New Developments in Understanding the Behavioral Science Factors in the "Stop Shooting" Response

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(Research at FSRC and elsewhere leads to an understanding of the behavioral reasons why officers cannot stop shooting the instant the threatening behavior of the subject ceases.)

The Shoot and Assess Dilemma

A law enforcement officer can use deadly force with a firearm in a variety of circumstances. However, once that officer has used deadly force, the microscope of the investigators, his or her department, the courts, and society will focus on the circumstances of the shooting and the officer's response(s) to those circumstances. Inherent within this investigation will be a close scrutiny on two phases of the shooting. First, the officer's decision and/or reaction to start shooting and then the officer's decision and/or reaction to stop shooting.

For understandable reasons, in lethal force encounters, the officer's primary focus is usually on surviving threats to his or her life, and most of the officer's preparation and training has focused on the officer's responses that would most likely guarantee that survival. Very little attention if any is focused on immediately stopping shooting when the lethal threat changes—even if stopping immediately was humanly possible.

There has been and continues to be a variety of approaches to what officers should do while shooting and when officers should "stop" shooting. A small number of officers and departments in the United States and elsewhere still believe in and train that an officer should shoot one round and then stop and assess. Others believe in and train the double tap and then assess. Still others believe in and train the triple tap and then assess. Since at least the mid 1980s, a developing and predominant training approach has been to have officers shoot and assess simultaneously. This training method of shooting and assessing evolved and became more popular as more was understood in the law enforcement community regarding the actual stopping power of a bullet and the kind of circumstances officers confront when attempting to save their lives or the lives of others by means of lethal force (Harper, 2000; Ogden, 2007).

It became apparent from research and a variety of high-profile incidents, such as the FBI/Miami incident, that shooting once, twice, or even three times and then stopping and assessing, which all take time, gave the opportunity and advantage to the "bad guy" who may be continuing to fire (Lewinski, 2000). Recent research has also revealed that even novice shooters can fire at least three rounds in 1.5 seconds (Lewinski, 2007). Therefore, the safest way for an officer to respond in a firefight is to shoot and continue to shoot accurate shots on target until the threat stops. Although *shooting and assessing* is undoubtedly the safest way for officers to respond in today's firefights, a downside has become apparent to the shooting and assessing

response. That downside is that while the shooting and assessing response helps an officer survive in the street, it could lead to a misunderstanding of an officer's competency or motivations. This could be especially true when a large number of shots is fired after the threat has ended or different officers in the same situation fire a different—and sometimes dramatically different—number of shots.

What has become clear is that officers from the same department with the same training and guidelines will respond differently in lethal force encounters and will start and stop shooting at different times. This is primarily because of individual perceptions and responses to the threat, and the perception of the cessation of that threat. These individual factors often are not directly linked to a department's training and policies but arise out of the human factors that an officer brings to and meets in these encounters.

The Results of FSRC's Research on Understanding the Time to Stop Shooting

History

In the past, problems that have arisen out of the shooting and assessing response have been alleged to be the result of emotional or personal factors on the part of the officer such as "too much firepower," "the officer being emotionally out of control," "bias or hatred," "malice or evil," "poor training and supervision," etc. The Force Science Research Center (FSRC) has been dedicated to understanding the *stop shooting problem* when an officer is shooting and assessing, and our research and the research of other universities are beginning to shed light on why an officer who is both shooting and assessing cannot stop shooting immediately.

The very act of stopping has been studied by several researchers to date. This research has found three main components to stopping: (1) that stop and go processes in the brain seem to operate independently of each other (Logan & Cowan, 1984, pp. 308-313), so the cognitive process to stop is racing against the cognitive process to go; (2) the longer the delay between the onset of the go stimulus and the onset of the stop stimulus, the harder it is to stop (p. 297)—theoretically, then, for police officers, the more rounds they have continuously fired, the harder it becomes to stop that reaction and the longer the time frame before they can stop; and (3) when you are asked to respond to more than one stimulus at a time, the reaction time to the second stimulus will be slower than if they both had been independently presented (Johnson & Proctor, 2004, p. 178). Officers who are both shooting and assessing will likely give more concentration and attention to one aspect over the other. The one with the lower level of attention or effort is the one that will suffer or be less sensitive and reactive to changes. For instance, an officer who is shooting to stop the threat and is intently focused on accurately shooting or, on the other end of the spectrum, an officer who is emotionally recoiling at the thought of his or her own apparent and imminent death and is intently shooting to save his or her own life are both going to be impaired in their ability to perceive and respond immediately to changes in the subject's behavior.

Further, much of the research conducted on stopping has been on the inhibition of a reaction that has yet to be completed; this is called the "stop signal paradigm" (Logan & Cowan, 1984, p. 296). This research shows that most people can stop in 200 ms an action that they had just started but have not completed. The ability to stop their reaction in this time also implies that the initial reaction and motor movement

time take longer than 200 ms to complete. When shooting, police officers are usually engaged in a continuous action, which Morein-Zamir, Nagelkirke, Chua, Franks, and Kingstone (2004) found to be strongly correlated with the stopping observed in the stop signal paradigm. Green (2000), however, found something very different. He investigated the research on stopping reaction time from a continuous action in more "real world" circumstances when he conducted a review of the literature on braking reaction times with drivers in automobiles or simulators—a slightly different form of stopping. He found that under expected conditions, reaction time to begin braking was between 0.70 to 0.75 seconds, while under unexpected conditions, reaction time was 1.5 seconds or longer (pp. 206, 209). This rather large disparity between 0.20 and 0.70 or even 1.5 seconds may be attributable to the differences between studies conducted in pure laboratory conditions that isolate a specific phenomenon compared to real-world research which involves a variety of phenomenon, including attentional problems and automatic motor programs that are difficult to interrupt or control for in real-world studies but are usually controlled for in a laboratory study.

Each one of these components cited above, if they applied, would add time to the overall ability of the officer to stop shooting as soon as the threat changes. Plus, there are other factors to consider. Damon, Stoudt, and McFarland (1966), for example, in examining a version of the conditions studied by Hick (1952), found that when a subject made a decision involving only one choice, it resulted in an average reaction time of 0.20 seconds. Each additional choice adds up to 0.05 seconds more (citied in Olson & Farber, 2003, p. 322). Stopping is therefore a singular or series of multiples and/or a complex of dynamic processes, which can be affected by several different factors, all of which have an impact on reaction time to both start and stop anything. In an effort to clarify this research and its application to a law enforcement population, FSRC took a closer examination at the *stop shooting response* with police officers.

FSRC's Research

First, FSRC's work with the "Tempe Study" was focused on the starting and stopping reaction to the most elementary circumstances (Lewinski & Hudson, 2003a, 2003b). When a light was turned on, an officer armed with a specially equipped training gun was to pull the trigger of the gun as often as he or she could until the light went off. The light was turned on randomly and turned off randomly so that the officer never knew when the test was going to begin or end, but the officer did know it was going to end and that this was not a threatening situation. It was apparent that the officers were under some stress during the testing and worked as hard as they could on the experimental tasks (Lewinski & Hudson, 2003a, p. 28).

From a previous "Tempe Study," FSRC knew that the average time to see the light come on and to begin to pull the trigger, for the average officer was a full quarter of a second. Through the expert work of Dr. Bill Hudson (Deputy Director of the FSRC and Chairperson of the Computer and Electrical Engineering Department at Minnesota State University, Mankato), FSRC was able to set up a Glock training pistol with a system that allowed a precise measurement of the time to complete the physical action of a trigger pull. That time was 6/100ths of a second for the average officer using a short stroke Glock. Therefore, the quarter of a second perception processing time and the 6/100ths of a second reaction/motor time resulted in a time to complete the first trigger pull in response to the simplest stimulus of 31/100ths of a second (Lewinski & Hudson, 2003a, p. 27).

Because of the simplicity of the stimulus in their study (a single light going on or off), FSRC was able to obtain the fastest reaction time possible for the average officer to respond to anything and that includes both starting and stopping shooting. Any other type of reaction or response in any other circumstance is going to take the officer longer. FSRC discovered that the quickest an officer could stop shooting in response to a simple change in external circumstances, when he or she was actively engaged in the process of starting to shoot or actually shooting until the threat stops, is approximately 35/100ths of a second, with most of the officers (68%) taking up to 6/10ths of a second (Lewinski & Hudson, 2003a, p. 28). Because the average time for the average officer to cycle through trigger pulls on a Glock while firing multiple rounds is approximately a quarter of a second, our data means that the average officer is able to react to the simplest external stimulus to shoot serially and back off the trigger pull after firing two rounds when the stimulus is extinguished (p. 29). This, of course, varies with at what point in the trigger pull sequence the officer detects the change. This study informs us that when the average officer stops shooting based solely on a perception of change in the outside world, the fastest the officer is able to do this is 35/100ths of a second or the completion of one full trigger pull cycle and the completion of the second shot by pulling the trigger back to the back of the trigger stop, resulting in two shots being fired (p. 28).

We must make two important qualifications here. First, for the most part, most of the officers were trying to pull the trigger as quickly as possible. Secondly, the officers knew the light was going to go off; they just didn't know when. The conclusion from this research is that even though some officers in real life shooting situations in the street will stop shooting as soon as the subject stops his or her threatening behavior, for most officers who perceive a threat and respond to that threat by shooting until the threat stops, those officers (shooting and assessing) will still fire at least two rounds from a Glock or similar short stroke weapon. This will occur not when the subject has changed their threatening behavior but after the officer begins to detect a change in the threatening behavior. This distinction is important because the psychological processes of perception and detection often take many times longer than the physical responses involved.

The Tempe Study measured the fastest time for the average officer in the simplest circumstance to stop shooting. As stated previously, every other type of shooting circumstance is going to generate a longer time to stop shooting in response to a change in circumstance outside of the officer. This is due to the following:

- *Simplest Challenge*—FSRC'S laboratory test was the simplest challenge the officer could face. It doesn't get any simpler than light on and light off. Actual shooting situations on the street often demand much more complex decisionmaking to both starting and stopping shooting than FSRC tested in the lab. These sometimes profoundly complex perceptual and decisionmaking processes can also be significantly emotionally laden and that can profoundly complicate and subsequently increase the time for the perception of a change in the threat and the resulting decision and reaction to stop shooting.

- *Selection of the "Right Threat to Focus On"*—Street encounters are more visually and auditorily complex than the test conditions in the laboratory and often require the officer to see and hear many things simultaneously. This requires the officer to select the most important thing to focus on and hopefully this also turns out to be the most important factor(s) for the officer's safety and ultimate survival on the street and in the legal aftermath. For instance, an officer who is focused on a

front sight placement will not be able to immediately see a change in the assailant's threat action and therefore will sometimes shoot many more rounds after the threat has changed or stopped. On the other hand, an officer who is focused on the subject and not their own gun sights will also be unable to stop immediately, but because of his or her focus, he or she may be able to stop sooner to a change in the behavior of the subject he or she is shooting at than an officer who is not focused on the subject. Unfortunately, this officer may also be very inaccurate with his or her shots. Simply stated, an officer has to be focused on the behavior of the subject that changes if he or she is going to be able to react to that change as quickly as possible (Lewinski, 2008b, p. 125; Vickers, 2007, pp. 53-54; Vickers & Lewinski, 2009).

- *Expectation that the Threat Will Stop or Continue*—In the laboratory, it was very clear that the light would go off and the officer would then be required to stop pulling the trigger. Most officers in an actual firefight do not know if or when the threat they are facing will cease or whether they will die before the threat stops. This primes their reaction to continue until a "noticeable" change occurs in "their perception" of the threat. If the "noticeable" change is different than what the officer expects or what actually occurs at a different location than the one the officer is focused on—that in and of itself will lengthen the officer's reaction time to stop shooting (Corbetta, Miezin, Dobmeyer, Shulman, & Petersen, 1991, p. 2395).

- *Role of Emotional Reactions in the Trigger Pull Response (Trigger Pull Cycle Time)*—Although fear and anger both fuel adrenaline and this enhances gross motor responses like running or lifting something heavy, it has a negligible or even an impairing effect on fine motor skills such as sighting a gun and pulling a trigger. Therefore, we expect an officer's trigger pull cycle time to vary little in the street from the cycle time that we discovered in the lab. Assuming the officer has good weapon management skills, all factors being considered, the emotional reaction of the officer will not significantly enhance or decrease their trigger pull cycle time (Schmidt & Wrisberg, 2004, p. 69).

Given all of these factors, it is clear that FSRC just laid down the bottom line on reaction time. It gets much more complicated from this point and, often, unfortunately for the officer, slower.

The Role of the Eye in Stopping Shooting

The following factors are very old and well-understood psychological principles that have been tested in a variety of circumstances and that in *performance psychology* are known to affect the areas of vision, perception, and attention. They do have a profound impact on perception, processing, and reaction time to both starting and stopping anything and so also impact the human performance reaction in a shooting situation. Recent studies in these areas, as published in *The Journal of Neuroscience* and a variety of other professional and popular publications, have lent further understanding as to how these factors function in lethal force encounters and will help explain why some officers take so long to both start and stop shooting (Shomstein & Yantis, 2004). Before we can understand the psychological factors in perceiving a threat, we first must understand the physical role of the eye.

Focus

To understand the significance of this, the reader must first understand how information gets into the brain. Seeing that a lethal force encounter is primarily a visually dominant activity, this will be illustrated with an explanation of the process of seeing. In doing so, it can be demonstrated that the research challenges the belief that we can see, record, and react to more than one thing at a time, particularly under conditions of intense visual focus. This does not mean that we cannot react to visual stimuli in the peripheral vision—in fact, quite the opposite is true—but under conditions of intense visual focus, our ability to perceive and react to stimuli in the peripheral vision is impaired.

The reality is that each eye is capable of clearly seeing only within two to three degrees of what it is staring at (Vickers, 2007, p. 18). Everything else is in our peripheral vision, and the clarity of the peripheral vision changes from "fairly good" when looking almost straight ahead to "very bad" at the outside of our peripheral vision.

To test this out, the reader can print out this page, stare at the X, and while staring at the X, try and see how well they can read the numbers on either side of the X right out to the edge of the paper. Try this at different distances and also try to see both sides of the page at the same time and you will see the impact focus has on clarity of perception both close up and further away, even on information that is directly in front of the reader, who presumably is doing this while under minimal stress.

50000 40000 30000 20000 10000 X 00001 00002 00003 00004 00005

What this means for an officer involved in a shooting is that the specific visual focus of the officer (left or right, near to far, and specific to general) will dictate what the officer is able to clearly see and react to or report. If the officer is not specifically focused on it, as we will see later, the officer—if he or she sees anything at all—will not be able to react very effectively to it or remember it.

A qualifying factor should be included here. Peripheral vision is excellent for acquiring a variety of information, including our distance from objects. Even so, it creates significant problems for officers involved in shooting situations in two areas. First, peripheral vision is excellent for judging the speed of travel of objects coming close to us such as a tackler in football or a fastball in baseball. However, the phenomenon of how the eye judges the path of travel and speed of an approaching object is conducted differently with focal vision than with ambient vision (Schmidt & Wrisberg, 2004, p. 115; Vickers, 2007, p. 20). When an officer becomes aware of an object coming toward him or her, such as an automobile, out of their peripheral vision, and then shifts to judging the path and speed of the vehicle with his or her focal vision, the shift in visual processing from focal to peripheral can result in the perception that the vehicle has "jumped" toward them. Forensic investigation may or may not find physical evidence to support this, but this perception of "jumping" may be due to a shift in how the information is processed by the eye and brain. This qualifying point is added here because the perception of the "jump" may lead an officer to begin to shoot when they normally would not have or to shoot earlier than they might have.

Eye Movement (Saccades)

This is the name for shifts in the eye that result in the ability to see clearly from side to side and up and down without moving the head (Vickers, 2007, p. 20). In the illustration just above, the reader will also see that when vision is shifted to the right or left, the reader's view of the X blurs, but the side of the page that is being looked at gets clearer. The important point here, though the reader probably did not notice this, is that shifting focus takes time. In fact, even though the reader might have thought of it as immediate or instant, for the average person, in average circumstances, the eye shift takes 2/10ths of a second to shift to one side and 2/10ths of a second to shift back (Crevits, De Clerck, & Van Maele, 2000, p. 322). If this is translated into trigger pulls, in the time it took the reader to glance from the X in the center to either side of the page and back, it would take 4/10ths of a second and, again, the average officer would have fired two rounds in that time span or—to shift the reference—two rounds could have been fired at the officer.

The reader can test this out for him- or herself. While looking at the X, the reader can count one thousand and one (the average time count for one second). Note, at the appropriate cadence, each word in this count takes one quarter of a second to think about). The reader can then simultaneously quickly shift his or her eyes, and he or she will see that the average quick look to either the left or the right, a quick fixation to note the number at that sight, and back again takes the word count of "one thousand," or just under a half second, or two shots if we translate that time into trigger pulls.

The reader should also note two other things during this illustration. One is that if he or she focused at all on the "5000" during the saccade, it takes a lot longer than half a second to complete this task. Secondly, while shifting his or her eyes quickly—and it has to be done quickly—he or she can partially see but not read the "4000," "3000," and "2000" as they go by them. The brain simply does not record what is in-between these focus points under a quick saccade (Vickers, 2007, p. 20).

The Role of Attention and Shifts in Attention

The brain, through the senses, primarily the visual sense, gets the information it needs to deal with the world. Because the senses and the brain are bombarded every second with vastly more information than the brain can use and most of which is irrelevant, the brain focuses on what is currently important to it and generally ignores everything else unless something "catches" our attention (Vickers, 2007, p. 54).

For instance, the reader of this article might be seated in a chair or standing. The pressure of the surface the reader is sitting or standing on is most likely ignored until he or she brings his or her attention to it. Try to remember how this "ignored" pressure felt 20 seconds ago and unless the reader's attention was focused on it then, they likely cannot remember it now, even though it is the reader's own bottom sitting on that chair or his or her feet standing on the floor. Imagine yourself in court three months to five years from now and an attorney is cross-examining the reader on the circumstances surrounding his or her reading of this article and asks the reader to describe the pressure of the chair on his or her body from the beginning of their reading of this article until now. Would the reader admit that it actually was his or her body in the chair, but he or she does not remember anything about how it felt to be there? Would the reader "fill in the blanks" by thinking about what the chair felt like at some other time and logically concluding it had to have felt the

same at the time he or she was reading this article? Or would they simply guess how it felt because he or she was too embarrassed to admit not remembering?

This same illustration of the focus of attention is true of the visual exercise we just presented. If you are focused (visual attention) on the X, you cannot completely and accurately report on "0005." This is the result of a combination of two factors: (1) visual and (2) attentional focus.

The same is also true for an officer in a shooting situation. Before the authors explore this further, the process of *visual accommodation* needs to be explained. Just as the reader can shift his or her visual attention from peripheral to focal vision, he or she can also shift it from near to far. This shifting process is called "visual accommodation" (Goldstein, 2002, p. 42). The reader can again experience this for him- or herself through conducting a simple study. First, the reader should hold the thumb of either hand in front of his or her body at arm's length. If his or her vision is focused on the thumb, the background will blur. If he or she focuses on the background, the thumb, or the foreground, will blur. Although, again, the reader is likely unaware of it, shifts in this type of focus from near to far and back again take time. If the reader was to also clarify what he or she saw at either end of the shift of visual focus from near to far and back again, it would take as long as half a second or more to shift and come back again. If an officer is focused on his or her sights or has his or her sights on a subject he or she cannot completely and accurately report what the subject he or she is aiming at, or anything else in front of the officer, is doing precisely at the time he or she is sighting. The implications of this officer's "inattention" are twofold. First, the officer will not be able to immediately "react" to anything that either newly presents as a threat to the officer or changes in the current threat situation while the officer is not narrowly focused on them. Secondly, the officer will not be able to "remember" things directly outside of his or her narrowly focused area of attention because he or she would literally not have seen it or not have seen it clearly enough to accurately remember it (Lewinski, 2008b; Vickers & Lewinski, 2009).

A caveat needs to be included here. Any reader who has participated in a dynamic game such as football, tennis, or baseball knows the value of using peripheral vision to assist in judgments and reactions. For instance, baseball players who are playing in the outfield will easily use the large dark object appearing in their peripheral vision as they are focused on catching a fly ball to know how far away they are from the outfield wall and to judge the speed of their travel, time to impact, etc. This is because of the *schematics* ball players have built in their brain from years of playing in a known environment. They do not need to focus on the wall to see it is there; they make assumptions or draw conclusions about facts that are not well-defined because these facts fit within their knowledge and experience. Similarly, officers in a force encounter will use information acquired from their peripheral sensory or attentional processes and match or compare that information to a schematic or blueprint in their head that was acquired from training or previous experiences. This helps them process and understand information that is incompletely perceived without their needing to focus on it just as the baseball players in the prior illustration. This means an officer in a highly threatening encounter who has information about the situation he or she is in that leads him or her to believe he or she is about to be assaulted will have a quicker reaction time to attacks coming from his or her peripheral vision. Unfortunately, use of the peripheral vision and context without visual clarification can lead to errors in judgment. The counter to that as the reader will see shortly is that visual clarification

can take a dangerously long period of time as well as possibly taking the officer's attentional focus off other relevant threats (Schmidt & Wrisberg, 2004, p. 264).

The reader might also logically conclude that if he or she cannot accurately see something and he or she needs to, the reader might have to first "focus" on it (visual and attentional focus takes time) to "clarify" that the reader is seeing what he or she believes he or she is seeing (this takes time); "make a decision" about it (this takes time); and, then, "stop" doing what he or she is doing—in this illustration, shooting. This simple illustration of the components of a stop shooting reaction informs us that the act of putting on the brakes on a motor activity like shooting takes time, particularly under conditions of intense focus as might occur when an officer is shooting to save his or her own life.

Some officers might skip some or all of these steps, but for those who engage in all of them, the total time to stop shooting in a visually complex, dynamic, rapidly unfolding circumstance as most officer-involved shootings are could be a total of the following approximate time factors: shift and focus (¼ of a second) (Vickers, 2007, p. 20), clarify (¼ of a second) (pp. 19-20), decision (¼ to ½ of a second or more) (Lewinski & Hudson, 2003b, p. 26), and stop shooting (¼ to ⅓ of a second) (Lewinski & Hudson, 2003a, 2003b).

If the reader totals up the numbers, he or she can see that an officer who engages sequentially in all of the proceeding steps can take a second to a second and a half or more to stop shooting. Measured in trigger pulls, which are occurring at a quarter of a second each, this is an extra four to six rounds after the threat stops. This is approximately the same amount of time that Green (2000) found for reactions to stopping in a real-world driving situation. If the reader changes the response from *stop shooting* to *start shooting*, he or she can also easily see that an officer who does all of the above steps will take three quarters of a second or more to start shooting.

Most officers do not take this long to stop shooting after the threat changes. Some take longer. Some of the officers may take longer because one of the previously mentioned stages is demanding more time of them such as a shift in focus, the officer needs to clarify a change in the threat, or the officer is actually engaged in a complex decision process. Each of these or combinations of these could dramatically increase the time it takes for an officer to stop shooting. Officers also take longer for other reasons. The primary author of this paper found the most frequent reason for delayed reaction time is that the officer is psychologically recoiling from being in the middle of an assault on his or her life. In attempting to emotionally cope with this threat and simultaneously rally a life-saving response, the officer is unable to instantly perceive even major changes in the threat. Preoccupation with his or her own reactions and efforts, literally draw the officer's focus and attention away from the threat and, in fact, anything outside of his or her own responses. In these cases, the officer is not shooting to stop but shooting to save his or her life. Although these two responses should be the same, the way they are being used here is quite different. The officer who is externally focused on the threatening subject, the behavior of that subject, has his or her sights focused on the subject, and is shooting to stop the threat is the officer who is most likely to actually hit and stop the threat and then be able to back off the trigger pull fairly effectively. The officer who is emotionally recoiling from what most frequently is a sudden, life-threatening assault and who is shooting to save his or her life because of his or her internally focused, emotional response may be more likely to not be focused on the threat and to engage in a "spray and pray" shooting pattern instead which is

ineffective—particularly in a dynamic, active, rapidly unfolding shooting scenario. It also means that an officer with this type of emotional response is going to be very unresponsive to changes in the behavior of the assailant who is threatening him or her because the officer simply will not notice it (Lewinski, 2008b).

The officers who do not take this long to stop shooting may be exceptionally fast; they may have skipped one or more of the steps, most likely the clarify step or the decision step; or they simultaneously engaged in several steps and thus shortened their total response time. Some officers who do not fire all of these "extra" rounds may stop for some other reason than a change in the threat level. Or they may see a change in the threat level but interpret it differently than their fellow officers—for instance, one officer may see someone collapsing to the ground and perceive he or she is no longer a threat and stop shooting, while another officer may perceive the same subject engaged in the same motion and see it as "crouching down" and believes that the subject is still a threat. This second officer will continue shooting even though the first officer has stopped.

Further, officers will sometimes stop shooting because in training they rarely fired more than two or three rounds in sequence, or they thought they would never have to fire more than two or three regardless of their training. Some officers may simply fire a few rounds because that is all they will ever fire under any circumstance. Some officers, regardless of the threat level, are reluctant to fire at all and do so only very slowly, thus allowing them to better see behavioral changes in the threatening subject and to stop shooting faster. It also makes it more dangerous for them under actual firefight conditions. Aside from these irregular patterns, it should be clear that whether an officer's focus of attention is externally focused on the threat or internally focused on his or her own emotional responses, that focus of attention is going to determine the effectiveness of the officer's shooting and his or her ability to change his or her response in relation to changes in the threat (Lewinski, 2008b, p. 130).

Recent research from Johns Hopkins University (Shomstein & Yantis, 2004) has shed further light on our understanding of other psychological processes in lethal force encounters, particularly our understanding of the puzzling issue of why officers are not able to stop shooting at the immediate termination of the threat.

One of these research findings directly relates to factors that elongate an officer's response to stop shooting and also to shifting to engage other targets or shooters. This research is to be found under the research name of "attentional blinks" (Raymond, Shapiro, & Arnell, 1992, pp. 858-859) or "inattentional blindness" (Mack, 2003, p. 180). They are different but related concepts. Very simply put, the research and theory holds that if you are even moderately focused on one thing, your brain not only does not process or ignores the other things you are not focused on but actually acts to suppress the information on which you are not focused. This means it could be impossible for an officer in a dynamic, visually complex, rapidly unfolding shooting situation to see anything other than that on which he or she is immediately focused. The reason he or she cannot really see anything but that on which he or she is focused is not only because there is too much going on for him or her to focus on anything other than what is immediately important, but also the officer's own brain is helping him or her stay focused by actively blocking out the information on which the officer is not focused. An important qualifier here is that what an officer sees as important in the middle of a firefight—such as scrambling to get a sight picture—might not be the same thing an attorney or court believes is important when they review the case months or years

later. For instance, an officer who is frantically scrambling to get a good sight picture or trying to rapidly bring his or her weapon up on target as quickly as he or she can to shoot to save his or her own life will be challenged for not noticing that the subject that was threatening the officer moved his or her head or turned his or her body during this very brief encounter.

The time price it costs the officer to shift attention from something that he or she is focused on to something else that needs to be focused on ranges from 2/10 to 6/10ths of a second at a minimum (Horowitz, Birnkrant, & Wolfe, 2003; Saarinen & Julesz, 1991). This means that an officer who is engaged and visually focused in putting his or her front sight on a threat could take a quarter to more than half a second or more just to notice a change in the behavior or status of the threat at which he or she is directly aiming. If the officer is engaged in shooting while he or she shifts his or her focus, the officer will fire an extra two rounds before he or she notices that the threat presented by the subject has changed or that another or a different threat is present.

Again, it is very important to remember that the brain of the officer who is focused on his or her front sight actually works to suppress the information about whatever else is going on in front of him or her for a very brief period while the officer is engaged in focusing and shooting (Vickers, 2007, p. 54). This also holds true for the brain of the officer who is focused on kinesthetic alignment, making a decision while being distracted with intrusive thoughts or anything else that draws his or her attention away from the threat. Logically, this makes sense because it is hard to simultaneously focus equally on two things at the same time or to even think of two things at the same time especially under threats to one's life. Neurologists such as Dr. Joseph LeDoux (1996) remind us about how and why we become very rigid, concrete, and inflexible in our attention and problem solving under this high level of stress. The more sudden and unprepared we are for the assault, the more instinctive our responses will be.

The officer reading this is likely aware of the current research and press announcements that relate to the difficulty of both talking on a cell phone and driving. The research informs us that focusing on a conversation impairs the ability to deal with visual problems while driving, such as the detection of a road hazard or the change of a driving condition, and then the processing or decisionmaking related to coping with that change (Green, 2000, pp. 212-213).

To escalate this illustration from talking on a cell phone and driving to a point where it is closer to the intensely focused experiences of an officer in a lethal force encounter, the reader should compare the ability to deal with a driving problem immediately after spilling very hot coffee on his or her lap. The reader's immediate focus, for even a very short duration, to the problem of the pain, wetness, mess, etc., of the spilt coffee would significantly impair his or her ability to see developing problems down the road, engage in a conversation with someone else in the vehicle, be able to report what song or news item was on the radio, or even to be aware of the red light he or she just drove through.

Dr. Steve Yantis from Johns Hopkins, in his research published in *The Journal of Neuroscience*, helps us understand what is happening to a human being in these kinds of split attention encounters (Shomstein & Yantis, 2004).

Dr. Yantis put his research subjects in a functional MRI machine so he could observe the activity of his subjects' brains as he challenged them with different tasks related to

attention. While they were in the MRI, they were able to look at a computer screen and had headphones on so they could focus on either their hearing, their vision, or both and be able to shift back and forth between them (Shomstein & Yantis, 2004, p. 10703).

Yantis observed that when he required his subjects to focus on the computer screen with their eyes, the part of their brain associated with hearing was "turned down." When he required the subjects to focus on their hearing through the headphones, the part of their brain dealing with vision was significantly "turned down" (Shomstein & Yantis, 2004, p. 10704). Yantis says this is because the human brain has problems dealing with more than one major item at a time. Yes, we can multitask as long as nothing we are dealing with becomes very important, in which case the brain shifts all its attention to what is important at that time and we lose the ability to detect, remember, and process other issues or items.

Officers in the street have observed that when they are focused on making their firearms work to shoot to save their lives that they too might not be able to even hear someone next to them screaming in their ear or even know that they fired their own guns or how often they fired them (Artwohl, 2002, p. 18).

Simply put, the work of Dr. Yantis illustrates and explains the attention and brain functions underlying tunnel vision and tunnel hearing. It also states that if we are focused on one thing—looking at something—and then a threat or challenge comes in through another sense, such as hearing, our response to that is going to be much slower than it normally would be.

So, if we are focused on seeing and specifically seeing what is important to us, we likely will not hear something that could be very important. Even if we did hear it, our reaction would be slower than it normally would be if we were listening for it.

Implications: So What Does All This Mean?

The implications of all of this are profound and wide ranging.

From the point of view of a trainer, it means that an officer dealing with a threat is going to react slower to that threat if they are not anticipating it or prepared for it. Also, dealing with multiple subjects in a high stress encounter is going to present an extreme challenge to the officer and trainer. Not only will the officer be able to primarily see only what he or she is focused on, but the officer's own brain may sabotage or delay the officer's ability to perceive and react to threats from others or even from the subject he or she is directing his or her attention to if he or she is not focused on or anticipating that specific threat. For instance, an officer focused on the subject's right hand and expecting that hand to contain a weapon is going to react much slower if the subject has the weapon instead in his or her left hand than if he or she had anticipated from the beginning that the weapon would appear in the left hand. The officer could also speed up his or her reaction time to a weapon in the left hand if he or she were open to the option that the weapon could appear in either or both hands. In previous news lines, FSRC has discussed visual scan patterns and the influence of scan patterns on the detection of threat and the memory of that threat (Lewinski, 2008a).

The trainer needs to develop programs that will assist an officer in rapidly scanning and precisely identifying the appropriate threat components of a scenario. This may

be as valuable for the officer as weapon skills. Yantis's work and the other research we have cited in this article inform us that weapon skills are far less productive if they are not combined with great target recognition and identification skills. Further, in regards to weapon management skills, instructors must provide training for their officers that involves dynamic movement relevant to incidents they will face and also that involves tracking and shooting at subjects who also are engaged in dynamic movement.

From the point of view of an investigator and prosecutor, the implications are even more profound. The work previously cited and the illustrations of the work at Dr. Dan Simons' visual cognition laboratory at the University of Illinois–Urbana-Champaign inform us that even under normal non-stress conditions we are seriously deluding ourselves if we think we can see, pay attention to, react to, and remember everything that we might ideally be able to see, even if it is present or happening directly in front of us (Simons & Levin, 1998). Yantis's work tells us that even in non-stress situations, if we are focused on the information coming into one sense, such as the eye, we are less aware or even unaware of information coming into the other senses, such as taste, smell, hearing, touch, or movement (Shomstein & Yantis, 2004). From the work of both Simons and Yantis, it is clear that at least during a brief period of "focused attention," we are "tuned down" to information coming in from another sense other than the one we are using to focus and even in that sense we are still "tuned down" to any other information coming into that very same sense—other than that information on which we are specifically focused.

Of course, in the laboratory, it is impossible to generate life-threatening situations with which the research subject needs to cope. However, street research informs us that an officer can be so focused on the threat or his or her attempt to cope with the threat that the officer literally cannot hear his or her partner screaming in his or her ear, do not notice where he or she is standing or moving to, do not record the number of rounds he or she has fired, etc. The officer also suffers significantly from an inability to perceive information that could be, at that time, tactically important to his or her own survival, let alone information that at some later point becomes significant in a court of law, based on someone else's perception of what should have been important to the officer at the time (Artwohl, 2002, p. 18).

In the past, these errors in attending to and recording information were termed and still are referred to as *perceptual distortions* as if in some non-stress environment we are able to sense, process, and remember in some nondistorted way everything that occurs to us. The reality is that most of us are very poor, in fact incapable, of perceiving and recording everything that occurs to us at any particular moment. We are often so preoccupied with our own thoughts or actions and so inattentive to the world outside ourselves that we frequently are not any more aware in the present moment in non-stress situations than when in high stress life-threatening situations. Therefore, the term *perceptual distortions* is a misnomer. Not perceiving the totality of an event is how we normally operate. In fact, even in non-stress situations, once we focus on anything, even if it is an idea in our own head, we significantly compromise our ability to perceive, react to, and remember anything that is occurring around and to us. Has the reader ever driven to work actively engaged in some internal problem or focused on an interesting discussion only to find that they have already reached his or her destination, oblivious of being on the journey? This phenomenon, although qualitatively different than the officer who is in a high stress, life-threatening encounter, is functionally identical. An illustration the

reader might relate to is one that the primary author has experienced while working on this article on a trip from England on Iceland Air. The author was listening to music and at times did not even notice the songs that had just been played or even remember that the music was on. According to Yantis, my brain had "tuned down" the background music from my ears so I could focus on what was important to me at that time, which was looking at my computer and thinking about this article. The author notes that some songs caught his attention, but then they distracted him from the attention this article required (Shomstein &Yantis, 2004).

This process of perceptual distortion has been called *tunnel hearing* or *tunnel vision* in the law enforcement world, but long before those terms entered the cop world they were being researched as a process of normal, everyday functioning under the names of *selective attention*, *attentional focus*, etc. An area of psychology entitled Attention was developed primarily to research these phenomena, and three journals dedicated to this area went into publication in the 1950s. For more information, see Niedenthal and Kitayama (1994).

What is most puzzling about all of this for the uninformed is why an officer who is in a life-threatening situation cannot remember something that is directly connected to his or her survival such as how he or she moved or shot, how many rounds were fired, or the movement of the very person he or she was shooting at to stop that person from killing him or her.

Besides the principles we have just covered, we need to refer to Tom Aveni's research cited in a previous news line (Lewinski, 2008a). Aveni's (n.d.) work informs us that the average officer-involved shootings, particularly those in which officers die, involve a shooting that occurs five to six feet or less from the officer. The average officer fires three rounds in response to the threat. FSRC's research informs us that the threat can rapidly unfold—perhaps as quickly as in a quarter of a second or less (Lewinski, 2000). In this very brief, usually dynamic, visually complex, rapidly unfolding, and life-threatening encounter, the officer, for the most part, is incapable of focusing on more than one thing at a time. If, for instance, the officer is focused on drawing his or her weapon, then he or she literally cannot see what the subject is doing. If the officer is skilled and trained enough so that drawing his or her weapon is automatic and instinctive, then the officer's mind is free to think of other things. The average officer, well-trained by current standards, can only directly focus on one other thing such as what the subject is doing, but he or she might not be able to report on where, geographically, the subject is doing this. Simons' (2000) work tells us that if you are focused on one thing in a visual field, you cannot see another thing in that visual field without shifting your focus, so an officer who is focused on the subject's hand on his or her waistband will not be able to see the subject's face (without directing his or her attention to it) let alone whether or not the subject is standing next to a tree, rock, car, etc. The officer often—unless it was noted at some other time than the immediate shooting encounter—is not able to tell us where he or she is in the scene other than some vague generalizations. The investigator needs to understand that in this brief encounter, the officer is only able to be relatively accurate about what he or she is focused on, not what the investigator later thinks is important. For instance, if the officer is focused on his or her gun and the number of shots fired, the officer can be very accurate about that behavior, but in the case in which the focus is on the officer him- or herself and the rounds fired, the officer will be reasonably inaccurate about the subject's behavior. If the officer is focused on the subject's behavior, he or she

often, for instance, cannot tell the investigator where he or she stood or accurately report his or her own behavior for that brief microsecond of time.

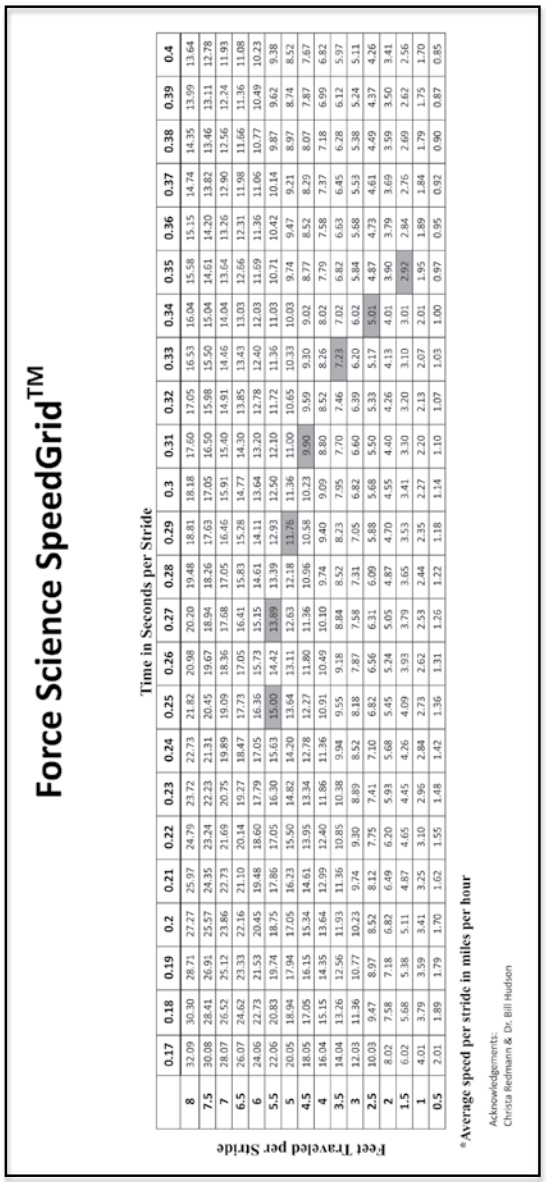
As stated previously, this inability to notice and react to anything other than that on which an officer is focused is not a myth generated by law enforcement officers. It is a well-documented phenomenon in cop shootings—from the early work by Dr. Roger Solomon to the current work of Drs. Artwohl, Honnig, and others (Artwohl, 1997, 2002, 2003; Honig & Roland, 1998; Klinger, 2002; Solomon, 1997; Solomon & Horn, 1986). This phenomenon has also been well-documented and explained by research in perception, attention, and cognition for over half a century. Please note the excellent summary of the literature (thousands of citations) in Niedenthal and Kitayama's (1994) *The Heart's Eye*, which focuses on almost fifty years of research on the effect of emotions on attention. Unfortunately, for a variety of reasons, the neuropsychology of why these phenomena occur has generally not reached the law enforcement world, and the law enforcement world has not reached into academia.

The general conclusion from all of this is that an officer must first perceptually and attentionally recognize that the subject has ceased to be a threat before the officer can then begin to alter his or her response to the threat. This process takes time and can result in many rounds being fired at the threatening subject for some period of time after the subject has ceased to be a recognizable threat.

Investigators in particular need to be informed about the dynamic action of subjects in deadly force encounters (Lewinski, 2000) and should use that information to help them understand shot placement or patterns of shot placement in the subject at which the officer is firing. For instance, a vehicle travelling at 10 miles per hour is going to travel about 14 and a half feet in one second. An officer standing in front of the vehicle with his or her weapon out as it begins to accelerate may take as little as 0.6 of a second to raise his or her weapon and fire one round (Lewinski, 2002) and spin to evade the vehicle. Even with this amazingly fast reaction time, which would occur without thought, the vehicle travelling at 10 miles per hour would cover over seven feet before it was hit with the first round. If the officer had any thought at all before he or she reacted, the first round to hit the vehicle would strike it after it had travelled over 14 feet. The same comparison could be made about the impact on the officer's stop shooting response and the influence of the time to assess that the vehicle had gone by and was no longer a threat.

The chart included in Table I (Lewinski, 2009) allows investigators to also compare the officers starting and stopping time with the travel time of a human being. The darkened squares in the chart (going from right to left) allow the reader to follow the average stride time and distance for the average person, starting with the first stride (the furthest right block) and ending with the person in a full stride at a "good" pace (the farthest left block). For instance, if the reader looks at the chart, he or she can see that the average person in moderately good running shape can, for at least a short period of time, cover at least five and half feet for every stride taken and can take each stride in one quarter of a second. Considering that the average person has no problem running 10 miles per hour for a short distance, the reader can then see that the same comparison can be made with a human as with the automobile. If an officer, reacting to a threat posed by a person running at 10 miles an hour, simply, without thought or aiming, raises his or her weapon and fires, the average person will be hit with the first bullet at a distance of seven or more feet away from where he or she first presented the threat, and that person will likely be in a different physical position.

Table 1. Speed of Person in Miles per Hour by Stride Length and Speed per Stride in Seconds



Force Science SpeedGrid™

Time in Seconds per Stride

Feet Traveled per Stride	0.17	0.18	0.19	0.2	0.21	0.22	0.23	0.24	0.25	0.26	0.27	0.28	0.29	0.3	0.31	0.32	0.33	0.34	0.35	0.36	0.37	0.38	0.39	0.4
8	32.09	30.30	28.71	27.27	25.97	24.79	23.72	22.73	21.82	20.98	20.20	19.48	18.81	18.18	17.60	17.05	16.53	16.04	15.58	15.15	14.74	14.35	13.99	13.64
7.5	30.08	28.41	26.91	25.57	24.35	23.24	22.23	21.31	20.45	19.67	18.94	18.26	17.63	17.05	16.50	15.98	15.50	15.04	14.61	14.20	13.82	13.46	13.11	12.78
7	28.07	26.52	25.12	23.86	22.73	21.69	20.75	19.89	19.09	18.36	17.68	17.05	16.46	15.91	15.40	14.91	14.46	14.04	13.64	13.26	12.90	12.56	12.24	11.93
6.5	26.07	24.62	23.33	22.16	21.10	20.14	19.27	18.47	17.73	17.05	16.41	15.83	15.28	14.77	14.30	13.85	13.43	13.03	12.66	12.31	11.98	11.66	11.36	11.08
6	24.06	22.73	21.53	20.45	19.48	18.60	17.79	17.05	16.36	15.73	15.15	14.61	14.11	13.64	13.20	12.78	12.40	12.03	11.69	11.36	11.06	10.77	10.49	10.23
5.5	22.06	20.83	19.74	18.75	17.86	17.05	16.30	15.63	15.00	14.42	13.89	13.39	12.93	12.50	12.10	11.72	11.36	11.03	10.71	10.42	10.14	9.87	9.62	9.38
5	20.05	18.94	17.94	17.05	16.23	15.50	14.82	14.20	13.64	13.11	12.63	12.18	11.76	11.36	11.00	10.65	10.33	10.03	9.74	9.47	9.21	8.97	8.74	8.52
4.5	18.05	17.05	16.15	15.34	14.61	13.95	13.34	12.78	12.27	11.80	11.36	10.96	10.58	10.23	9.90	9.59	9.30	9.02	8.77	8.52	8.29	8.07	7.87	7.67
4	16.04	15.15	14.35	13.64	12.99	12.40	11.86	11.36	10.91	10.49	10.10	9.74	9.40	9.09	8.80	8.52	8.26	8.02	7.79	7.58	7.37	7.18	6.99	6.82
3.5	14.04	13.26	12.56	11.93	11.36	10.85	10.38	9.94	9.55	9.18	8.84	8.52	8.23	7.95	7.70	7.46	7.23	7.02	6.82	6.63	6.45	6.28	6.12	5.97
3	12.03	11.36	10.77	10.23	9.74	9.30	8.89	8.52	8.18	7.87	7.58	7.31	7.05	6.82	6.60	6.39	6.20	6.02	5.84	5.68	5.53	5.38	5.24	5.11
2.5	10.03	9.47	8.97	8.52	8.12	7.75	7.41	7.10	6.82	6.56	6.31	6.09	5.88	5.68	5.50	5.33	5.17	5.01	4.87	4.73	4.61	4.49	4.37	4.26
2	8.02	7.58	7.18	6.82	6.49	6.20	5.93	5.68	5.45	5.24	5.05	4.87	4.70	4.55	4.40	4.26	4.13	4.01	3.90	3.79	3.69	3.59	3.50	3.41
1.5	6.02	5.68	5.38	5.11	4.87	4.65	4.45	4.26	4.09	3.93	3.79	3.65	3.53	3.41	3.30	3.20	3.10	3.01	2.92	2.84	2.76	2.69	2.62	2.56
1	4.01	3.79	3.59	3.41	3.25	3.10	2.96	2.84	2.73	2.62	2.53	2.44	2.35	2.27	2.20	2.13	2.07	2.01	1.95	1.89	1.84	1.79	1.75	1.70
0.5	2.01	1.89	1.79	1.70	1.62	1.55	1.48	1.42	1.36	1.31	1.26	1.22	1.18	1.14	1.10	1.07	1.03	1.00	0.97	0.95	0.92	0.90	0.87	0.85

*Average speed per stride in miles per hour

Acknowledgements:
Christa Redmann & Dr. Bill Hudson

	Average Stride Distance in Feet	Average Stride Time in Seconds	Speed in MPH
1	1.5	.35	2.92
2	2.5 - 3	.34	5.01
3	3.5 - 4	.33	7.23
4	4.5	.31	9.90
5	5 – 5.5	.29	11.76
6	5.5 - 6	.27	13.89
7	5.5 - 6	.25	15.00

On average, it was found that when youthful, vigorous, relatively fit people start to run, their first step takes about .35 of a second (not counting reaction time) and covers 1.5-2.0 feet. Their second step requires about .34 of a second and covers about 3.0 feet. Their third takes about .33 of a second and the stride lengthens to 3.5 to 4.0 feet… and so on. Typically, after 5 to 7 steps, people max out at about .25 of a second per 5.5- to 6.0-foot stride, which they can then maintain for a short period of time.

It is the responsibility of investigators to inform themselves of these phenomena and their implications for officer performance and memory in a lethal force encounter.

Conclusions

The following conclusions can be drawn from the theoretical research, applied research, clinical research, and the experiences of law enforcement officers who have survived lethal force encounters:

- An officer is usually not able to immediately see and react to changes in the subject(s) at whom he or she is shooting. This is not determined by whether that change is an increase or a decrease in the threat presented to the officer by the subject.

- The focus of the officer's attention—internal or external, specific or general, near or far, and left or right—will determine the officer's "ability" to perceive and react to changes in the threat and also the length of time it takes for the officer to perceive and then react to that change.

- The delay in noticing any change in the nature of the threat and having the officer change his or her behavior in response to that threat could theoretically take the average officer a second to a second and a half in a dynamic, "real-world," life-threatening encounter if the officer did not expect that the threat would cease. This process alone could be the reason for an extra three to six rounds being fired by the officer after the threat ceased—particularly if the officer was shooting as quickly as possible, was focused on shooting to save his or her own life, or emotionally recoiling in response to that threat and also simultaneously involved in assessing the threat. Of course, the more an officer is directly focused on the threat, the quicker a change can be identified and the officer can stop shooting.

- Officers will both start and stop shooting based on a variety of factors, including their visual angle on the incident and their ability to perceive the threat, their attentional and reactive capabilities, their weapon skills, and their psychomotor movement times.

It is one of the stated missions of FSRC to bring to law enforcement the current scientific research at FSRC and other universities. This article is written to further that end.

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