Differences in Stress Shoot Performance Among Special Forces Operators Who Participate in a Human Performance Program Versus Those Who Do Not

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ABSTRACT

Background: The purpose of this investigation was to determine if Army Special Operation Forces (ARSOF) Operators who participate in the Tactical Human Optimization, Rapid Rehabilitation and Reconditioning program perform significantly better on a simulated stress shoot scenario than ARSOF Operators who do not participate in the program. **Methods:** Deidentified archival data from 64 male ARSOF Operators (mean ± standard deviation: age, 31.1 ± 4.96 years; SOF experience, 3.44 ± 4.10 years) who participated in the Special Forces Advanced Urban Combat stress shoot were assessed to determine if differences in performance existed between program users (n = 25) and nonusers (n = 39). A series of bootstrapped analyses of variance in conjunction with effect-size calculations was conducted to determine if significant mean score differences existed between users and nonusers on raw and total course completion times, high-value target acquisition (positive identification time), and penalties accrued. **Results:** Small to medium effect sizes were observed between users and nonusers in raw time, penalties, and total time. Although there were no significant differences between users and nonusers, there was less variation in raw time and total time in users compared with nonusers. **Conclusion:** Our findings becomes a question of practical versus statistical significance, because less performance variability while under physical and psychological duress could be life saving for ARSOF Operators.

KEYWORDS: *Tactical Human Optimization, Rapid Rehabilitation and Reconditioning program; human performance; stress shoot; duress*

Introduction

Special Operations Forces (SOF) Operators have expert training that exceeds the training and capabilities of traditional military Soldiers.[1-4] As part of their essential job duties, Operators are required to carry out military operations in austere environments (Table 1).[3] SOF Operators must be experts in engaging military targets at various distances, often within a few feet of both friendly and enemy personnel. They must demonstrate superior marksmanship, with the ability to identify, engage, and eliminate threats while under significant mental and physical duress. Missions may require SOF Operators to move long distances to an objective and then sprint to cover while under enemy fire. The slightest misstep or miscalculation, at

TABLE 1 *Special Operations Forces Operator–Required Capabilities*[3-4]

Superior physical and physiological performance
Maintenance of peak physical performance
Enhanced cognition and ability to adapt quickly to high-stress operational environments while increasing resilience to combat stressors
Strength and endurance to complete extended Special Operations missions and quickly recover for follow-on missions
Enhanced ability to stay alive, adapt, and continue to operate within a wide range of extremely hostile operational environments
Mental and physical stamina to sustain any level and duration of operational activity to accomplish the mission

best, may only jeopardize the mission and, at worst, affect the safety or lives of the team in contact. For these reasons and more, like elite athletes training for elite competitions, SOF Operators must perform at an optimal level, with each able to contribute to the assigned missions.

In June 2008, the US Special Operations Command (USSOCOM) approved a command-wide, $84 million human performance initiative, initially called the Warrior Rehabilitation and Performance Centers. The US Army Special Operations Command (USASOC) portion of the initiative was $46 million over the first 5 years. USASOC is the largest component of USSOCOM, with approximately 27,000 personnel, which is more than all other SOF components combined, and required the most USSOCOM funding to build the vital human performance program. USASOC consists of Special Forces (Green Berets), Rangers, Special Operations Aviators, Civil Affairs Soldiers, Military Information Support Operators, Sustainment Soldiers, and Training Cadre from the John F. Kennedy Special Warfare Center and School.[4]

USSOCOM released its initial capabilities document in February 2009 with the requirement for all SOF organizations to develop human performance programs. The focus of the initial capabilities document was on optimizing the physical and mental conditioning of US SOF, to sustain elevated physical function and conditioning, and, if injured, to improve the recovery process. The ARSOF community named their human performance program the Tactical Human Optimization, Rapid Rehabilitation and Reconditioning (THOR3) program to capture the purpose of the program and give it a memorable acronym that embodied the ethos of the SOF Operator. The

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THOR3 program, funded via The Preservation of the Force and Family, comprises subject matter experts in the fields of strength and conditioning, performance nutrition, mental performance, athletic training, physical therapy, and performance analytics.[4,5] For the Special Forces groups, initial priority for support was to the Operational Detachment Alpha (ODA), but this later changed to encompass all assigned personnel within ARSOF, with priority given to the ODA.[4]

At the request of USASOC, Kelly et al.[6] conducted a study to assess the effectiveness of the THOR3 program and to identify areas for programmatic improvement. These researchers concluded that USASOC should periodically ask outside organizations in the Department of Defense or organizations under contract to conduct independent assessments of the THOR3 program to provide objective evidence of its effectiveness for the SOF Operator.

Therefore, the purpose of this investigation was to determine if SOF Operators who participate in the THOR3 program perform significantly better on a live, outdoor stress shoot than do Operators who do not participate in this program.

Methods

Experimental Approach

Deidentified archival data for 64 male SOF Operators (mean age ± standard deviation: 31.31 ± 4.96 years; SOF experience, 3.44 ± 4.10 years) completed the Special Forces Advanced Urban Combat (SFAUC) stress shoot at the conclusion of nine flat-range combat marksmanship training days. Time, in seconds, was collected and comparisons made between users and nonusers in four categories: raw time, total time, positive identification (PID) time, and penalty time. All data were collected during the stress shoot for the SOF unit by committee instructors and the Human Performance Program staff at the military base at which the stress shoot occurred.

Before data analysis, a University of Colorado institutional review board (IRB) granted research approval for research with human participants (IRB Protocol No. 17-156). Based on the archival nature of this analysis, the institutional ethics committee approved the use of retrospective nonidentifiable data. The Special Forces Group and the Army Human Research Protections Office gave permission to conduct this investigation. Furthermore, this research followed procedures in accordance with the ethical standard of the Helsinki Declaration for human subjects.

SFAUC stress shoot procedures

The overall purpose of the SFAUC stress shoot was to evaluate the Operator's ability to accurately engage targets near fellow assaulters, with increasing physiological and psychological demand. The stress shoot was a timed event consisting of the ability to maneuver over and around a variety of obstacles, and acquisition and engagement of several targets (i.e., combat marksmanship). Techniques, tactics, procedures, and accuracy of the Operator were evaluated by the SFAUC instructors.

For the SFAUC stress shoot, Operators wore their duty uniform, Kevlar vest, and combat helmet, and carried two weapon systems (M4 5.56 assault rifle and the 9mm sidearm) with three fully loaded magazines for each weapon, and a radio. The average total weight for all personal protective equipment and weaponry was approximately 18kg. The THOR3 staff presented the Operator with a facial picture of a high-value target (HVT) that they had to engage at the conclusion of the shoot. Operators followed shot assessment protocols when engaging targets. Two shots were fired on all paper E-type silhouettes (law enforcement targets, International Practice Shooting Confederation target) and accuracy was assessed by target scoring zones. Steel targets required two hits with a maximum of five attempts, and accuracy was assessed as hit or no hit.

At the start command, the Operator moved through three shooting stations (Figure 1) that consisted of various obstacles designed to physically and mentally stress the individual performing the tasks. The tasks were designed to mimic similar physiological and psychological demands put on Operators in certain combat environments. Upon completion, time was recorded to the nearest 0.10 seconds using a standard stopwatch.

FIGURE 1 *SFAUC stress shoot layout.*
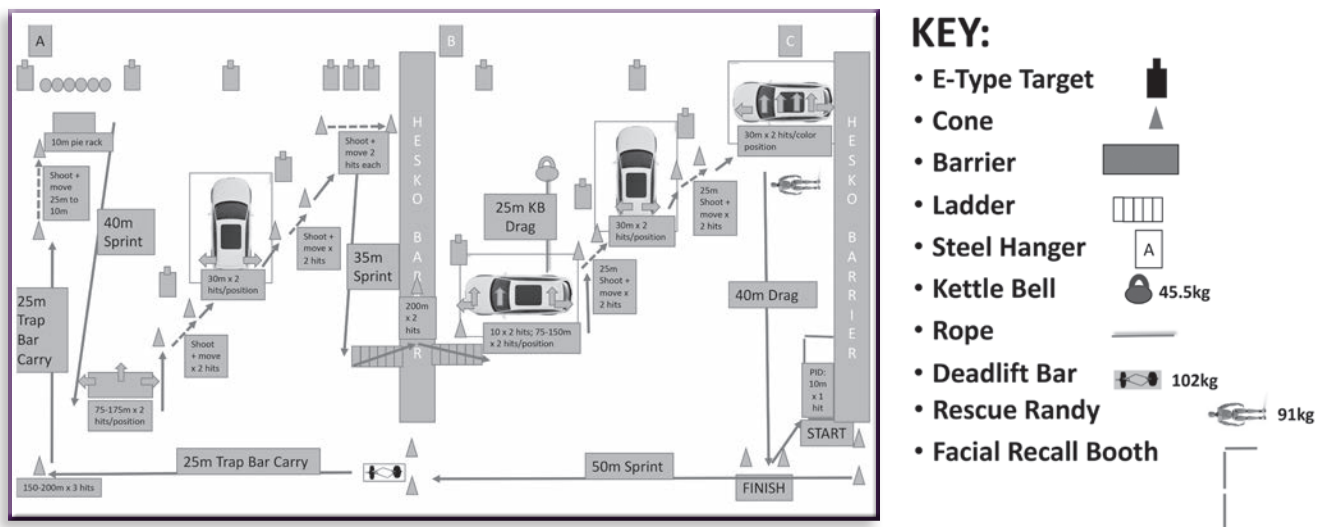
PID, positive identification.

PID Station

Once the course was completed, the Operator received specific instructions from the THOR3 staff for the kill HVT station (i.e., PID station). At this station, Operators were told to face the instructor, with each Operator's back to the HVT faces, and then asked if they were provided an HVT face at the start of the stress shoot (all said yes). The Operator was instructed to turn once the beeper sounded and engage the HVT they were shown at the beginning of the stress shoot, with only one shot from their secondary weapon system (pistol). Failure to positively identify and/or accurately engage the HVT in 10 seconds resulted in a 30-second time penalty, whereas successful engagement resulted in a 10-second time deduction. Upon completion of the Kill HVT task, the Operator cleared their weapon systems. Proper clearing procedure was evaluated by an SFAUC instructor.

Data Analysis

The collected data were entered in a computer file suitable for statistical analysis using Statistical Package for Social Sciences, version 24.0.[7] Prior to electronic transmission to researchers at the University of Colorado, all data were rendered anonymous by the training staff. Each individual Operator was given a unique number so confidentiality could be maintained. Only members of the THOR3 training staff had access to specific identifiers for the data analyzed and they followed their standard operating procedures to maintain the confidentiality of this information.

A descriptive statistical analysis was conducted to determine the mean scores and standard deviations for the total sample of Operators. The data were then subdivided by those that used services provided by THOR3 (i.e., users [$n = 25$]) and those that did not use these services (i.e., nonusers [$n = 39$]). A series of independent bootstrapped analyses of variance (ANOVAs) then was conducted to determine if significant mean score differences existed between users and nonusers on raw and total course completion times, PID time, and penalties.

Although *t* tests are the intuitive statistical method to analyze these data, SPSS, version 24.0, does not currently provide calculations of effect size for the use of *t* tests. The program does provide calculations of effect size for ANOVA,[8] however, which is an equivalent option and allows for more efficient analysis of the study data. Bootstrapping is an alternative to more traditional statistical methods that use the median as a measure of central tendency (i.e., nonparametric statistics). It is a robust method of analysis that treats samples as populations and randomly draws smaller samples from them to correct for non-Gaussian distributions.[8] Before each subsequent sample is drawn, the previously used samples are returned to the data set. For this analysis, 5,000 bootstrap samples were used; hence, the process was done 5,000 times to create a new sampling distribution that meets the assumptions of parametric statistical methods (i.e., ANOVA).

All tests were measured at the a priori α of $< .05$. Partial η^2 effect size calculations were also conducted to determine the magnitude of the differences between the mean scores of each group. The thresholds for small (0.01), medium (0.09), and large (0.25) effect sizes used in this study have been described by Cohen.[9]

Results

Descriptive statistics and mean scores differences are displayed in Table 2. Although performance time means were slightly lower for users, there were no significant differences in performance between the groups in raw time, total time, and PID time. There were also small effect sizes between users and nonusers in penalty time. However, variance in scores between groups for raw, total, and penalty times was less in the user group when compared with that of the nonuser group (Figures 2, 3, 4 and 5) and had more homogeneous scores when compared with those of nonusers. Hence, there was more consistency among users when compared with score consistency among the nonuser group. Conversely, there appeared to be more variation in PID time for users (Table 3).

TABLE 2 *Comparison by Tactical Human Optimization, Rapid Rehabilitation and Reconditioning (THOR3) User Classification*

| Characteristic	User ($n = 25$)[a]	Nonuser ($n = 39$)[a]	Partial η^2
Age, y	31.18 ± 4.57	31.39 ± 5.27 ($n = 38$)	0.00
SOF experience, y	2.61 ± 3.27 ($n = 18$)	4.00 ± 4.61 ($n = 27$)	0.03
Raw time, s	489.4 ± 68.8	523.2 ± 102.7	0.03
Total time, s	568.8 ± 74.5	613.0 ± 125.9	0.04
Positive identification time, s	2.9 ± 1.8 ($n = 17$)	3.1 ± 2.1 ($n = 19$)	0.00
Penalty time, s	81.2 ± 34.17	89.6 ± 39.5	0.01

Data are given as mean ± standard deviation unless otherwise indicated. Descriptive statistics for all outcome variables are based on 5,000 bootstrap samples.
[a]Unless otherwise indicated.
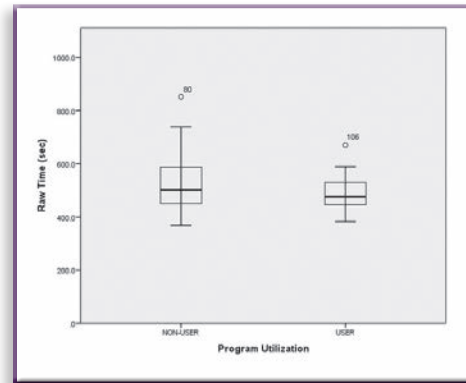
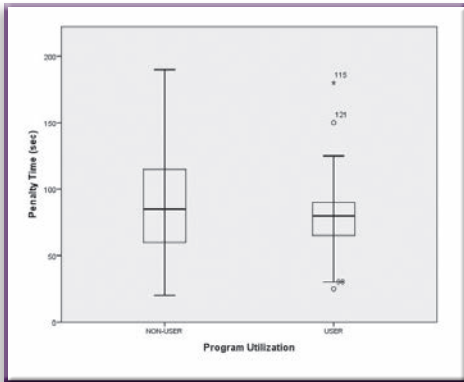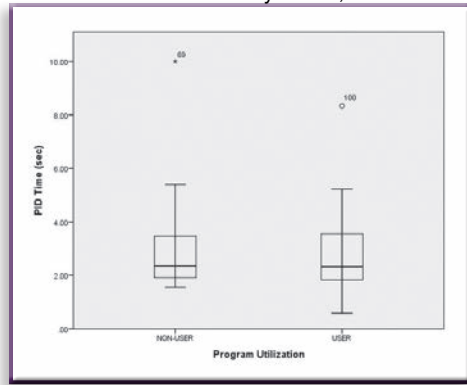**FIGURE 2** *Comparison of raw time to completion between users versus nonusers.*

FIGURE 3 *Comparison of total time between users versus nonusers.*
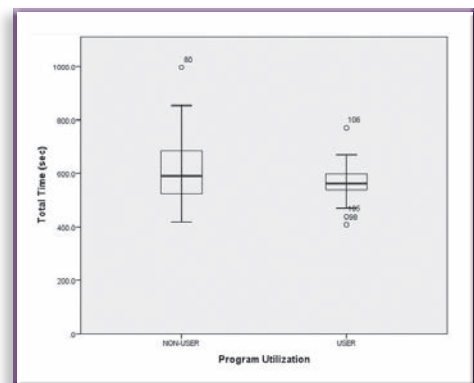
Discussion

The primary purpose of this study was to determine if significant mean score differences existed in SOF performance capabilities between Operators who participate in the THOR3 program and those who do not. Although there were no statistically significant differences between the two groups, a small

FIGURE 4
Comparison of positive identification time (PID) between users versus nonusers.

FIGURE 5
Comparison of penalty time between users versus nonusers.

findings of this study, it appears that Operators exposed to the THOR3 program may have a greater opportunity for success when engaging targets under physical and psychological duress. This fills a significant gap in the current literature; to our knowledge, this is the first study to investigate the relationship between stress shooting and participation in a human performance training and education program in the SOF community.

The ability to accurately and positively engage the enemy is extremely important in any conflict.[15] The US Military is held to a high standard of conduct, and mistakes on the battlefield may result in negative political and/or strategic worldwide ramifications.[15] When compared with the nonuser group, overall performance scores of Operators participating in the THOR3 program were more consistent than those of the nonuser group in raw time, total time, and penalty time. These findings suggest users of the THOR3 program, as a group, tend to have more homogeneous performance when compared with those who do not use these services. However, users tended to have more variation in PID time.

Although this study makes an important contribution to the literature in this area, it is not without limitations. Based on the constraints of the environment, there was no way to control for Operator actions before they participated in the shoot. Physiological measures during the stress shoot were not collected; subsequently, the physiological burden of this activity could not be accurately measured. Previous research does indicate that a significant correlation exists between lower resting heart rates and marksmanship ability.[16] Therefore, there is a need to look at heart rate and other physiological measures during similar events to provide more insight related to the stress of these events and to develop physical and mental training programs to address these demands. Future studies should consider nutritional and hydration status, heart and respiration rates, experience levels of Operators, and the specific level of exposure to the THOR3 program to obtain better information on performance indicators. Furthermore, future research should be performed using larger sample sizes for greater statistical power.

Nutritional status was not controlled for in the stress shoot in this study. Peak physical performance, mental performance, and dietary intake may be elements that affect the SOF Operator in the SFAUC. These are all factors that may affect success in SOF missions, when speed, accuracy, and cognitive performance in stressful situations are paramount to success.

Conclusion

SFAUC leadership concluded the ODA completing the stress test with the fastest average time was also the ODA that used at least one service provided by the THOR3's performance team before SFAUC. The differences between the users and nonusers of the THOR3 program suggest there may be a critical advantage to using this program with regard to performance enhancement and cognitive performance under stress. Having a higher level of physical performance and knowledge of mental skills training methods may provide advantages to Operators performing in a stress shoot or similar tasks.

Disclosures
The authors have indicated they have no financial relationships relevant to this article to disclose.

to medium effect size was discovered between raw time and total time to completion between users and nonusers of the THOR3 program. In addition, a small effect size was discovered in total penalty time. However, the scenario presented in this study may well be one of statistical significance versus practical significance. It is important for the reader to remember that all ARSOF personnel are highly trained, regardless of their use of the THOR3 program. Therefore, any differences between users and nonusers may be small enough that statistical analysis will show no difference between groups. However, such small differences in the ability of ARSOF personnel to engage targets near friendly and enemy personnel are essential and could mean the difference between life and death for Operators, hostages, or other friendly personnel.

Several studies have identified that physical and mental performance training may improve cognitive function under stress.[10] Kramer et al.[11] were first to propose the "selective improvement" hypothesis comparing aerobic exercise training and performance tasks. Selective improvement suggests that only a few specific cognitive functions (i.e., executive functions and tasks that require cognitive control) are affected by aerobic exercise.[10] Another study, by Holzschneider et al.,[12] combined physical exercise and spatial memory training to test the effects on spatial memory functions. Kempermann[13] concluded that physical exercise may prepare the brain to respond to cognitive stimulation. Hotting and Roder[10] stated that exercise-induced changes in the nervous system with follow-on cognitive training will facilitate neuronal changes to occur more effectively. The benefits of combining physical and mental training associated with mission tasks, as done in the THOR3 program, may cause a deliberate change in the neuroplasticity of the Operator.

Speed and accuracy in shooting is a critical skill for all Soldiers in the military, not just SOF Operators.[14] Based on the

Author Contributions

All authors approved the final version of the manuscript.

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