<u>Reaction Time - Lethal Force Encounter</u>

<u>Shooting Scene Considerations:</u>

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"*The essential elements to be considered are the inherent danger reasonably perceived at the time and the physical realities that apply at the time. These physical realities include the factors of action versus reaction times, the abilities of the involved parties, the limited time available to recognize, react, initiate and implement a response, the sensory distortions that will occur in any high stress life-threatening incident and the limited means available to compel a timely halt to the threatening activity. These elements must be judged from the perspective of a reasonable officer within the incident and not with the application of 20/20 hindsight.*" [Ref. 15 Patrick & Hall]

The justified use of force elements hold true whether Officer or Citizen. Officer or Citizen need to be viewed from the perspective of the incident and **not** with 20/20 hindsight.

To understand the timing of a lethal force encounter we need to discuss reaction time, both the mental process and the physical process. For anyone to respond to a threat requires both a mental and a physical investment of time. The general thinking is that you can respond immediately. The facts are that there is a finite measurable passage of time between recognizing a threat (Reaction) and responding to protect yourself (Action). Bell [Ref. 1] "THE REACTION RULE: <u>ACTION IS FASTER THAN REACTION</u>." If someone decides to take action ... reaction is always behind the action. Position changes will occur prior to the response being accomplished.

This process of responding (Reaction/Action) is variously referred to as Response time, Reaction / Response time, Decision-Making / Response-Reaction, or Reaction / Action time. Regardless of what you call it, the response can be broken down into at least two components. The reaction or mental time and the action or movement time. These can be tested and measured to some degree.

There are two components associated with discharging a firearm in a typical defensive encounter. The first is the Reaction or mental time and involves the time required to process information and make a mental decision to discharge a firearm. Hontz & Rheingans [Ref.2] break this mental time down into stages.

First is **perception**. This is sensory, primarily visual, for example, the car is moving or the subject is coming at me. It may be auditory, I hear the engine revving, or I heard a gunshot. It might be olfactory, for example, I smell smoke. It may even be tactile, for example, I have been hit or something has grabbed me.

The second stage is **analyze and evaluate**. For example; the vehicle is moving ("*I started to fall back and as the car started to move, ... I thought I was gonna be dragged down the street.*"), he lunged forward ("*he came toward me... I thought he had a knife and I would be killed.*").

The next stage is the formulation of a **plan**. This results in the officer or citizen defending themselves. The manner depends on the experience, training and the tools that are available to achieve cessation of the threat.

The final stage to the mental or reaction process is to initiate **motor action**. For example, draw your firearm, bring the gun to bear, finger move to trigger, sight picture, and press trigger.

Tobin and Fackler [Ref. 3] found the average human reaction time for 17 police officers to mentally justify firing their pistols during a simple decision-making scenario of 0.211 seconds. The same officers in a complex scenario took 0.895 seconds. This time is the Reaction time only, or the mental time to get to the point of sending a signal to press the trigger.

Tobin and Fackler [Ref. 4] test 46 police officers that knew they were going to fire their pistols and it was simply a matter of doing so when they received the signal. This test result in an average Action time of 0.365 seconds with the officers' finger already on the trigger. It should be noted that when these same officers started with their fingers outside the trigger guard the average action-response time grew to 0.677 seconds. In the 2001 article [Ref. 3] the 17 officers in this study also had their fingers on the trigger with their pistols pointed at the scene with the instruction to fire as soon as they could mentally justify the use of deadly force. In the real world, not having these instructions generally make the times greater.

The combined Reaction time and Action time result in the average total time to make a decision and actually fire a pistol in simple and complex scenarios with the finger on the trigger was found to be 0.576 and 1.26 seconds and with the finger off the trigger 0.888 seconds and 1.576 seconds respectively.

James Bell Jr. [Ref. 1] in his "Principles of Self Defense" article reminds the student to maintain a reactionary gap. This is the distance between you and a threat that gives you time to react/act. This reactionary gap distance has been thoroughly tested and is well established. Most firearms instructors won't let an individual with a knife get closer than 21 feet before drawing and firing if the individual continues to approach. Dennis Tueller's tests reported in 1987 [Ref.5] found that the traditional seven yard distance gap could be closed in the same time that the officer could react/act or about one and a half seconds for a tie.

Hontz and Rheingans compiled and published an extensive study in 1997 [Ref. 2] that includes the scientific basis for the so-called "21-foot rule" regarding adversaries armed with edged weapons. More recent work by Dr. Bill Lewinski [Ref.6] a law enforcement professor at Minnesota State University tested 101 officers. This study has been published in a series of articles in The Police Marksman and can be viewed collectively at his web site [6]. The Lewinski work and others like it, (Scott Reitz [Ref.7]) continue to validate the "21 foot" rule, if any variance exists it suggests that the distance be greater, closer to 25 feet. My own tests have also concluded that the average Reaction/Action time of 1.5 seconds is sufficient time for an attacker to close a reactionary gap of 7 meters.

Hontz and Rheingans [Ref.2] quote Schmidt [Ref. 8] who states "Reaction time is the interval of time from a suddenly presented, unanticipated stimulus until the beginning of the response." Schmidt goes on to define movement or action time as "The (time) interval from the initiation of movement until its completion." Response Time by these authors is defined as the sum of Reaction Time and Movement Time. The first is a mental process and the second is a physical process. These authors go on to state that pure reaction time for most people is 0.2 to 0.3 seconds. Movement Time will depend, in part, on the complexity of the planned movements but can take fractions of a second or even seconds.

Hillman [Ref. 9] cites studies by the DOT for the FAA and the Los Angeles Police Department Driver's Training Unit and gives average human reaction times ranging from 0.4 to 0.8 seconds. The upper value is very close to Fackler and Tobin's average decision-making time (reaction time) of 0.895 seconds.

Hontz and Rheingans go on to break down the mental processes associated with Reaction Time into the following four components:

-Perception (a sensory event or events; visual, auditory, olfactory, or tactile.),

-Analysis and Evaluation (judgments regarding what has been perceived),

-Formulation of a Plan (based on life experience and training),

-Initiation of Motor Action (the brain sends messages to the appropriate muscle groups to carry out the plan).

These authors provide some interesting figures for average movement times (Table 7, page 31) some of which are given below.

Time to Draw (a pistol) from a Holster	1.19 seconds
Time to Raise (a pistol) and Fire	0.59 seconds
Time to Run 15 feet	1.28 seconds

Time to Run 20 feet 1.57 seconds

A subsequent chart on the following page provides an average response time of approximately 1.96 seconds to draw from a holster and shoot at a single large target. When the officers started from the 'ready' position, their average response time dropped to 1.20 seconds.

If we look at running speeds in general, we see that average speeds vary greatly between people, somewhere between 8-20 mph or 12.87-32.19 km/h. For most of us; [Ref. 10] a sprint is about 10-15 mph or 16.09-24.14 km/h. In a long distance run about 5-8 mph or 8.05-12.87 km/h. Walking speed is in the neighborhood of 3-4 mph or 4.83-6.44 km/h.

Taking a look at our fastest speeds; Men's World Records (as of May 2010) [Ref.11] Translated Into ***Average Speeds:***

-Maurice Green - 60m @ 6.39 sec. (9.39 m/sec., 33.80 km/h. or 30.81 ft/sec., 21.00 mph.),

-Usain Bolt - 100m @ 9.58 sec. (10.43 m/sec., 37.55 km/h. or 34.22 ft/sec., 23.33 mph.),

-Usain Bolt - 200m @ 19.19 sec. (10.42 m/sec., 37.51 km/h. or 34.19 ft/sec., 23.31 mph.) and

-Michael Johnson - 400m @ 43.18 sec. (9.26 m/sec., 33.34 km/h. or 30.38 ft/sec., 20.71 mph.).

It is interesting to note that the 60 meter race has a slower average speed (21.00 mph) than the 100 meter race (23.33 mph) or even the 200 meter (23.31 mph). This is because of reaction time (getting off the blocks) and acceleration time at the start. The longer distance allows more time to assimilate this time. When we get to longer runs (400 meter and longer) we don't have enough gas to keep up our fastest speeds and we must pace ourselves to get through the race at best average time. Also the effect of reaction / acceleration time becomes less and less conspicuous.

Women's World Records;

-Irina Privalova - 60m @ 6.92 sec., (8.67 m/sec., 31.21 km/h. or 28.44 ft/sec., 19.39 mph.),,

-Florence Griffith Joyner - 100m @ 10.49 sec., (9.53 m/sec., 34.31 km/h. or 31.27 ft/sec., 21.32 mph.),,

-Florence Griffith Joyner - 200m @ 21.34 sec., (9.37 m/sec., 33.73 km/h. or 30.74 ft/sec., 20.96 mph.),, and

-Marita Koch - 400m @ 47.60 sec., (8.40 m/sec., 30.24 km/h. or 27.56 ft/sec., 18.79 mph.),

As with men, reaction time / acceleration time results in both 100 meter and 200 meter race with faster average times than the 60 meter race. Once we are doing 400 meters or more, women too have to conserve energy to get their best average time in a race.

Looking at the Running Speed of Major League Baseball Players [Ref. 12] we see an average time for home plate to first base (90 feet) of 5.03 sec. for an average time of 17.89 ft/sec., 12.20 mph or 5.45 m/sec., 19.63 km/h.

A randomly picked group of police officers [Ref. 2] ran 15 feet in 1.28 seconds (11.72 ft/sec., 7.99 mph, 12.86 km/h) and 20 feet in 1.57 seconds (12.74 ft/sec., 8.68 mph, 13.88 km/h). As seen with the sprinters the average is slower due to reaction /acceleration time for the shorter distance.

Questions often arise about the K-9 Officer, the attack speed of his German Shepard. There is considerable range reported here also (12-33 mph or 19.31-51.50 km/h) the prevailing speeds reported are in the range of 25-30 mph, 36.6-44 ft/sec. or 40.23-48.28 km/h, 11.2-13.4 m/sec. We must remember that reaction time is compounded, the handler's reaction time for command and release, then the reaction and acceleration time for the dog. In any event it looks like your average police department "man-snapper" can move about twice as fast as your average "culprit" (dog @ 25-30 mph verses man @ 8-20 mph), I'm going to bet on the Dog.

Roger M. Enoka, Ph.D. [Ref. 13] has published description and mechanism of unintentional discharges, the result of **sympathetic contraction**, **loss of balance**, or **startle reaction** any of which might apply in a high stress extreme encounter.

"The term <u>sympathetic contraction</u>, which was coined by law enforcement officers, refers to an involuntary contraction that occurs in the muscles of one limb when the same muscles in the other limb are performing an intended forceful action. A common situation that could evoke a sympathetic contraction sufficient to produce an unintentional discharge would be a law enforcement officer attempting to restrain a struggling suspect with the left hand while holding a handgun in the right hand.

The second scenario involves the <u>loss of balance</u>. One of the most common uses of involuntary contractions are those elicited by the nervous system to maintain the variety of postures that we assume during activities of daily living. Consider the case of a law enforcement officer who has pulled over a pickup truck on a highway *and walks alongside the passenger side of the vehicle with his weapon drawn. The side of the road is covered with gravel and has a modest slope. The officer slips on the gravel. Without a conscious decision, the officer's nervous system will activate a sequence of involuntary contractions to prevent him from falling. If the officer is not close enough to grab either the pickup truck or his vehicle for support, the involuntary contractions will be focused in the leg muscles. If the officer can grasp either vehicle for support, however, most of the involuntary contractions will occur in the arm and hand muscles. Thus, the rapid involuntary contractions could involve the same muscles being used to hold the gun.*

The third scenario involves the <u>startle reaction</u>. This is a whole-body, reflex-like response to an unexpected loud auditory stimulus; sometimes it can be evoked with visual, vestibular, or somesthetic stimuli (Bisdorff, Bronstein, & Gresty, 1994: Bisdorff et al., 1999; Hawk & Cook, 1997). The startle reaction evokes rapid involuntary contractions that begin with an eye blink and progress to include bending of the neck, trunk and shoulders, elbows, fingers, and legs (Brown, 1995; Landis & Hunt, 1939). The reaction in the hands, which occurs less than 200 milliseconds after the stimulus (loud sound), is for the person to make a fist. The magnitude of the startle reaction is variable, including increases in amplitude with fear and arousal (Davis, 1984). Accordingly, an officer who is startled by a loud, unexpected noise while searching for a suspect with his weapon drawn would surely increase the grip force on the weapon, perhaps enough to cause an unintentional discharge."

Whether or not the shooting is intentional or unintentional any of these response stimulus might apply.

Another phenomenon that occurs with high stress encounter is **perceptual distortion**. For example; having no recollection of the gun going off or things recalled as having been in slow motion are very common. These events are generally called tunnel vision and tunnel hearing or perceptual tunneling. Lewinski 2002 [Ref.14] refers to this as the result of "<u>funneled concentration</u>" on the threat. A study cited in this article by Drs. Honig and Roland published in October 1998 edition of The Police Chief indicated that 90% of the officers involved in 348 shootings experienced some type of perceptual disturbance. This is mentioned because we see times from several seconds to several minutes among the various witness statements of same shooting event.

Patrick & Hall [Ref. 15] refer to these distortion as; a. Tunnel Vision, b. Increased Visual Acuity, c. Altered Hearing, d. Time Distortion, e. Dissociation, f. Temporary Paralysis, and g. Memory Distortion. These not only occur in the players of lethal force encounter but witnesses as well.

These distortion have been tested and demonstrated. William Lewinski, PhD. [Ref. 18, 19, 20] "A person's attention is an extremely significant factor in determining what that person perceives and then remembers." "It would be extremely rare, if not impossible, for an officer involved in a fluid, complex, dynamic, and life-threatening encounter to remember peripheral details beyond that on which he or she was focused." "The average person will actually miss a large amount of what happened in a stressful event and , of course, will be completely unaware of what they did not pay attention to and commit to memory."

Such distortion can be easily demonstrated by such illustrations as "the invisible gorilla" [Ref. 21], an illustration where white clothed and black clothed groups of young people are passing a basket ball. The observers are instructed to count the number of passes by the white clothed people. During the scene a gorilla suited individual walks through the scene (beats chest in the middle of scene). Over half of observers do not see the gorilla and those who do tend to loose count of passes. Attention blindness or tunnel vision ... concentrating on one thing and not conscious of the rest of the scene.

We only see a fraction of what we think we see. [Ref. 22] The eye is not a camera, it does not take pictures of events. What is seen as the eyes move about depends on who is doing the seeing. Not only does seeing depend on who, it depends on what. A professional golfer would view a golf course differently than someone who has never played the game. Experts and novices tend to look at things in different ways. One of these differences involves something known as the "quiet-eye period." This is the amount of time needed to accurately program motor responses. It occurs between the last glimpse of our target and the first twitch of our nervous system. We tend to see on a need-to-know basis. If we don't think it is important we tend to ignore it.

Reaction time studies and examination of actual lethal force encounters indicate that most of these events take place in no more than three (3) seconds usually on the order of half that or about 1½ seconds while witness statements are often on the order of minutes and very rarely reflect an accurate count of the number of shots fired.

Rate of fire is part of the equation when we look at how long an event takes. My own tests and tests of others [Ref. 16, 17] demonstrate that five (5) shots in one second is common. Five shots in one second results in a shot-to-shot interval of 0.25 seconds for the average shooter.

Witnesses and even the immediately involved participants rarely recollect actual time. Time distortion affects nearly all witnesses. Even without distortion, if a witness looks away or blinks, they miss much of or even all of the shooting event.

In addition to perceptual distortion, many if not most **eyewitness** accounts are more likely **ear-witness** accounts. A gunshot is heard, the witness turns to see the gun in a subject's hands, resulting in an "I saw the gunshot" conclusion. Sound travels much slower than sight, by the time someone observes the source of sound the image or eyewitness account is long gone. The speed of sound in air is approximately ~1125 ft/sec, ~767 mph or ~343 m/sec, ~1235 km/hr or traveling a kilometer in about three seconds or a mile in about five seconds. On the other hand, the speed of sight (light) is approximately ~983,571,056 ft/sec, ~670,616,629 mph or ~299,792,458 m/sec, ~1,079,252,849 km/hr. Light moving about ~874,135 times faster than sound, or an ear-witness being way behind the curve when they look toward the sound. Note: all of these figures are approximates as propagation of light and sound is significantly affected by atmospheric conditions, the medium through which it passes (figures were obtained from [24] Unit Conversion web site).

Automobiles are often part of the equation. One mile per hour is ~1.4666 feet per second per mile an hour. In a 1 second shooting event a car traveling an average speed of 10 miles per hour will travel ~14.666 feet.

In a five shots fired in one second event a car will move ~3.67 feet between each shot at 10 miles per hour.

Compiled by Gaylan Warren 2012
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