COMBAT HUMAN FACTORS: Triggering the Survival Circuit

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"Fear makes men forget, and skill that cannot fight, is useless."
Phormio of Athens, 429 BC

In the study of combat human factors, one of the most challenging problems has always been how to validate the survival stress response. When studying the physiological and psychological aspects of survival stress performance, researchers have had difficulty with the following:

1. How can the researcher confirm survival stress has actually been induced?
2. How can survival stress be induced with consistent reliability?
3. How can the researcher compare the test subject's actual performance against his/her perceived performance?

How, then, could these questions be answered, or these requirements be satisfied?

Historical Perspective of Combat Human Factors Study

Isosceles and One Hand Point shooting systems originated in the early 1920's by W. E. Fairbairn and E. A. Sykes. In Shooting to Live, they record the systems development as a method to survive close quarter combat. Bill Burroughs (1997) observed, "The thrust of their findings was to promote the concept of point shooting as a means of employing the handgun in spontaneous, violent events without the need or use of the front sights. Their observations (crouching, pointing and one hand techniques) were found to be reproducible during periods of life threatening violence. Most important was the acquisition of greater speed in response as a result of not consciously being involved in using the sights of the weapon as a prerequisite for firing".

After working with Sykes and Fairbairn in 1942, Col. Rex Applegate refined the Isosceles and Point Shooting system at the U. S. Army Military Intelligence Training Center at Camp Ritchie, Maryland through 1943-1944. He refined the system to enhance combat accuracy for the military and intelligence community. His system was proven to be highly effective and is credited with saving the lives of countless U. S. personnel. Col. Applegate first wrote about this system in 1943 in his book Killed or Get Killed, which is now in its sixth edition and 28th printing.

In his 1950's classic, "The Soldier's Load and the Mobility of a Nation", S. L. A. Marshall became one of the first to document the deteriorating effects of survival stress on combat performance. Since Marshall's observation in the 1950's, a substantial body of research has developed providing a framework for designing combat skills.

Hicks' research into reaction time (1952-1953) and Siddle's early research into Survival Human Factors, leading to his publication of "Sharpening the Warrior's Edge" in 1995, helped bring a scientific perspective to the survival field. Science now understands how a threat perception activates the sympathetic nervous system (SNS), which has catastrophic effects on the visual system, on fine and complex motor skills, and on the ability to cognitively process threats.

Recent Combat Human Factors Research

Recent research on stress and officer performance has identified various distortions an individual may experience while engaged in a stressful lethal force encounter. Most of this research has been designed to solicit responses from the participants regarding their perception of stress during the use of force encounter. Survey or interview questions usually addressed six areas: selected officer demographics, physiological manifestations, perceptual distortions, mental processing, physical responses, and post-encounter survival stress manifestations.

Artwohl and Christensen (1997) surveyed 72 police officers that survived lethal force encounters, Hoing and Roland (1998) studied 348 shootings by the Los Angeles Sheriff's Department, and Klinger (1999) interviewed 80 officers involved in shootings.

Siddle (2002) conducted a much larger study that looked at a variety of lethal force encounters. During 2001 and 2002 PPCT use of force instructors distributed a 54-item survey to police officers, military personnel, and aviators attending a subject control instructor-training program. The survey was designed to solicit responses from the respondents regarding their perception of stress during a use of force encounter. In 2001, the survey instrument was pre-tested with 30 officers prior to distribution and, based on the initial assessment, modifications to some of the questions were made.

A total of 619 surveys were collected and 560 were suitable for analysis. Responses were designed around the Guttman scale, allowing the officer to indicate a yes, no, or do not recall response to the item. Other items required the officer to respond by indicating recall of certain factors surrounding the event by answering, before, during, after, or do not recall. For example, officers were asked if they experienced tunnel vision before, during, or after the event. Respondent surveys reflected a broad geographical representation of the United States that includes the Southeast, Southwest, Midwest, and Northeast portions of country.

The Federal Law Enforcement Training Center (2003) did an observational study designed to validate their scenario-training program, during which they attempted to identify psychological and physiological factors that might predict performance in high-stress encounters and to identify an "optimum stress level for optimum performance.

Overcoming Apparent Shortcomings

While all of these research efforts added to the research base and furthered our understanding of Combat Human Factors, each had shortcomings, such as the inability to control environmental variables or to track physiological and cognitive changes.

Artwohl and Christensen (1997), Hoing and Roland (1998), Klinger (1999), and Siddle (2002) all utilized surveys and/or interviews to gather data, and thus were dependent upon officer recall and memory, some after extended periods of time. The role that Critical Incident Amnesia may or may not have played in those studies cannot be measured.

The Federal Law Enforcement Training Center (FLETC) study (2003) was based on a sustained series of stressful events, not on a particular spontaneous one. Physiological responses can be expected to be different in sustained situations.

In none of these studies was the researcher able to confirm that survival stress had actually been induced or to compare the test subject's actual performance against his/her perceived performance.

In an effort to overcome these shortcomings, Bruce and Sandy Siddle, and PPCT Management Systems, Inc. provided grants to the Psychology Department at Eastern Illinois University, the Southwestern Illinois Law Enforcement Commission (SILEC), and Warrant Officer (5) Steel Parsons of the United States Army's 160th Special Operations Aviation Regiment to further the current research on survival stress. The intent was to overcome the shortcomings of previous research efforts by controlling as many environmental variables as possible and actually tracking physiological and cognitive changes as they occurred by tracking heart rate variability and linking it to performance, measuring changes in stress hormones and linking them to performance, and checking recall by comparing post-event surveys with real-time video documentation of subject performance.

The first problem that had to be solved was verifying a survival stress response. Many people equate heart rate with stress. Research has shown that while heart rate can be an indicator of stress it is believed that it was not the sole indicator. It was determined that the best way to prove that a startle response was induced was to draw blood for analysis. Blood analysis presented problems for the team. There were time limits on how long a blood sample could be stored prior to analysis without a breakdown of the blood sample occurring. A transportation process was designed to get the blood sample from the test site to the lab in a timely manner.

The next problem the team had to solve was the consistent application of a stimulus to induce the survival stress response. This was accomplished utilizing a PRISM shooting system, a fully contained FATS- type firearms simulator with shoot-back capabilities, housed in a trailer.

It has over two hundred scenarios to choose from, and it has a 'shoot-back cannon'. The shoot-back cannon fires a .68 caliber nylon paint ball at fifty miles per hour. The cannon is laser aimed and can fire in single shot or auto mode. This allowed the researchers to increase the survival stress response.

Two days were spent setting up the PRISM, reviewing the scenarios, selecting the scenario and rehearsing. The research team looked at scenarios until they found one that would not last too long, yet still allow the subject to experience a high stress event. More stress was introduced by placing a dispatcher in the trailer and utilizing standard dispatch terminology to maintain contact with the participants in a manner such as they would actually experience in the field, and further stress was induced by a team member sounding an air horn at a certain point during the scenario.

Research Methodology

The research methodology required each study participant to complete a simulated firearms event. The scenario design was intended to put the participants under stress from the time they arrived to the end of the scenario. As the participants arrived, the first thing they did was read and sign the waiver forms. The waiver forms were actually the first stressor. They mentioned things about possible death, etc…and the fact that they would not hold the researchers liable. All weapons and ammunition were then collected and stored, a wireless heart rate monitor was attached to the participant, and blood was drawn to establish a baseline measure.

The participants were taken to the PRISM trailer. Upon arrival at the trailer, they were frisked and checked with a metal detector to insure that no weapons or ammunition were inadvertently retained. They were outfitted with a GLOCK weapon that was pinned and set up for firing a laser, making it physically impossible to insert a magazine of ammunition. They were issued eye protection, a radio with a remote microphone, and hearing protection that had a 'hoser cam' wireless color transmitter attached to the right earmuff. This allowed the researchers to see where the participants' heads were oriented and provided a reference point for the researchers to see where the weapon was in relation to the field of view.

After putting on the equipment, the participants watched a ninety-second introduction slide show, after which they were allowed to test fire the weapon for accuracy. The participants were urged to shoot as accurately as possible, to provided a reference point for the research team to see where the weapon had to be for the participants to use the sights for a precision shot.

After the participants were satisfied with the accuracy of the weapon, it was holstered and they stood in the center of the trailer and watched the screen as the scenario started. Another part of the scenario included having a dispatcher in the trailer who started using standard dispatch terminology to maintain contact with the participants and maintain normal communications that he/she would experience in the performance of their duties.

The entire scenario lasted less than two minutes, during which time the participants were required to engage three armed subjects. The stress level was increased because the shoot-back cannon was fired in relation to the scenario 'bad guys' firing at the participants. At a certain point, the air horn was sounded.

As soon as the participants completed the scenario, a second blood sample was taken for analysis. Stress chemicals start to break down in less than three minutes in the blood, so it was vital that the blood sample was drawn quickly. The participants then returned to the staging area, removed the heart monitor, put their equipment back on, and filled out a questionnaire about what happened. When finished, they were given another questionnaire and a self-addressed, stamped envelope and asked to fill it out the next morning and mail it back for analysis.

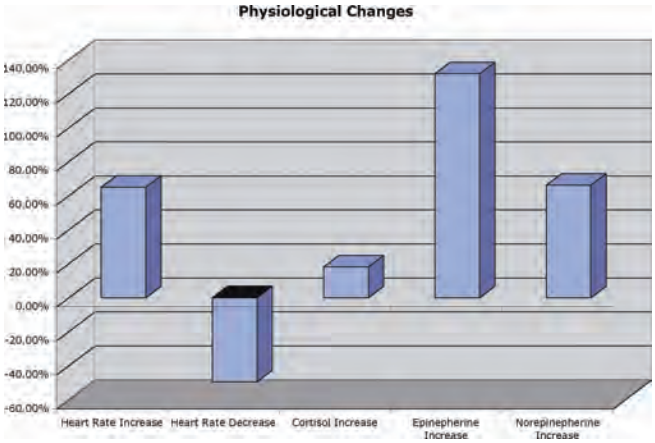
Preliminary Findings

Survival Stress

Preliminary findings relating to physiological changes that apparently occurred during the study appear to confirm that our researchers did, in fact, induce survival stress in the study participants and did so with consistent reliability. Readings from the heart rate monitors indicated fluctuations in all study participants. Participants began with an average baseline heart rate of 82.46 BPM and then attained an average peak rate of 133.94 BPM, with some peaking as high as 175BPM. The average heart rate increased was 65% during the event and then decreased an average of 67.65% afterward.

Preliminary blood test results also indicate corresponding

changes in the stress hormones cortisol, epinephrine, and norepinephrine, again confirming that survival stress was induced and with consistent reliability. The increase in cortisol levels averaged 18.15% across the board, with peak levels increasing as much as 206.41%. Epinephrine levels climbed an average of 131.83% and norepinephrine an average of 66.26%.



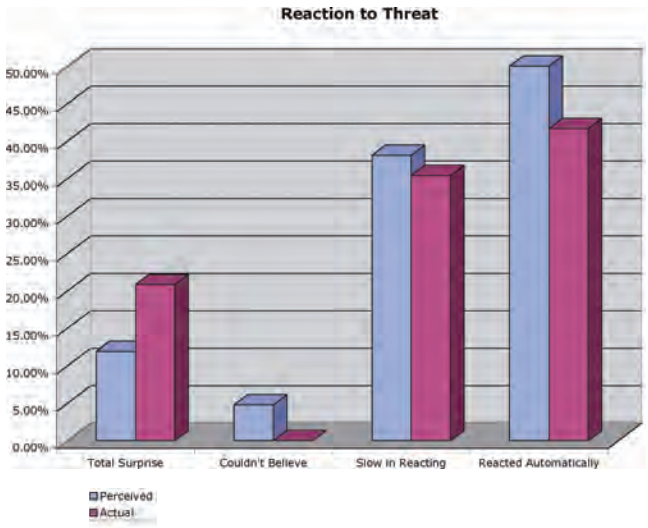
Actual v. Perceived Performance

In an effort to compare actual performance against perceived performance, researchers used video footage from the PRISM trailer's shoot back camera and from the 'hoser cam' to compare the test subjects' actual performance against their perceived performance as indicated on post-event surveys. Differences in two primary areas were immediately evident during the initial video review: how participants perceived and reacted to the threat, and how participants perceived their shooting performance and skills.

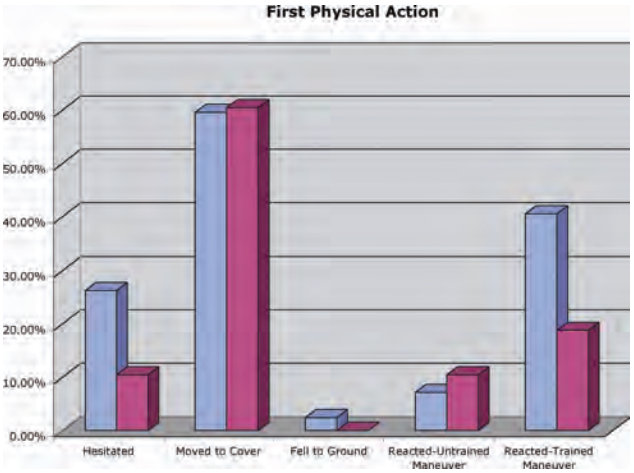
Perception and Reaction

Indicators of initial perception and reaction will, of course, be somewhat subjective in nature, as each participant would no doubt perceive things differently from others in the study and from the researchers reviewing the tapes. Researchers could only use physical actions/reactions, facial expressions, and body language to judge apparent perceptual responses.

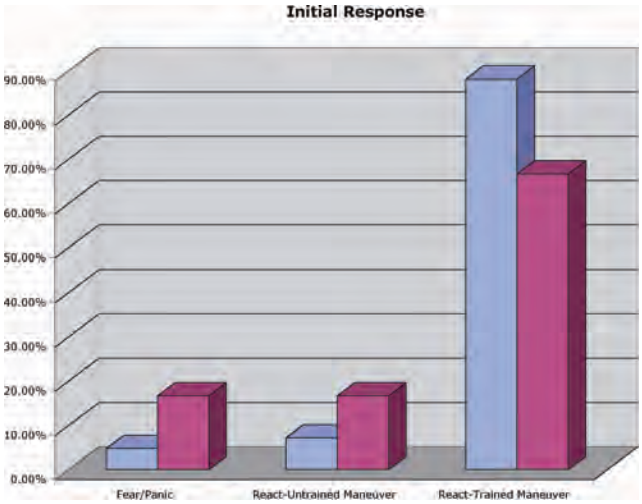
Reaction to the Threat: When asked to describe their reaction to the threat, 50% of the study participants indicated that they saw the threat developing and reacted automatically, slightly higher than the actual number that researchers felt the tapes indicated. While 38.1% of the participants felt that that they saw the threat developing but were slow in reacting, researchers believed that number to be slightly less. While only 11.9% of the participants reported being totally startled and caught completely off guard, researchers felt that to be the case 20.83% of the time.



First Physical Action: When asked to describe their first physical action, most participants (59.52%) indicated that they moved to cover or reacted to the threat with a trained maneuver or technique (40.48%). There seemed to be some confusion as to the difference between moving to cover and reacting with a trained maneuver or technique, since both could, and probably should, be one in the same. More participants seemed to feel that they hesitated before responding (26.19%) than their taped performances would indicate, as researchers only felt that to be the case 10.42% of the time.



Initial Response: When asked to describe their physical response during the event, 88.10% of the participants indicated that they reacted with an automatic response that was based on their training, a number much higher than the 66.67% indicated by researchers. While 7.14% describe their responses as being automatic and appropriate, but not based on their training, researchers felt that to be the case in 10.42% of the scenarios. Though only 4.76% of the participants described their responses as being a fear or panic reaction, researchers felt that 16.67% appeared respond in such a manner on the tapes. Though the difference is significant, it is not necessarily surprising, considering the personality types commonly drawn to the law enforcement profession.

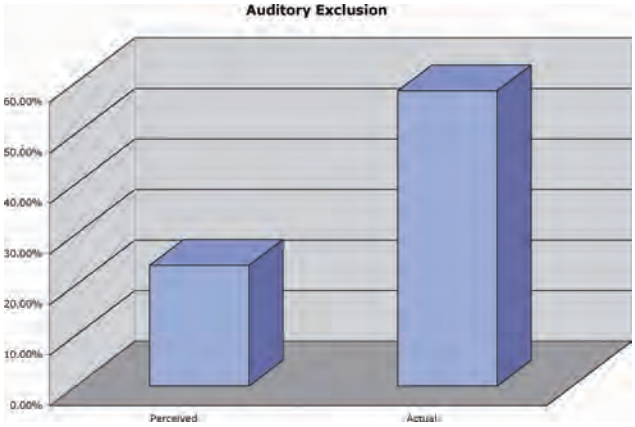


Auditory Exclusion

Indicators of Auditory Exclusion will also be somewhat subjective in nature, as researchers could only use physical actions/reactions, facial expressions, and body language to judge apparent perceptual responses. Two specific survey questions directly related to auditory exclusion, whether it occurred, and/or whether participants realized it occurred or not.

Survey question #16 specifically asked participants if they experienced "auditory exclusion" and gave as an example, "the failure to hear verbal warnings or other loud noises". To that question, 23.81% of the participants indicated that they had experienced auditory exclusion, while 47.62% claimed that they did not and 28.57% said they couldn't remember.

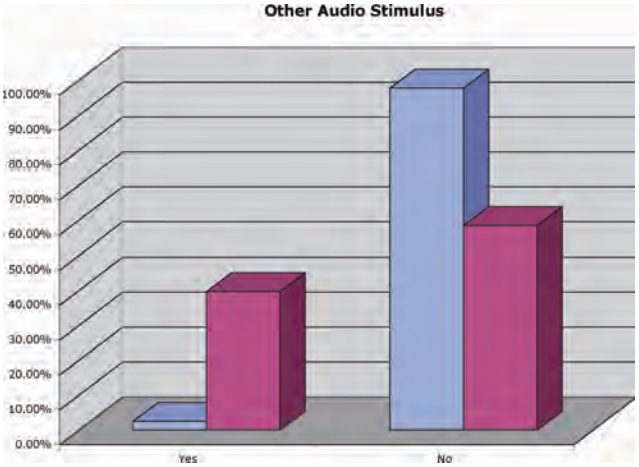
Survey question #49 specifically asked participants if they heard "any audio stimulus besides voice and weapon fire". To that question, only 2.38% answered yes, while the other 97.62% said that they did not.



By keeping in mind that at a certain point in each scenario an air horn was sounded, and closely monitoring the scenario tapes for any physical indication of reaction to the air horn, researchers determined that 39.58% of the participants did actually hear and react to that stimulus. 58.33% apparently did not hear the air horn, or at least gave no physical indication that they did.

Relating these findings to question #16, though only 23.81% of the participants indicated experiencing auditory exclusion, 58.33% of them apparently did, a considerable difference.

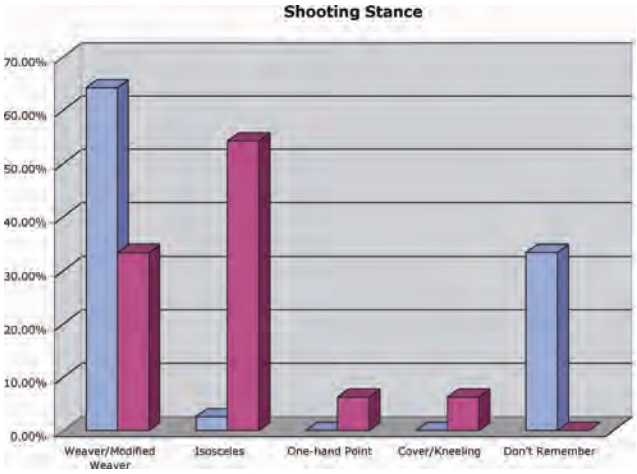
Relating them to question #49, only 2.38% of the participants reported hearing "any audio stimulus besides voice and weapon fire", though 39.58% of them apparently did and physically reacted to that stimulus. Though 97.62%% of the participants denied hearing the stimulus, many of more of them did and either didn't realize it or forgot doing so.



Shooting Performance and Skills

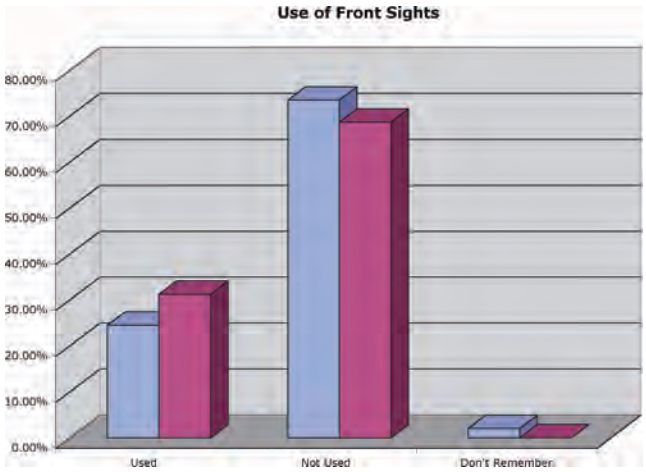
Initial findings relative to firearms performance and skills proved to be interesting, to say the least, especially as they pertain to shooting stance, the use of sights, and overall accuracy.

Shooting Stance: It was interesting to note that the vast majority of those involved in the study were apparently trained to shoot in the asymmetrical Weaver stance, which is a bladed approach, as opposed to the symmetrical isosceles stance, which squares the body to the target. In fact, while sighting the weapon prior to starting the study scenario, many went into either a full Weaver or a modified Weaver stance to do so. However, when the scenario actually started, 54.17% of the participants squared their upper body toward the target and extended both arms in an Isosceles/Modified Isosceles stance, though only 2.56% of them reported doing so. Though 64.1% of the participants reported that they used a Weaver/Modified Weaver stance, the review of the scenario tapes indicated that only 33.3% of them actually did. Under the survival stress of a combat situation, far more reverted to using an Isosceles/Modified Isosceles stance than not.



Use of Sights: Data pertaining to whether the study participants were actually able to see their front sights and whether they used them or not is somewhat subjective, in that researchers were obviously not able to actually see through the participants' eyes. Researchers could only determine the probability of a participant being able to see his/her front sights based on the position of the weapon and the shooting stance. Likewise, when trying to determine which of the participants actually used their front sights during the engagement, researchers could only determine which participants appeared to do so, based on the same criteria.

Only 30% of the participants reported that they were able to see their front sights during the scenario and only 24.5% reported using them. Based on the videos, 31.25% of the participants appeared to use their sights, a number that closely correlates to the above. That indicates that between 68-73% never used their sights while firing.

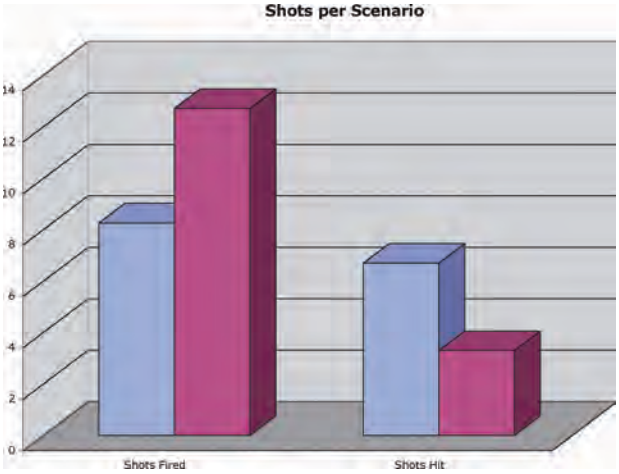


Shooting Accuracy: Study participants did not fair well in the category of shooting accuracy, and their perception of just how well they did varied greatly from the reality of the actual results.

Participants fired an average of 12.71 shots per scenario, but only hit and average of 3.3 times. The overall accuracy rate was 24.41%, meaning less than one out of every four shots hit their intended target. Some participants did quite well, hitting up to 90% of their shots, while others had no hits at all. Approximately 8% of the participants never even fired a shot.

In general, the participants' perception of how well they did

far exceeded the reality described by the above numbers. Participants believed that they had only fired an average of 8.26 shots per scenario, and felt that those shots had been accurate nearly 53% of the time. Overall, 98% of them scored lower than they had perceived, and 15% of them thought that they had hit the target more times than they had even actually fired. Approximately 17% of them had no clue how many hits they made.



Summary

Physiological Changes

Heart Rate:

Average baseline heart rate:	82.46BPM
Average peak heart rate:	133.94BPM
Highest peak heart rate:	175.00BPM
Average heart rate increase:	65.00%
Average heart rate decrease:	67.65%

Stress Hormones:

Cortisol

Average pre-scenario level:	16.56
Average post-scenario level:	19.20
Average change:	+18.15%

Dopamine

Average pre-scenario level:	18.67
Average post-scenario level:	33.34
Average change:	+23.89%

Norepinephrine

Average pre-scenario level:	404.71
Average post-scenario level:	607.13
Average change:	+66.26%

Epinephrine

Average pre-scenario level:	64.71
Average post-scenario level:	117.3
Average change:	+131.83%

Perception and Reaction

Reaction to Threat:

Startled/surprised:	20.83%
Slow in reacting:	35.42%
Automatic reaction:	41.67%

First Physical Action:

Hesitated:	10.42%
Moved to cover:	60.42%
Untrained maneuver:	10.42%
Trained maneuver:	18.75%

Initial Response:

Fear/panic:	16.67%
Automatic:	16.67%
Automatic as trained:	66.67%

Auditory Exclusion:

Reported:	23.81%
Apparent:	58.33%

Shooting Performance and Skills

Stance:

Weaver/Modified Weaver:	33.33%
Isosceles/Modified Isosceles:	54.17%
One-hand Point	6.25%
Cover/Kneeling:	6.25%

Ability to See Sights:

Reported:	30.00%
Apparent:	31.25%

Use of Sights:

Reported:	24.50%
Apparent:	31.25%
Not used:	68-73%

Shots per Scenario:

Reported:	8.26
Actual:	12.71

Hits per Scenario:

Reported:	4.38
Actual:	3.30

Accuracy Rate:

Reported:	53.00%
Actual:	2.41%