioning between their firearms and their TASERs. While this was not a measure the study was designed to capture, it was clear that transitioning between these tools was not something these officers were proficient at. Many of the officers fumbled with their gear and had to look down at their TASER and/or firearm holster(s) during the process. Three of the officers failed to disengage the safeties on their TASERs prior to attempting to pull the trigger. It is telling that over 70% of the officers that participated in the study had never participated in department training that required them to transition between their TASER and their firearm. When you combine this with the disparities in training frequency and duration between these force modalities, this may provide some account for the significant difference in transition times.

Finally, and more generally, this relatively simple study demonstrates the value of human factors research focused on police practitioners, their tasks, and the tools they employ for understanding and improving the outcomes they achieve. The same type of research that has been so beneficial to the reform and continued improvement of fields like medicine, aviation, nursing, transportation, and the military should also be systematically applied to policing. While there are certainly a few individual researchers moving in that

direction, a more comprehensive approach is warranted given the public scrutiny, social liabilities, and physical risks associated with police work in the United States. A human factors/applied ergonomics approach to understanding and improving system safety in law enforcement is long overdue and much needed.

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