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Holster and Handgun: Does Equipment Effect Response Time?

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Abstract

This quasi-experimental research study determined if there was a significant difference in response times to draw and fire one round of ammunition from different weapons systems and holsters. The current study is the first to explore whether specific holsters and weapons systems have a significant effect on shooter response times. Two Safariland holsters (6280 SLS Level II Retention™ and 6390 ALS Level I Retention™) and two handguns (Glock and Sig Sauer 1911 TacOps) were compared. A significant difference in response time was found based on the type of holster used. This result may have implications for police policy, training, and forensics. Suggestions for future research directions on handgun response time to draw and fire are presented.

Introduction

Holsters and handguns are sophisticated tools used in law enforcement that are available from a long list of manufacturers providing a litany of ergonomic variables. Holster variants may be configured for thigh, hip, or shoulder wear (not all inclusive) and range in complexity from no safety retention device to several retention devices. Holster retention mechanisms can require movement of an external thumb release, a protective hood, or a specific weapon manipulation (e.g., rocking the weapon forward or backward) to remove the weapon from a holster. Once holster retention mechanisms are defeated and the weapon has been drawn, additional finger and hand operations are necessary to fire the handgun. Handguns often have an external safety and variations in trigger press (e.g., length/weight) that must be overcome (e.g., safety) for the weapon to fire.

Previous research on law enforcement shooting response times has included time to draw and fire a weapon (Hontz, 1999), time to fire a weapon from various positions (Lewinski, Dysterheft, Bushey, & Dicks, 2015), time to fire a weapon with decision making (Lewinski, Hudson, & Dysterheft, 2014), and time to draw and fire from identical leg and thigh holsters (Campbell, Roelofs, Davey, & Straker, 2013). However, no known research has been conducted on the specific ergonomic effects of different weapon and holster systems on response time to draw and fire a handgun.

The current research is based on several points found in the contextually relevant literature. Most of the associated research provides little detail on the type of weapons system or holster used, nor does it compare the device placement as Campbell et al. (2013) did with leg and thigh holsters. Additionally, Lewinski et al. (2015) have recommended more research on response time associated with modern thermoplastic Level II holsters due to pilot information indicating they might provide for a .30 second (s) speed advantage over traditional active restraint holsters. Moreover, Campbell et al. (2013) recommended additional research on the impact of changes in “force option carriage requirements” (p. 433) as they may affect performance. Therefore, there exists a research gap that the current study endeavors to reduce.

The purpose of the current study was to determine if there is a statistically significant difference in response time to fire a handgun based on the ergonomic differences in types of handgun or holster. The primary ergonomic difference between the types of handguns researched include size, trigger pull weight, and safety mechanisms. The primary ergonomic difference between the types of holsters researched include the type and location of retention mechanism and direction of manipulation for the retention device (e.g., forward or backward). The "Methods" section will provide a full description of each device and their differences.

The null and alternate hypotheses for this study are as follows:

> HO: There is no statistically significant difference in response times to draw and fire one round based on the interaction between weapon and holster type.
>
> HA: There is a statistically significant difference in response times to draw and fire one round based on the interaction between weapon and holster type.

Methods

Participants

The participants were law enforcement officers (N = 128) whose experience ranged from less than a year to 30 years and included both males (n = 111) and females (n = 17). All participants were certified peace officers by Arizona Peace Officers Standards and Training (POST). One of the requirements to obtain and maintain this certification is an annual qualification based on Arizona POST standards. All participants volunteered as a part of their annual qualification attempt.

Weapons Systems and Holsters

The firearms used for this study consisted of several variations of the Glock handgun, which include models G17, G19, G22, G21, and G23; and the Sig Sauer TacOps model (Figures 1a and 1b, respectively). The weapons were chambered in 9 mm (G17 and G19), .40 caliber (G22 and G23), and .45 ACP (G21 and Sig Sauer TacOps). The Glock weapons consisted of both the standard (G17, G22, and G21) and compact (G19 and G23) models.

The Glock handguns used in this study were ergonomically configured in the same manner requiring no manipulation of external devices

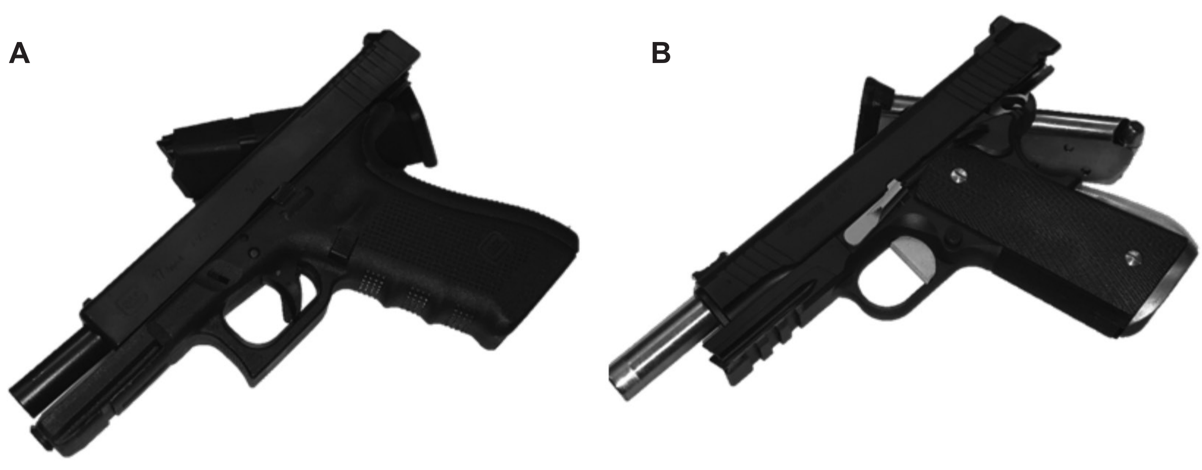

Figure 1. (A) Glock 17 – 9 mm; and (B) Sig Sauer TacOpts 1911

beyond one trigger press. All Glock weapons systems used in this study have a factory trigger pull of ~5.5 pounds. The trigger travel for all included Glock weapons is ~.49 inches. Due to the similar nature of the Glock weapons systems used in this study, no differentiation was made by model as to study variables. The Glock weapons in this study only require the shooter's finger to depress the trigger to fire as there is no external safety beyond that found on the trigger itself. The authors considered that the similarity between Glock weapons (e.g., external manipulation and trigger pull) as well as the participants' comfort with their assigned weapon would mitigate performance variability between the Glock models.

The Sig Sauer TacOps model (Figure 1b) was the largest weapons system within this study (e.g., height × length) and was significantly different in ergonomic design (e.g., thumb safety and grip safety). The factory trigger pull was ~5 pounds with no trigger travel length listed in the description of the weapon (Sig Sauer, 2017). The Sig Sauer TacOps model is carried in a holster with the hammer locked back and the safety on. The safety mechanism at the back of the grip must be engaged (i.e., pressed in), and the thumb safety must be disengaged before the Sig Sauer TacOps weapon becomes functional. The Glock's only external safety mechanism (there are internal mechanisms) is a trigger safety that is automatically depressed when the finger is on and depresses the trigger. Based on the larger size, the difference in handling configuration, the trigger pull weight, and safety variants, the TacOps weapons system has significant variations from all Glock models utilized in this research. There is speculation within the law enforcement community that the deactivation of the 1911 variant weapon system's thumb safety increases overall response time.

The two holster types were manufactured by Safariland and consisted of Models 6280 SLS Level II Retention™ (Figure 2a) and 6390 ALS Level I Retention™ (Figure 2b). The Safariland 6280 SLS Level II Retention™ is described as "a top draw, straight cant duty holster with the self-locking system (SLS)" (Safariland, 2017a). The Model 6280 SLS incorporates a locking hood that wraps around the back of the slide of the weapon and must be pushed down via thumb manipulation and then rotated forwards to unlock the holster for removal of the weapon. A demonstration of how the holster operates can be seen via Internet video (*Model 6280 SLS Mid-Ride Level II Retention Duty Holster Model 94 Buckleless Belt*, 2014).

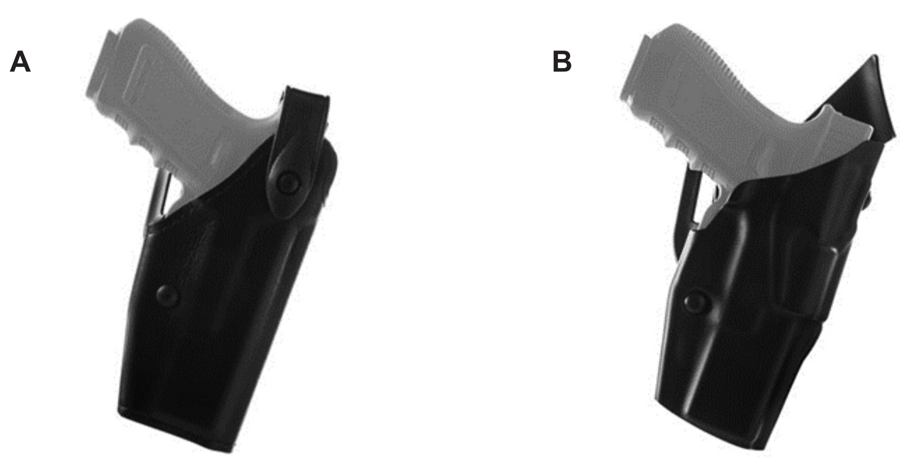

Figure 2. (A) Model 6280 SLS Mid-Ride Level II Retention™ Duty Holster (Reprinted from Safariland, 2017a); and (B) Model 6390 ALS® Mid-Ride Level I Retention™ Day Holster (Reprinted from Safariland, 2017b)

The Safariland 6390 ALS Level I Retention™ is described as "an open top holster featuring the automatic locking system (ALS), an internal locking device that retains the weapon in all directions with no straps of snaps to manipulate" (Safariland, 2017b). The 6390 ALS incorporates a small switch that rides between the holster and the officer's body. The switch is manipulated backwards by the shooter's thumb to unlock the holster for removal of the weapon. A demonstration of how the holster operates can be seen via Internet video (*Model 6390 ALS Mid-Ride Level I Retention Duty Holster with Model 7200 Duty Equipment Belt*, 2014).

While both holster systems require a thumb manipulation, there are inherent differences. The Safariland 6390 ALS Level I Retention™ holster's unlocking mechanism sits under the rear of the weapon and between the shooter's body and the weapon, while the Safariland 6280 SLS's unlocking mechanism sits higher and is attached to a hood strap. Another difference is the direction of the manipulation of the thumb retention mechanism between each holster. Whereas the 6390 ALS requires pushing back, the 6280 SLS requires pushing down and forward. A video demonstration of the variations between the two retention devices (ALS and SLS) on a single holster provides further insight (*Safariland ALS + SLS Holster Systems Demonstration Video*, 2013).

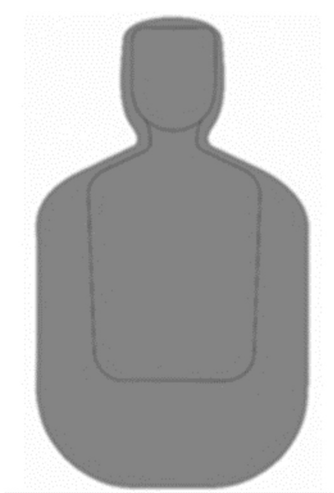

Figure 3. TQ-21 Targets Used for Law Enforcement Firearms Qualifications (Reprinted from Action Target Store. Retrieved from www.shop.actiontarget.com)

Data Capture

An audible shot timer (CED 7000; Competitive Edge Dynamics) was used to initiate and record shot times. The CED 7000 provides an audible signal strength of 110 dB+ at 2,500 Hz and measures shot times in the millisecond time frame.

Target

The TQ-21 paper target used for this research is intended for law enforcement use; its dimensions measure 23" x 45". The target has a grey target zone incorporated within a human form silhouette (Figure 3). The target was placed three yards away from the participants.

Testing

This quasi-experimental between subjects study used a convenience sample of officers based on their already assigned weapon/holster configuration. Participants arrived in one of four configurations: (1) Glock handgun with 6280 SLS Level II Retention™ holster (n = 48), (2) Glock handgun with 6390 ALS Level I Retention™ holster (n = 32), (3) Sig Sauer TacOps 1911 with 6280 SLS Level II Retention™ holster (n = 16), and (4) Sig Sauer TacOps 1911 with 6390 ALS Level I Retention™ holster (n = 32).

Participants stood in a designated location within the firing line and exactly three yards from the TQ-21 target, which was hung approximately three feet from the ground. Participants were told to stand on the line, directly in front of the target, with their hands resting on their chest. Upon hearing the audible signal, participants drew their weapons as quickly as possible and fired one unsighted round at the target from a standard two-hand shooting stance (i.e., arms extended forward to target).

An Arizona POST-certified firearms instructor stood next to the participants and ensured they were ready. Once ready, the instructor held the audible timer approximately one foot from each participant's head. The audible timer was set with a delay of up to 3 s to avoid the potential for an anticipatory response. Upon the audible signal, participants drew their weapons and fired one round. The instructor ensured the timer captured the data after each trial. The recorded response time to the audible stimulus was recorded for each participant in an *Excel* worksheet for later analysis. There were no warm-up or practice opportunities provided to participants.

Results

A two-way ANOVA (2 × 2 between subjects) was conducted to examine the effects of the holster (Models 6280 SLS Level II Retention™ and 6390 ALS Level I Retention™) and weapon type (Sig Sauer 1911 vs. Glock) on the total response to draw and fire one round. Residual analysis was performed to test the assumptions of the two-way ANOVA. Inspection of a boxplot assessed outliers. Normality was assessed using Shapiro-Wilk's normality test for each cell of the design, and homogeneity of variances was assessed by Levene's test. There were no outliers, and the data met assumptions for homogeneity of variances ($p = .897$). The majority of data were normally distributed; however, there was an abnormal distribution for the ALS-Safariland holster and 1911 weapons system. We chose to move forward as larger sample sizes allow for parametric procedures, and the ANOVA is robust to violations of normality (Ghasemi & Zahediasl, 2012; Laerd Statistics, 2017).

There is no statistically significant difference in response times to draw and fire one round based on the interaction between weapon and holster type, $F(1, 124) = .252$, $p = .616$, partial $\eta^2 = .002$. Therefore, an analysis of the main effect for holster type was performed, which indicated that the main effect of holster type was statistically significant, $F(1, 124) = 5.173$, $p = .025$, partial $\eta^2 = .040$. The unweighted marginal means for "response time" to shoot for the 6390 ALS and 6280 SLS holsters were 1.71 (SE = .038) and 1.84 (SE = .044), respectively. The 6280 SLS holster was associated with a mean response time of .132, 95% CI (.017 to .248) milliseconds slower than the 6390 ALS holster, a statistically significant difference, $p = .025$. There was no statistically significant finding of the main effect for handgun, $F(1, 124) = .050$, $p = .824$, partial $\eta^2 = .000$.

Discussion

Previous draw to fire one-round response time research has been conducted through a myriad of methods including using (1) visual and audible stimuli; (2) live fire weapons, paint cartridge weapons, and non-firing training weapons; (3) sighted and unsighted shooting; and (4) small (e.g., human leg) and large (e.g., human silhouette) targets. The related draw to fire research provided the following mean and standard deviation results: (1) 1.90 s with small targets (Hontz, 1999), (2) 1.52 s (.45 s) with large targets (Jason, 2010), (3) 1.94 s (.30 s) trigger pull only (Campbell et al., 2013), (4) 2.09 s (.42 s) (pretest experimental group) and 2.31 s (1.16 s) (pretest control group) with small targets (Nieuwenhuys & Oudejans, 2011), and (5) 1.82 s (.31 s) sighted fire (Lewinski et al., 2015). Excluding Campbell et al. (2013) who evaluated holster position (hip/thigh) response times, none of the related studies control for the weapon/holster type or evaluates response time variants based on the differences.

The current study is the first of its kind to explore whether specific ergonomic requirements of holsters and weapons systems have a significant effect on response times. We hypothesized the differences between devices might have a cumulative effect on the overall response time to draw and fire from the holster. We found no such effect. We also did not find a significant difference between the Glock and Sig Sauer 1911 weapons systems. Regarding the lack of difference between weapons systems, we believe these results demonstrate the perceived slower response time associated with the 1911 thumb safety device is a myth. Our results indicate those who are trained adequately with the 1911 weapons system can disengage the thumb safety during the draw stroke without loss of speed to fire.

While there was no combined effect found in this research, we found the holster systems evaluated did have a significant impact on response time. The 6280 SLS holster was associated with a mean response time of .132 milliseconds slower than the 6390 ALS holster. We believe this is due to the ergonomic and security retention differences between the holsters as defined by Safariland's Level I (6390 ALS) and Level II (6280 SLS) Retention test descriptions (Safariland, n.d.). Depressing and holding the hood device down (first retention mechanism) while moving the hood forward (second retention mechanism) on the 6280 SLS may not offer an economy of movement compared to depressing the thumb mechanism backward (sole retention mechanism) on the 6390 ALS holster.

Our average response time of 1.78 s from Level I and Level II thermoplastic holsters provided consistency to previous "draw to fire" research while also updating it with the use of more modern holster systems. Specifically, our research showed the mean time to draw and fire from all combinations of weapons systems and holsters in the sample (N = 128) to be 1.78 s (SD = .31). The mean times for the Glock/6390 (N = 32) and the Glock/6280 (N = 48) were 1.69 s (SD = .033) and 1.85 s (SD = .29), respectively. The mean times for the Sig Sauer/6390 (N = 32) and the Sig Sauer/6280 (N = 16) were 1.73 s (SD = .30) and 1.83 s (SD = .31), respectively.

A secondary interest is a point made by Lewinski et al. (2015) concerning Level II thermoplastic holsters. Lewinski et al., using an audible stimulus, required trained police officers (N = 68) to draw and fire one round from a snapped and unsnapped holster. They found the average response time to be 1.82 s (SD = .31) and 1.68 s (SD = .27), respectively. The types of holsters were not defined beyond the fact that they had one or more active restraints.

Lewinski et al. (2015) reported a small sample of participants (N = 10) (in a separate study) using Level II thermoplastic holsters were able to draw and return fire in 1.21 s, which was significantly faster than the times within their own 2015 study. They indicated further research should be conducted using thermoplastic holsters. We conducted such research with Level I and Level II thermoplastic holsters and did not find such a decrease in response time. Our unsighted response times were similar or in between Lewinski et al.'s snapped and unsnapped sighted shooting response times from traditional holsters.

We do recognize that Lewinski et al.'s (2015) findings concerning thermoplastic holsters circumscribed a realistic and anxiety-inducing scenario response and not a static laboratory test such as ours. Nieuwenhuys and Oudejans (2011) have demonstrated that anxiety can decrease static shooting response times from the holster by up to .19 s. We hypothesize that the differences Lewinski et al. reported may be partly due to stress rather than the holster system. Also, it is possible that those participants with thermoplastic holsters had practiced more often or under increased intensity than others in Lewinski et al.'s study.

Limitations

The current research focused on determining whether significant response time differences existed between holster or weapon types. We did not control for experience, age, or gender; however, Campbell et al. (2013) previously found that gender, years of service, and familiarity had no significant effect on response time to draw and fire one round (in successful trials).

Although generalizability is challenged with non-random samples, we believe allowing volunteer officers to use the weapons systems with which they had trained, were qualified in, and carried on patrol met the standard for a homogeneous convenience sample and offered increased generalizability (Jager, Putnick, & Bornstein, 2017).

We also wish to point out that response times from an auditory stimulus are likely faster than those generated from a visual stimulus (Vickers, 2007). Additionally, this was a controlled experiment where participants were aware of the task and expecting the go-signal. A real-world environment would likely include competing stimuli that (1) is of a primarily visual nature, (2) causes increased physiological arousal, and (3) requires decision making before acting—all variables that are likely to influence response time (Lewinski et al., 2014; Schmidt & Lee, 2014).

Lastly, we did not collect data on the frequency of practice with the holster/weapons systems used by participants. This variable was not included based on a belief that the participants had met a minimum standard of proficiency as tenured Arizona Peace Officers (e.g., qualification). We realize some participants may have practiced more frequently and developed increased automaticity in psychomotor skills; however, we believe these instances would have been identified in the statistical analysis as an outlier. No such outliers were found.

Future Research Recommendations

A fair amount of controlled laboratory research has been conducted on shooting response times. The results have benefitted the criminal justice system by providing an understanding of human response time to draw and fire or to fire from various positions when responding to a threat. Yet, there remains several contextually related gaps in the literature such as (1) the effects of the amount and type of practice, (2) differences between experts vs. novices, (3) effects of accuracy, and (4) effects of decision making under stress in realistic environments (e.g., increased ecological validity).

Regarding ecological validity, the effects of realistic decision-making while experiencing physiological arousal (as discussed in our narrative) is an important direction for future handgun response time research. Based on empirical findings, Force Options Simulators (e.g., shoot/don't shoot computer simulations) have been discussed as providing increased ecological validity for the study of use of deadly force decision-making (James, James, & Vila, 2016). The simulators most accurately reflect real-world environments and have been shown to increase the physiological arousal of participants (Ross, Murphy, & Hazlett, 2012). Physiological arousal has been demonstrated to decrease response times in certain situations (Nieuwenhuys & Oudejans, 2011) while also significantly decreasing accuracy (Nieuwenhuys, Savelsbergh, & Oudejans, 2012). Therefore, we recommend future draw from holster or positional shooting-related response time research be conducted using the Force Options Simulator while including decision making (e.g., various difficulty levels), accuracy, training, experience, weapon/holster type, and physiological arousal as variables.

There are no conflicts of interest regarding this research and no funding was received.

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