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THE STRESS OF SILENCE: EVALUATING THE STRESS INDUCED BY TACTICAL SILENCE DURING FIREFIGHTER MAYDAY EVOLUTIONS

by

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Between 2015 and 2021, the United States Fire Service experienced 18,697 Mayday events where a firefighter needed rescue. Of those events, almost one-half of all successful rescues were made by the Mayday firefighters themselves. The ability to remain calm, think critically, and act is crucial to increasing the chances of survival. When faced with a life-or-death situation, an individual rapidly assesses if their personal resources are sufficient to overcome the problem. Fire service training does not facilitate the learning of this evaluative process due to the constant presence of instructors during training in environments that are immediately dangerous to life and health (IDLH). Similar high-reliability professions, such as the airline and spaceflight industries, have incorporated Stress Exposure Training (SET) techniques to prepare pilots and astronauts before facing stressful situations. This thesis will explore current stress training programs in the U.S. Fire Service, SET programs in similar professions, and evaluate the effectiveness of tactical silence to induce stress in a training environment. Findings show a significant difference in recruit firefighter performance when completing a Combined Skills Evolution under tactical silence conditions and support the inclusion of scenarios without instructor support in basic firefighter training programs.

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THE STRESS OF SILENCE: EVALUATING THE STRESS INDUCED BY TACTICAL SILENCE DURING FIREFIGHTER MAYDAY EVOLUTIONS

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ABSTRACT

Between 2015 and 2021, the United States Fire Service experienced 18,697 Mayday events where a firefighter needed rescue. Of those events, almost one-half of all successful rescues were made by the Mayday firefighters themselves. The ability to remain calm, think critically, and act is crucial to increasing the chances of survival. When faced with a life-or-death situation, an individual rapidly assesses if their personal resources are sufficient to overcome the problem. Fire service training does not facilitate the learning of this evaluative process due to the constant presence of instructors during training in environments that are immediately dangerous to life and health (IDLH). Similar high-reliability professions, such as the airline and spaceflight industries, have incorporated Stress Exposure Training (SET) techniques to prepare pilots and astronauts before facing stressful situations. This thesis will explore current stress training programs in the U.S. Fire Service, SET programs in similar professions, and evaluate the effectiveness of tactical silence to induce stress in a training environment. Findings show a significant difference in recruit firefighter performance when completing a Combined Skills Evolution under tactical silence conditions and support the inclusion of scenarios without instructor support in basic firefighter training programs.

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LIST OF ACRONYMS AND ABBREVIATIONS

AACOFD	Anne Arundel County Fire Department
AFD	Annapolis Fire Department
AHJ	authority having jurisdiction
CBT	cognitive behavioral therapy
CISD	Critical Incident Stress Debriefing
CISM	Critical Incident Stress Management
COSFA	Combat and Operational Stress First Aid
CPT	cold pressor test
EMS	emergency medical services
FSR	Firefighter Survival and Rescue
IAFC	International Association of Fire Chiefs
IAFF	International Association of Fire Fighters
IDLH	immediately dangerous to life and health
JPR	job performance requirements
KSA	knowledge, skills, and abilities
MFRI	Maryland Fire and Rescue Institute
MICRB	Maryland Instructor Certification Review Board
MSA	Mine Safety Appliances
MUSC	Medical University of South Carolina
NFFF	National Fallen Firefighters Foundation
NFPA	National Fire Protection Association
NIOSH	National Institute of Occupational Safety and Health
NVFC	National Volunteer Fire Council
PEAS	Protective Envelope and SCBA
PPE	personal protective equipment
PTSD	Post-Traumatic Stress Disorder
RIT	rapid intervention team

PRD	recognition primed decision
SAM	sympathetic-adrenal-medullary
SCBA	self-contained breathing apparatus
SET	stress exposure training
SFA	Stress First Aid
SIT	stress inoculation training

EXECUTIVE SUMMARY

One of the most stressful and dangerous situations a firefighter may ever encounter is calling a Mayday – when a firefighter is trapped, lost, disoriented, or otherwise incapable of getting to safety. Between 2015 and 2021, the United States Fire Service experienced 18,697 Mayday events.[1] Almost one-half of successful Mayday rescues were accomplished by the endangered firefighters themselves.[2] To maximize the chances of survival, firefighters in these situations need to remain calm and think clearly to analyze their situation. Over the past four decades, changes in building construction and furnishings have significantly decreased the time available for the decision-making process. Once a fire starts, the time to flashover (total involvement of the room) is less than four minutes in modern homes, compared to more than thirty minutes in older homes.[3] This decrease in discretionary time enhances the reliance on recognition-primed decision-making (RPD). The RPD process is based on intuitive or naturalistic decisions based on an individual's past experiences.[4] Upon completing basic training, recruit firefighters have minimal expertise on which to base RPD processes. Once released to the field, trainee firefighters today receive less on-the-job training due to increasing call demands. Although overall call volume nationwide increased from 10.8 million calls annually in 1980 to 36.4 million annually in 2020, the incidence of fires decreased by 53%.[5] The increase in other call volume and the decrease in fire responses limit the amount of experience firefighters gain

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1 Don Abbott, "2021 Career Part 1 of 2," Don Abbott's Project Mayday, accessed July 19, 2022, http://www.maydaystudy.com/; Don Abbott, "2021 Volunteer," Don Abbott's Project Mayday, accessed July 19, 2022, http://www.maydaystudy.com/.

2 Abbott, "2021 Career Part 1 of 2"; Abbott, "2021 Volunteer."

3 Stephen Kerber, "Analysis of Changing Residential Fire Dynamics and Its Implications on Firefighter Operational Timeframes," *Fire Technology* 48 (2012): 888, https://doi.org/10.1007/s10694-011-0249-2.

4 Scott Carrigan, "Fireground Decision-Making: A Qualitative Study" (research paper, Executive Fire Officer Program, National Fire Academy, 2015), 5, https://nfa.usfa.fema.gov/pdf/efop/efo48927.pdf; Gary Klein, "The RPD Model: Criticisms and Confusions: Six Challenges to the Recognition-Primed Decision (PRD) Model," *Seeing What Others Don't* (blog), February 9, 2021, https://www.psychologytoday.com/us/blog/seeing-what-others-dont/202102/the-rpd-model-criticisms-and-confusions.

5 Carrigan, "Fireground Decision-Making," 9; Rita F Fahy et al., *Fire Service in the United States: Trend Tables* (Quincy, MA: National Fire Protection Association, 2022), 16.

as references in the RPD process. The lack of on-the-job training places greater demands on the basic training environment while firefighters learn basic skills. Fire service training programs include hands-on training, but teaching every possible scenario a firefighter may encounter is impractical. The bunker-like construction of most live-fire-training structures contributes to minimal scenario variability. This results in trainees performing skills of a repetitive nature and reinforcing learned skills, but does not result in teaching critical thinking, and may contribute to overconfidence in the real-world environment. Research has shown firefighters may execute learned responses without recognizing subtle situational differences, leading to flawed decision-making based on the application of incorrect RPD references.[6] When faced with extreme stress, an individual makes a rapid assessment of whether their available resources are sufficient to meet the demands of the situation. When stress overwhelms the ability to cope, an individual may experience tonic immobility – profound motor inhibition and unresponsiveness to stimuli.[7] In the fire service training environment, instructors are constantly present, and trainees most likely never encounter this feeling of being overwhelmed. Once released to the field, however, an individual who becomes lost or separated from their crew must recognize situational cues and make RPD-based decisions without assistance to affect their own survival. The airline and spaceflight industries face similar high-risk consequences for inadequate decision-making. These professions have incorporated Stress Exposure Training (SET) into their basic pilot and astronaut training programs, commonly by introducing fire or smoke in their simulation programs – stressors already present in fire service training. The fire service must explore ways to induce stress in the training environment to ensure firefighters maintain the ability to think critically when faced with a Mayday situation.

This thesis explores how tactical silence affects recruit firefighters' performance when performing practical training in a Combined Skills Evolution. The use of tactical silence from the instructional staff will increase the stress levels experienced by the

6 Paul M. Junger, "The Effects of Hypervigilance on Decision-Making during Critical Incidents" (master's thesis, Naval Postgraduate School, 2018), 47, https://hdl.handle.net/10945/60416.

7 Carlos Eduardo Norte et al., "Tonic Immobility in PTSD: Exacerbation of Emotional Cardiac Defense Response," *Frontiers in Psychology* 10, no. 1213 (May 2019): 1, https://doi.org/10.3389/fpsyg.2019.01213

recruits, resulting in longer times to complete and higher average heart rates during the evolution. Eleven recruit firefighters were randomly assigned to the experimental or control groups and equipped with wireless heart rate monitors before conducting the evolution. All individuals completed the Maryland Fire and Rescue Institute (MFRI) Firefighter I, Firefighter II, and Firefighter Survival and Rescue (FSR) courses prior to the experiment. The recruits previously learned to successfully navigate each obstacle presented in the Combined Skills Evolution. However, they had not navigated from obstacle to obstacle continuously. Each individual was equipped with full structural firefighting personal protective equipment, self-contained breathing apparatus, and a Smoked Out Series face shield to obscure their vision. The participants navigated the Combined Skills Evolution course, during which time to complete and heart rate were monitored. During the first attempt, the experimental group received no guidance or support from the instructional staff and operated in tactical silence. The control group received support, advice, and instruction from the staff as they navigated the course. Core elements were rearranged before a second attempt at the course to ensure a different scenario for both groups. Both groups operated under tactical silence during the second attempt and received no instructor support.

During the first attempt at the course, the experimental group completed the course in an average of 26.03 minutes. Compared to the control group's average of 18.05 minutes, the experimental group took 44% longer to complete the course. On the second attempt, the experimental group completed in an average of 14.87 minutes, while the control group completed in 16.33 minutes. The experimental group completed the second run 10% faster than the control group. Data analysis of the first attempt showed a significant difference in times between the experimental and control groups ($t(7) = 2.43$, $p = .023$). Additionally, there was a significant difference in time for the experimental group between the first and second attempts ($t(6) = 3.54$, $p = .006$). Although the course was reconfigured, it is important to note there was no significant difference for the control group between the first and second runs (1.72-minute difference compared to the 11.16-minute difference for the experimental group). When comparing the control group's first and second attempts, there

was no significant difference, and there was also no significant difference on the second attempt between the experimental group and the control group.

Comparing the average heart rates of the two groups, the first attempt recorded an average heart rate of 165 beats per minute (bpm) for the experimental group and 157 bpm for the control group. The experimental group had an average heart rate of 161 bpm on the second attempt, and the control group had an average of 152 bpm on the second attempt. Data analysis of heart rates shows no significant differences between the two groups or the two attempts.

When faced with operating independently without instructor support, the experimental group took significantly longer to complete the course. Had this been an actual Mayday event, the difference in time could have resulted in the death of the firefighter. Fires can develop to the point of flashover in less than four minutes. Any time delay in exiting a structure fire is crucial. Recruits who operated in a condition of tactical silence during their first attempt performed significantly better on their second attempt at the Combined Skills Evolution. Although there were no significant differences in heart rate, sampling with a larger group or comparing test heart rates against baseline heart rates may yield different results.

This study demonstrates the need for a shift in the prevailing fire service training model. Even if recruits are successful in the training environment when they are supported and guided by their instructors, their first exposure to an event where they are isolated from help and support can significantly affect the time required to extricate themselves from danger. Future training programs should include capstone scenarios where instructors are present for safety only and do not provide instruction to students. The broader topic of stress training in the fire service warrants further discussion and research. This experiment evaluated the use of tactical silence to induce stress in the training environment. However, this research did not include Stress Inoculation Training to teach techniques to manage stress during an emergency response. Additionally, when comparing the results of both groups, it is important to note both groups already completed the Combined Skills Evolution when conducting their second attempt. To gain a clearer perspective of performance differences, a comparison should be made between the experimental group

on the second run and the first run of a third comparator group on an identical course. Further research should also evaluate other means of stress measurement to gain an accurate perspective of the effect of tactical silence in a fire service training environment. The physical stress of wearing full protective equipment and self-contained breathing apparatus may overwhelm the statistical significance of the psychological stress induced through tactical silence.

Firefighting is a hazardous occupation, and firefighters will continue to make split-second decisions with limited information. The responsibility of the training environment is to prepare firefighters for the emergencies they will encounter during their careers. It is impractical, however, to present every scenario they will ever face. Teaching critical thinking while under stress is crucial to a firefighter's survival, and the fire service needs to explore Stress Inoculation and Stress Exposure Training programs used in similar high-reliability professions for adaptability and inclusion in fire service training.

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I. INTRODUCTION

Firefighting is a dangerous profession. Each year, the U.S. Fire Service experiences the death of approximately one hundred firefighters in the line of duty. Many times, these fatalities are the result of a Mayday event in which a firefighter becomes lost, disoriented, or trapped. When these events occur, there is limited time for the firefighter to be rescued due to the progressively destructive nature of fire. During Mayday training scenarios at the Anne Arundel County Fire Training Academy, a trainee experienced an episode of tonic immobility, or complete inaction. The individual's lack of responsiveness and motor control resulted in the training staff rescuing the recruit from the evolution. Tonic immobility is associated with extreme stress, extreme fear, or inescapability. An episode of immobility while performing tasks in a non-training environment may lead to severe injury or even the death of the firefighter. When faced with the stress of a life-threatening event, the ability to think clearly and act based on available information is critical, yet training for these types of events is inadequate. It does not include teaching firefighters the skills to think critically in high-stress situations. Training programs for astronauts, pilots, ship navigators, and some law enforcement agencies include Stress Exposure Training (SET), which may be utilized by the fire service to prepare individuals to survive a Mayday event. The fire service must explore ways to induce stress in the training environment to increase the likelihood of firefighter survival in a Mayday situation. This thesis will explore current fire service stress training models, different types of SET used in other high-stress professions for applicability in the fire service, evaluate the effectiveness of these techniques during stressful training scenarios, and test the efficacy of tactical silence to induce stress during Mayday training.

Between 2013 and 2022, over 1,000 firefighters died in the line of duty across the United States.[1] Data collected by the National Institute of Occupational Safety and Health (NIOSH) shows there were 457 fatalities between 2013 and 2022 on the scene of emergency responses; 354 of those involved either structural or wildland fire suppression

[1] "Summary Incident Report: Jan 1, 1990 to Oct 5, 2023," Firefighter Fatalities in the United States, October 5, 2023, https://apps.usfa.fema.gov/firefighter-fatalities/fatalityData/incidentDataReport.

activities.[2] Many incidents resulting in a firefighter fatality have a declared "Mayday," a summons for help, before the firefighter's death.[3] The term "Mayday" is used by firefighters in life-threatening situations, including firefighters who are lost or disoriented, experiencing a low air or loss of air condition, a member who is trapped, injured, incapacitated, or otherwise unable to exit the hazardous environment or any other life-threatening situation where a firefighter needs to be rescued.[4] While Mayday events receive significantly less attention than firefighter fatalities, between 2015 and 2021, Project Mayday collected reports on 18,697 incidents where a Mayday event occurred, an average of one every three hours in the U.S.[5] Poor or impaired decision-making was cited as a critical factor in 75% of the events submitted to Project Mayday.[6] In almost one-half of the successful rescues from Mayday situations, the firefighters in distress rescue themselves.[7] A firefighter's ability to think critically and clearly when faced with a life-threatening situation is crucial for survival, yet it is rarely taught in basic training programs. This is due to a lack of emphasis on Mayday training in the national training standards and the lack of a nationally recognized training curriculum.

Firefighter training standards in the U.S. lack uniformity. The National Fire Protection Association (NFPA) standards recommend Job Performance Requirements (JPRs), defined by Knowledge, Skills, and Abilities (KSAs). Basic competency requirements for firefighters are included in *NFPA 1001: Standard for Fire Fighter*

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[2] "FFFIPP – About the Program," Fire Fighter Fatality Investigation and Prevention Program (FFFIPP), February 13, 2023, https://www.cdc.gov/niosh/fire/abouttheprogram/abouttheprogram.html.

[3] Burton A. Clark, "We Have Permission to Use the Word Mayday," *Firehouse*, January 17, 2003, https://www.firehouse.com/safety-health/article/10573233/we-have-permission-to-use-the-word-mayday. "Mayday" is a term most often associated with maritime and aviation industries in dire emergencies to summon help and is recognized both nationally and internationally by the U.S. Coast Guard.

[4] Don Abbott, "2021 Career Part 1 of 2," Don Abbott's Project Mayday, accessed July 19, 2022, http://www.maydaystudy.com/; Don Abbott, "2021 Volunteer," Don Abbott's Project Mayday, accessed July 19, 2022, http://www.maydaystudy.com/.

[5] Abbott, "2021 Career Part 1 of 2"; Abbott, "2021 Volunteer."

[6] Abbott, "2021 Career Part 1 of 2"; Abbott, "2021 Volunteer."

[7] Abbott, "2021 Career Part 1 of 2"; Abbott, "2021 Volunteer."

Professional Qualifications.[8] Mayday situations and self-rescue receive limited focus in the NFPA 1001 standard, and there are no references to critical thinking skills. The only use of the term "Mayday" occurs in an explanatory appendix stating the following:

> **A.4.2.4** An emergency call for assistance can be initiated by the use of a radio, pass device,[9] or other means to alert others to a fire fighter's need of emergency assistance. This should also include the term *mayday, fire fighter down,* or other such terminology as determined by the AHJ.[10]

Firefighter rescue is covered in NFPA 1001, section 4.3.9(B). Specifically, a requisite skill for a firefighter is to rescue a firefighter with and without functioning respiratory protection. No section of the standard addresses self-rescue scenarios, and there is no standard definition of a Mayday event for reference when designing training programs. Additionally, NFPA standards are consensus standards, and compliance is not mandatory, further contributing to the lack of consistent training standards.

A companion standard, *NFPA 1500: Standard on Fire Department Occupational Safety, Health, and Wellness Program*, addresses firefighter behavioral health and exposures to atypically stressful events but does not address preventative training or critical thinking abilities.[11] Behavioral health training in NFPA 1500 is limited to peer support team training and smoking cessation. There is no recommendation for preventive stress awareness or stress management training.[12] Other high-reliability occupations, such as law enforcement, spaceflight, and the airline industry, have incorporated induced stressors during training to improve performance when faced with future high-stress events. To increase the likelihood of survival for firefighters in a Mayday situation, the fire service

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[8] National Fire Protection Association, *NFPA 1001: Standard for Fire Fighter Professional Qualifications, 2019 Edition.* (Quincy, MA: National Fire Protection Association, 2018), http://codesoneline.nfpa.org.

[9] A personal alert safety system (PASS) device is a body-worn device that continually monitors for lack of movement and automatically activates an alarm signal indicating a need for assistance; the device can also be triggered manually.

[10] National Fire Protection Association, *NFPA 1001*, 15. AHJ stands for the Authority Having Jurisdiction.

[11] National Fire Protection Association, *NFPA 1500: Standard on Fire Department Occupational Safety, Health, and Wellness Program, 2021 Edition* (Quincy, MA: National Fire Protection Association, 2020), http://codesonline.nfpa.org.

[12] National Fire Protection Association, NFPA 1500, 12.

must explore ways to train for Mayday events while inducing stress, similar to other high-reliability professions.

A. PROBLEM STATEMENT

Today's U.S. fire service faces many challenges when training firefighters to be prepared for the situations they may encounter during emergency responses. These challenges include changes in the decision-making demands, decreasing time to make critical decisions, training challenges, and the limitations of current stress training models adapted for use in the fire service. It is incumbent on training agencies to prepare firefighters to respond to emergency calls safely, efficiently, and effectively, all while limiting the time devoted to training as much as possible. Additionally, the ever-increasing call volume limits the amount of on-the-job training emergency services personnel can accomplish following their initial training.

1. Decision-Making Demands of the Fire Service

Firefighters are tasked with making critical decisions under extreme time constraints. This is similar to airline pilots, astronauts, police officers, emergency medical personnel, and combat personnel. These professions are referred to as "high reliability" occupations.[13] The common feature is individuals in these professions experience high stress levels due to the need to make complex decisions under extreme task demands. Firefighters must predict complex phenomena while performing fire suppression tasks and take action based on their predictions. The consequences of poor decision-making can be severe, including the death of the firefighter, a fellow firefighter, or a civilian. As a firefighter assesses a fire, the fire continues to grow and develop, changing the environment, and the information the firefighter uses to make decisions quickly becomes obsolete.[14] Law enforcement officers are faced with similar challenges. They are expected

[13] Michael R. Baumann, Carol L. Gohm, and Bryan L. Bonner, "Phased Training for High-Reliability Occupations: Live-Fire Exercises for Civilian Firefighters," *Human Factors: The Journal of the Human Factors and Ergonomics Society* 53, no. 5 (October 2011): 548, https://doi.org/10.1177/0018720811418224.

[14] Baumann, Gohm, and Bonner, 549.

to assess a situation quickly, decide if a use of force is warranted, and determine the best option on the continuum of force. This thought process must occur rapidly and under the stress of the situation.[15] Firefighters and law enforcement officers rely on training and experience to make decisions rapidly when confronted with these situations.

Classical analysis processes are too time-consuming in rapidly changing, complex environments. As a result, many decisions are based on quicker intuitive or naturalistic decision-making processes. This is known as the Recognition Primed Decision (RPD) model.[16] Research has shown these decisions are primarily based on an individual's experiences in similar situations.[17] Incidents an individual does not see often (or has never seen before) pose the most significant risk to life and safety due to a lack of comparable experiences on which to base decisions. Of particular concern is how novice firefighters make decisions when they have faced a limited variety of situations and do not possess the expertise to make decisions based on the RPD model.

As the fire grows and conditions change, firefighters make decisions rapidly based on information that quickly loses validity. The pressure to make decisions under time constraints also degrades the quality of the choices.[18] This is especially true when firefighters are in a situation posing mortal peril. Fires are unpredictable, and the irregularities of each incident (presence of accelerants, climactic conditions, number of occupants trapped, etc.) make it nearly impossible to be fully prepared or to have faced an

[15] Jarrod Matthew Bowen, "An Exploratory Case Study of the Efficacy of Stress Inoculation Training (SIT) in California Law Enforcement Academies" (PhD diss., University of Phoenix, 2020), 9, ProQuest.

[16] Scott Carrigan, "Fireground Decision-Making: A Qualitative Study" (research paper, Executive Fire Officer Program, National Fire Academy, 2015), 5, https://nfa.usfa.fema.gov/pdf/efop/efo48927.pdf; Gary Klein, "The RPD Model: Criticisms and Confusions: Six Challenges to the Recognition-Primed Decision (PRD) Model," *Seeing What Others Don't* (blog), February 9, 2021, https://www.psychologytoday.com/us/blog/seeing-what-others-dont/202102/the-rpd-model-criticisms-and-confusions.

[17] Deanna M. McDevitt, "Searching for Effective Training Solutions for Firefighting: The Analysis of Emergency Responses and Line of Duty Death Reports for Low Frequency, High Risk Events" (master's thesis, Naval Postgraduate School, 2017), 4, https://hdl.handle.net/10945/56157.

[18] Robert N. Goplin, "Human Factors Affecting Mayday Decisions in Green Bay Firefighters: Will They Call for Help When They Need It?" (research paper, Executive Fire Officer Program, National Fire Academy, 2009), 6, https://www.hsdl.org/c/view?docid=695453.

identical situation previously.[19] The only way to fully prepare a firefighter is to mimic every potential situation they could eventually encounter, an unrealistic expectation. Police officers making rapid decisions in a life-or-death situation commonly attribute their decision-making to a "gut feeling" or "sixth sense."[20] These situations lack time to validate the decision-making process, and officers rely on the RPD model. Airline pilots make similar RPD-based decisions due to the need to act rapidly while facing high consequences for poor decisions.[21] Both professions recognize the need for rapid decision-making in complex, time-constrained environments and utilize Stress Inoculation Training (SIT) to prepare officers and pilots for emergencies.

a. Maydays

One of the most stressful situations a firefighter may ever encounter is calling a Mayday. Once a firefighter declares a Mayday, the most significant potential for a positive outcome lies with the endangered firefighter – the firefighter in the Mayday situation accomplishes 43% of all successful rescues. The firefighters' crew makes the second most frequent rescue (19.7%).[22] In a study of thirty tasks conducted in Fire & Rescue New South Wales, rescuing a firefighter is perceived as the most important, most physically demanding, and lowest frequency event firefighters perform.[23] With the greatest chance of survival resulting from self-rescue, the ability of the firefighter to remain calm and clearly analyze their situation becomes critically important. Maintaining cognitive and behavioral control is essential to survival for individuals engaged in high-reliability

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[19] David E. O'Neal, "Training for Failure in the United States Fire Service" (master's thesis, Naval Postgraduate School, 2019), 56, http://hdl.handle.net/10945/64038.

[20] Paul M. Junger, "The Effects of Hypervigilance on Decision-Making during Critical Incidents" (master's thesis, Naval Postgraduate School, 2018), 55–57, https://hdl.handle.net/10945/60416.

[21] Christopher K. McClernon, "Stress Effects on Transfer from Virtual Environment Flight Training to Stressful Flight Environments" (master's thesis, Naval Postgraduate School, 2009), 1, https://hdl.handle.net/10945/10441.

[22] Abbott, "2021 Career Part 1 of 2"; Abbott, "2021 Volunteer."

[23] Nigel A.S. Taylor et al., "Employment Standards for Australian Urban Firefighters: Part 1: The Essential, Physically Demanding Tasks," *Journal of Occupational and Environmental Medicine* 57, no. 10 (2015): 1063–71.

occupations.[24] The ability to make clear decisions while under stress is even more imperative when a firefighter does not have sufficient experience to apply references using the RPD model.

When faced with overwhelming stress in a life-threatening situation, firefighters revert to the RPD decision-making model, relying on intuitive or naturalistic decisions. Flawed decision-making was a critical contributing factor in 75% of Mayday events.[25] When firefighters are inadequately trained to manage stress, the diversion of cognitive resources to manage emotional states reduces the ability to perform problem-solving.[26] Making clear and controlled decisions may mean the difference between life and death.[27] In a study of 72 law enforcement officers, Artwohl found almost 90% of respondents reported experiencing "tunnel vision," also known as perceptual narrowing.[28] A similar survey of 458 respondents by Grissom found one-half of individuals exposed to life-threatening situations reported tunnel vision.[29] Grissom concluded exposure to stress limited the availability of cognitive resources to deal with the stressful event. When perceptual narrowing occurs, a firefighter is not able to process all of the cues from their surroundings and may make flawed decisions based on incorrectly interpreted or unrecognized situational cues. Recognizing and interpreting situational cues is imperative due to the rapid obsolescence of information resulting from the changing nature of the fire scene.

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[24] Baumann, Gohm, and Bonner, "Phased Training for High-Reliability Occupations," 56; Heather L. Clifton, Panagiotis Matsangas, and Nita Lewis Shattuck, *Assessment of Stress Inoculation Training at the U.S. Navy Surface Warfare Officer School* (Monterey, CA: Naval Postgraduate School, 2020), 2, http://hdl.handle.net/10945/65799.

[25] Abbott, "2021 Career Part 1 of 2"; Abbott, "2021 Volunteer."

[26] Tor Finseth et al., "Manipulating Stress Responses during Spaceflight Training with Virtual Stressors," *Applied Sciences* 12, no. 5 (2022): 1, https://doi.org/10.3390/app12052289.

[27] Lindsay A. Clements, "The Effect of Stress Inoculation on Ship-Simulator Training in Novice Ship Drivers" (master's thesis, Naval Postgraduate School, 2020), 5, https://hdl.handle.net/10945/64846.

[28] Loren W. Christensen and Alexis Artwohl. *Deadly Force Encounters: What Cops Need to Know to Mentall and Physically Prepare for and Survive a Gunfight* (Boulder, CO: Paladin Press, 1997), 252.

[29] James C. Grissom, "Visual Distortion during Periods of Survival Stress and the Implications for Survival Skills Training" (master's thesis, Sam Houston State University, 2017), 11, https://shsu-ir.tdl.org/bitstream/handle/20.500.11875/1242/0853.pdf?sequence=1&isAllowed=y.

When performing fire suppression activities, firefighters have limited time to operate based on the conditions they encounter. Time may be limited by the potential for structural collapse or the amount of air carried in their Self-Contained Breathing Apparatus (SCBA). Time compression becomes a contributing factor in the level of stress faced by firefighters during emergency operations. Most firefighter injuries and fatalities occur during high-consequence, low-frequency events with no discretionary time for decision-making.[30] These events are very risky, done very rarely, and have no time to apply classical decision-making models, resulting in RPD-driven decision processes. These processes, however, are flawed due to the lack of references resulting from the infrequency of these events. Once firefighters begin to feel time pressure and perceive a life-or-death situation, panic begins, resulting in decreased situational awareness.[31] In a panicked state, the ability to conduct situational analysis is reduced, and firefighters rely on RPD decision-making because it is quick and easy. Once in this state of thinking, it is difficult to transition back to a slower, more analytical method of thinking.[32] When individuals encounter a situation they feel unprepared to handle, they enter a state of "hypervigilance." Junger describes the process:

> Individuals, without planning, must recognize they are in a critical situation, think through a proper solution to the situation, and implement the solution all while they are experiencing it. As time passes without a practical solution, the individuals start to experience hopelessness, which adds to their stress.[33]

Firefighters without experience on which to base their RPD decisions can easily find themselves in a situation they feel unprepared to manage, and the increased stress rapidly leads to cognitive restriction, attention narrowing, and improper actions.

On the opposite end of the spectrum is overconfidence, or a firefighter's belief they are prepared for critical thinking in stressful situations when, in reality, they are unprepared

30 "Gordon Graham on Risk Management," video, 15:09, YouTube, December 3, 2018, 11:42, https://www.youtube.com/watch?v=GvOSoTA4JMg.

31 Junger, "The Effects of Hypervigilance on Decision-Making during Critical Incidents," 42.

32 Junger, 42.

33 Junger, 52.

for these events. Police academies that fail to teach officers the harmful effects of stress on the decision-making process directly contribute to a sense of overconfidence.[34] In a study of ship groundings and collisions experienced by the U.S. Navy in 2017, Neill found subjects failed to take action and initiate emergency procedures when facing extreme circumstances.[35] This failure was attributed to insufficient training, resulting in a loss of situational awareness when faced with dangerous or extreme situations. Even if firefighters are trained in emergency procedures, when they are facing mortal danger, they may not revert to their training if their RPD model does not fit the current situation. For RPD to be effective in a Mayday event, research indicates firefighters must have previous experience with Mayday situations.[36] If a situation poses extreme risk but is rarely (if ever) encountered, the individual does not have the expertise to make critical decisions using the RPD model.[37] Training must be coupled with experience for firefighters to recognize the subtle cues that may lead to a successful self-rescue. Even for experienced firefighters, recent changes in building construction have affected fire behavior sufficiently to make previously learned assumptions invalid foundations for RPD-based decisions.

b. Changing Building Construction

The time constraints of a Mayday are not simply limited to a firefighter's available air supply, but also the time before a room experiences flashover, and the time before the structure collapses. Flashover is the near-simultaneous ignition of the combustible material in an enclosed area. Room temperatures rapidly spike from 1,100 degrees to more than 2,300 degrees Fahrenheit. Once a flashover occurs, firefighters have extraordinarily little time to escape the structure – the time from onset of flashover to firefighter untenability is less than ten seconds.[38] Changes in building design, construction, and contents have all

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[34] Junger, 3.

[35] Clarese L. Neill, "Effects of Stress Inoculation Training on Bridge Simulator Skills Acquisition and Performance" (master's thesis, Naval Postgraduate School, 2020), 2, https://hdl.handle.net/10945/64870.

[36] Goplin, "Human Factors Affecting Mayday Decisions," 39.

[37] McDevitt, "Searching for Effective Training Solutions for Firefighting," 14–15.

[38] Drager, *The Flashover Phenomenon: Understanding the Nature of Flashover and Recognizing Its Warning Signs* (Houston: Drager, 2019), 1, https://www.draeger.com/Content/Documents/Content/fire-flashover-wp-9108654-us-1912-1.pdf.

drastically reduced the time to flashover. Legacy construction (before the mid-1980s) utilized dimensional lumber, and the shorter spans between supports necessitated a compartmentalized design for residential structures. In the mid-1980s, lightweight construction using lighter-weight, more cost-effective engineered materials for faster construction time became popular.[39] Engineered I-joist floor systems collapse under fire conditions in approximately one-third the time of a floor system constructed with dimensional lumber. In addition, these lightweight materials have allowed open spaces within a home to increase in size, including taller ceilings, two-story foyers, great rooms, and open floor plans.[40] In 2008, the average home size in the U.S. was 2,600 ft^2, up from an average of 1,500 ft^2 in 1973. Two-story homes increased from 23% of single-family dwellings in 1973 to more than 56% in 2008.[41] As the size of the structure increases, more air is available to support fire growth. In addition to the air volume, these open spaces allow for more rapid fire and smoke travel, leading to more rapid fire spread throughout the structure. Both the design and the time to structural failure invalidate the expertise of experienced firefighters and decrease the time for classical decision-making.

In addition to structural changes, the composition of a structure's contents has led to dramatic changes in fire behavior. A traditional cotton-padded chair has a peak heat release rate of 370 kW at 910 seconds after ignition. A modern, foam-padded chair has a peak heat release rate of 1,900 kW just 260 seconds after ignition.[42] Just this one chair produces five times the heat in one-quarter of the time. The changing contents and construction differences have reduced the time to flashover from 31 minutes and 52 seconds in legacy construction to less than four minutes (3 minutes, 55 seconds) in a modern home.[43] The fire scene is changing so rapidly that firefighters are forced to make decisions with information that is becoming obsolete more quickly than ever before, and if

[39] Stephen Kerber, "Analysis of Changing Residential Fire Dynamics and Its Implications on Firefighter Operational Timeframes," *Fire Technology* 48 (2012): 869, https://doi.org/10.1007/s10694-011-0249-2.

[40] Kerber, 868.

[41] Kerber, 866–67.

[42] Kerber, 869.

[43] Kerber, 888.

they encounter a Mayday situation, the ability to think clearly is more critical due to the decreased time for survivability.

2. Fire Service Training Challenges

The fire service training environment faces numerous challenges hindering the accumulation of experience required for effective decision-making by firefighters. To gain necessary experience regarding dangerous situations, Goplin recommends that "firefighters must be involved in hands-on practical training that will mimic real-world scenarios to the safest extent possible." [44] NFPA 1001 recommends teaching techniques that would realistically be used on the fireground[45] without placing firefighters in excessive danger during training evolutions.[46] The creation and presentation of various realistic training scenarios to build references for the RPD model is imperative but is constrained by the amount of experience firefighters are able to gain during on-the-job training, training program design, and limitations based on design and construction considerations of training facilities.

a. Time Limitations

A critical element of the RPD decision-making process is knowledge gained through experience. Over the past three decades, the incidence of fire has decreased nationwide. In 1980, there were 2.99 million fires, compared to 1.39 million fires in 2020, a decrease of 53%.[47] In the same period, call volume tripled from 10.8 million to 36.4 million emergency responses. Fires have become high-risk, low-frequency events with no time for decision-making. The decrease in fires reduces the amount of on-the-job experience firefighters gain while operating on emergency incidents. This decrease in

[44] Robert Goplin, "The Protocol of the Mayday Call," *Fire Engineering*, January 2012, 32.

[45] *Merriam-Webster,* s.v. "fireground," accessed October 11, 2023, https://www.merriam-webster.com/dictionary/fireground. Fireground is "an area in which fire-fighting operations are carried on."

[46] National Fire Protection Association, *NFPA 1001*, 16.

[47] Carrigan, "Fireground Decision-Making," 9; Rita F Fahy et al., *Fire Service in the United States: Trend Tables* (Quincy, MA: National Fire Protection Association, 2022), 16.

hands-on experience puts more pressure on training to compensate.[48] Graham recommends training programs that focus daily on these types of high-risk, low-frequency events.[49] However, the overall increase in call volume limits the amount of training time available once firefighters leave the basic training academy. The Navy has seen similar limitations with decreased training and less time at sea, resulting in junior officers and sailors not learning basic seamanship skills.[50] These constraints result in training focused on fundamental skill mastery, not managing physiological responses to stress or expanding experience to be used in the RPD model. Research in spaceflight training found task-specific training in conjunction with induced stress exposure may diminish physiological responses to life-threatening situations.[51] Limitations of on-the-job training necessitate this training in the academy before firefighters report to an operational duty assignment.

b. Training Limitations

The inducement of stress in the training environment has unique challenges. Typically, fire service training programs begin with a significant amount of classroom instruction and then transition to the practical application of skills. Although many skills are practiced in the training environment, not all can be practiced due to time or fiscal limitations and the impracticability of creating scenarios for every challenge a firefighter may face. Adding stress during the practical application phase of training is imperative, as research with ship navigators has proven classroom training did not improve task performance in stressful environments.[52] Practical application of skills of a repetitive nature reinforces learned skills but may not have the effect of teaching critical thinking, just reactionary responses. Firefighters may execute responses learned during training without recognizing subtle differences in the situation, leading to overconfidence and

[48] O'Neal, "Training for Failure in the United States Fire Service," 1.

[49] "Gordon Graham on Risk Management," video, 15:09, YouTube, December 3, 2018, 12:08, https://www.youtube.com/watch?v=GvOSoTA4JMg.

[50] Neill, "Effects of Stress Inoculation Training," 1.

[51] Tor T. Finseth et al., "Evaluating the Effectiveness of Graduated Stress Exposure in Virtual Spaceflight Hazard Training," *Journal of Cognitive Engineering and Decision Making* 12, no. 4 (December 2018): 265, https://doi.org/10.1177/1555343418775561.

[52] Clements, "The Effect of Stress Inoculation," 5–6.

inappropriate decision-making.[53] Skills learned to the point of habitual behavior may contribute to poor responses when faced with new stressors or unpredictable conditions. Research with firefighters, ship navigators, and pilots has shown cognitive function improves with multiple exposures to the same stressful scenario but decreases when trainees are presented with new yet similar scenarios.[54] To maximize the effectiveness of practical training, a variety of scenarios must be presented to trainees while under stress to improve their decision-making abilities. Research shows improving decision-making abilities under time constraints should involve the presentation of many different scenarios over an extended period (days or weeks).[55] This becomes challenging when attempting to create real-world stress as the scenarios may seem contrived or the trainees feel a sense of safety in the training environment.[56] The continual presence of instructional staff to ensure successful outcomes supports this sense of safety. When faced with the perceived inability to resolve a threatening situation, hypervigilance and a sense of hopelessness can result.[57] Trainees who perceive a sense of safety in the training environment are not faced with this challenge and the resulting cognitive decreases from hypervigilance. Training programs must invoke these physiological responses so the trainee learns to think critically in stressful situations.

As mentioned previously, there are no nationwide criteria for fire service training. However, 64% of firefighters believe there are nationally recognized criteria for when to declare a Mayday.[58] No such standards exist. When reviewing NIOSH reports, Goplin found numerous reports where firefighters were in situations where they needed to be

[53] Junger, "The Effects of Hypervigilance on Decision-Making during Critical Incidents," 47.

[54] Baumann, Gohm, and Bonner, "Phased Training for High-Reliability Occupations," 554; McClernon, "Stress Effects on Transfer from Virtual Environment," 21; Finseth et al., "Evaluating the Effectiveness of Graduated Stress Exposure in Virtual Spaceflight Hazard Training," 249.

[55] Carrigan, "Fireground Decision-Making," 14.

[56] Clifton, Matsangas, and Shattuck, *Assessment of Stress Inoculation Training*, 3–4.

[57] Clifton, Matsangas, and Shattuck, 3–4.

[58] Goplin, "Human Factors Affecting Mayday Decisions," 6; Goplin, "The Protocol of the Mayday Call," 32.

rescued and never declared a Mayday.[59] NIOSH reports only include firefighter fatalities, so these undeclared Mayday events always resulted in tragedy. There may be many more incidents where a Mayday should have been declared that did not result in a fatality and were not included in Goplin's research. Because a Mayday was not declared, these are not included in the Project Mayday research either. This creates a significant knowledge gap where firefighters are experiencing close calls and surviving the event. Yet, data is not collected for analysis to make training programs efficient and better prepare firefighter trainees. A broader, more formal approach to Mayday training is needed, but repeating the same scenarios may lead to RPD-based reflexive actions instead of critical analysis and decision-making. Presenting a variety of Mayday training scenarios is challenging due to the limitations of many training venues.

c. Training Venue Limitations

During the operational phase of their careers, firefighters will respond to incidents in various structures, including single-family dwellings, multi-family dwellings, commercial buildings, and even industrial complexes. Each building will have unique design characteristics and furnishings, making every fire unique. As mentioned previously, a lack of variety in training scenarios can lead to reflexive responses instead of critical thinking. Practical training emulating real-life scenarios must be conducted to ensure firefighters adequately understand and recognize dangerous situations. However, training exercises must be conducted with the highest degree of safety possible to avoid injuries in a training environment.[60] This is challenging because of the destructive nature of fire. Construction of buildings to withstand repeated fires requires a "bunker-like" design, often using prefabricated steel structures or purpose-built concrete buildings.[61] These buildings are not easily reconfigured, and training becomes the repetition of a limited set of scenarios. The design of these buildings does not mimic the vast majority of residential or commercial construction and leads to a false expectation of the time available for action prior to

[59] Goplin, "Human Factors Affecting Mayday Decisions," 23–27.

[60] Goplin, "The Protocol of the Mayday Call," 32.

[61] Baumann, Gohm, and Bonner, "Phased Training for High-Reliability Occupations," 549.

structural collapse (these buildings should never collapse in a training scenario). In addition, the fuels used for live-fire training are restricted by *NFPA 1403: Standard on Live Fire Training Evolutions*, specifically banning flammable liquids, plastics, rubber, and treated wood.[62] This limits the number and types of fires a trainee will experience, including free-burning fires.[63] The author does not advocate using other fuels for training fires; however, the RPD cues developed from burning these materials build unrealistic expectations for fire behavior in the operational environment. Similar limitations are encountered when developing spaceflight training, where simulations may lack stressors found in real-world performance.[64] This semi-realistic training does not prepare trainees for the stresses they will encounter in the operational environment and does not create a wide range of experiential memories to support Recognition-Primed Decisions when facing a life-or-death situation.

3. Current Stress Training Models

In recent years, the topic of responder health and wellness has become a high priority for the fire service across the country. However, examining the current stress training models demonstrates their inadequacy in preparing firefighters to face Mayday situations. NFPA first introduced standards for health and wellness in 2002. In the 2002 and 2007 editions of the NFPA 1500 standard, the topic of behavioral health was limited to evidence of substance abuse with no reference to other behavioral health issues of any type.[65] In the current edition (2021), NFPA 1500 discusses peer support programs, behavioral health training, behavioral health programs, and response to occupational exposure to potentially traumatic events.[66] NFPA does not recommend a specific type or structure for a program, but there are a variety of approaches currently in vogue, including

[62] National Fire Protection Association, *NFPA 1403: Standard on Live Fire Training Evolutions, 2018 Edition* (Quincy, MA: National Fire Protection Association, 2017), http://codesonline.nfpa.org.

[63] O'Neal, "Training for Failure in the United States Fire Service," 20.

[64] Finseth et al., "Manipulating Stress Responses during Spaceflight Training," 1.

[65] National Fire Protection Association, *NFPA 1500: Standard on Fire Department Occupational Safety and Health Program, 2007 Edition* (Quincy, MA: National Fire Protection Association, 2006), http://codesonline.nfpa.org.

[66] National Fire Protection Association, *NFPA 1500, 2021 Ed.*

the two most common: Critical Incident Stress Debriefing (CISD) and Stress First Aid (SFA).

a. Critical Incident Stress Debriefing

Critical Incident Stress Debriefings are a reactive approach for emergency responders exposed to traumatic events. Dr. Jeffrey Mitchell pioneered debriefings in the mid-1970s and quickly expanded to a broader program under the Critical Incident Stress Management (CISM) umbrella. From the 1980s until the early 2000s, CISM was the fire service's most popular stress management model.[67] CISM is a seven-step intervention to reduce stress, restore group cohesiveness, and return an individual to operational readiness.[68] This field proliferated rapidly, with no empirical evidence to support the approach's effectiveness. Recent studies have shown CISM does not effectively reduce the probability of post-traumatic stress disorder. There are also indications CISM may have a harmful effect on responders who did not already feel traumatized by the incident.[69] The CISM model is limited in focus, concentrating on responders exposed to traumatic events.

b. Stress First Aid

The Stress First Aid (SFA) model was developed through a partnership between the National Fallen Firefighters Foundation (NFFF) and the Medical University of South Carolina (MUSC) to address a broader spectrum of mental health issues in the fire service beyond exposure to traumatic events. SFA aims to restore health and operational readiness

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[67] Karen F. Deppa and Judith Saltzberg, *Resilience Training for Firefighters* (Cham, Switzerland: Springer International Publishing AG, 2016), 10, https://doi.org/10.1007/978-3-319-38779-6.

[68] Margaret A. Maglione et al., *Stress Control for Military, Law Enforcement, and First Responders: A Systematic Review* (Santa Monica, CA: RAND, 2022), 2, www.rand.org/pubs/research_reports/RRA119-3.

[69] Deppa and Saltzberg, *Resilience Training for Firefighters*, 10; Martin P. Deahl et al., "Evaluating Psychological Debriefing: Are We Measuring the Right Outcomes?," *Journal of Traumatic Stress* 14, no. 3 (2001): 527–28, https://doi.org/10.1023/A:1011160606866; Richard Gist and S. Joseph Woodall, "There Are No Simple Solutions to Complex Problems: The Rise and Fall of Critical Incident Stress Debriefing as a Response to Occupational Stress in the Fire Service," in *Response to Disaster: Psychosocial, Community, and Ecological Approaches*, ed. Richard Gist and Bernard Lubin (London: Taylor & Francis Group, 1999), 212; Morag B. Harris, Mustafa Baloglu, and James R. Stacks, "Mental Health of Trauma-Exposed Firefighters and Critical Incident Stress Debriefing," *Journal of Loss & Trauma* 7, no. 3 (July 2002): 224, https://doi.org/10.1080/10811440290057639.

to fire and rescue personnel following an adverse stress reaction.[70] SFA focuses on stress reactions with any underlying cause, job-related or personal. The main components of SFA are peer-to-peer interactions and connections to professional mental health resources when indicated. SFA is adapted from the Combat and Operational Stress First Aid (COSFA) program used by the Department of the Navy. COSFA assesses and provides preclinical treatment of stress injuries in individuals.[71] A meta-analysis conducted to evaluate the effectiveness of COSFA found programs had no significant difference in Post-Traumatic Stress Disorder (PTSD) symptoms for participants with or without intervention.[72] While broader in scope than the CSIM model, SFA is still a reaction-based approach to stress management and does not incorporate stress exposure or stress management into proactive training models before an individual experiences a stressful event.

c. Other Programs

In recent years, multiple organizations have proposed alternative behavioral health awareness and training models. The International Association of Fire Fighters (IAFF) and International Association of Fire Chiefs (IAFC) outlined broad recommendations on firefighter behavior health, including suicide awareness and prevention programs, as part of a Fire Service Joint Labor Management Wellness-Fitness Initiative.[73] The National Volunteer Fire Council (NVFC) Share the Load program provides support and guidance to emergency responders managing problems at work and home.[74] The Code Green Campaign publishes anonymous stories of firefighters' behavioral health struggles as a means for responders to realize they are not alone and reduce the stigma of asking for help.[75] The Firefighter Behavioral Health Alliance maintains a database for documenting

[70] Deppa and Saltzberg, *Resilience Training for Firefighters*, 11.

[71] William P. Nash et al., *Combat and Operational Stress First Aid: Caregiver Training Manual* (Washington, DC: Department of the Navy, Bureau of Medicine and Surgery, 2010), 1.

[72] Maglione et al., *Stress Control for Military, Law Enforcement, and First Responders*, 90.

[73] Deppa and Saltzberg, *Resilience Training for Firefighters*, 11.

[74] Deppa and Saltzberg, 11.

[75] Deppa and Saltzberg, 11.

firefighter suicides to raise awareness about behavioral health issues.[76] Post-9/11, increased attention has been given to Cognitive Behavioral Therapy (CBT) techniques such as Meaning Making, Following the Effect, and Interpreting Defenses when treating first responders who experienced post-traumatic stress disorder following the attacks in New York.[77] None of these programs provide education or training on the recognition of stress prior to an emergency response, managing stress during an emergency response, or thinking critically during a stressful event. All are strictly reflexive reactions to stressful events or injuries, leaving a noticeable gap in fire service education and training.

d. Overall Effectiveness

Similar to CISM, no empirical evidence supports the efficacy of any of these approaches. Many of these approaches are new or localized enough that research has yet to be conducted to determine a level of effectiveness. Overall, debriefings are no more effective than no treatment for combatting stress.[78] Furthermore, these approaches lack a preventive approach to stress – they are not proactive mechanisms to reduce or overcome stress during an operational event.[79] Trainee firefighters are not taught how to manage stress during emergencies and do not develop critical thinking skills to overcome the RPD process, highlighting the importance of a wide variety of experiences, which trainees lack.

With the limitations presented by the training environment and lack of opportunity for on-the-job training, today's firefighters cannot develop the memory markers for effective decision-making using the RPD model. Although there are current initiatives in the fire service focusing on mental health and wellness, none of the existing programs address a proactive approach to stress management and critical thinking when faced with

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[76] Deppa and Saltzberg, 11.

[77] Peter T. Haugen et al., "Integrative Approach for the Treatment of Posttraumatic Stress Disorder in 9/11 First Responders: Three Core Techniques," *Psychotherapy* 50, no. 3 (2013): 339, https://doi.org/10.1037/a0032526.

[78] Frank Robert Rose, "Psychological Debriefing for First Responders: Helping Those Who Help" (PhD diss., Widener University, 2017), 96, ProQuest (1787585898).

[79] Finseth et al., "Evaluating the Effectiveness of Graduated Stress Exposure in Virtual Spaceflight Hazard Training," 249; Brian S. Miller, "Improving Resilience among Law Enforcement Officers" (master's thesis, Naval Postgraduate School, 2020), 83, https://hdl.handle.net/10945/64931.

stressful situations. Similar to spaceflight training, the ability to induce stress in the training environment is limited by available resources and the physical capability of a firefighter to perform tasks.[80] There is a clear need for stress exposure during training activities, but techniques used in other professions are not practical for firefighters in full protective equipment and breathing apparatus.

B. RESEARCH QUESTION

To improve the survivability of firefighters in Mayday situations, training scenarios must match the real world as much as possible without exposing the firefighter to unwarranted risk. Mechanisms to induce stress reactions in a controlled environment must be examined for practicality and applicability to replace the risk potentially faced in real-world operations. Can tactical silence in a training environment be used to replicate real-world stress? How will tactical silence affect heart rate and time to complete when recruit firefighters navigate a Combined Skills Evolution?

C. RESEARCH DESIGN

This thesis explored stress, stress reactions, and stress responses faced by the fire service and other similar high-reliability professions. Additionally, the literature review examined Stress Inoculation and Stress Exposure Training. It evaluated the effectiveness of these training programs in teaching individuals to function effectively when facing conditions of extreme stress. The experimental design examined the use of tactical silence to induce stress and evaluated the performance of recruit firefighters operating without instructor guidance and support.

D. CONTRIBUTION TO SCHOLARSHIP AND PRACTICE

This research highlights the need to incorporate training evolutions where firefighter trainees must function independently without instructor support. This will require a re-evaluation of training curricula and an increase in minimum requirements for training new firefighters before they are released operationally. Examining methods to

[80] Finseth et al., "Manipulating Stress Responses during Spaceflight Training," 1.

induce stressors in a training environment safely will contribute to expanding the variety of training scenarios firefighters face, improving the reliability of the RPD decision process. Lastly, exploring Stress Inoculation Training techniques will bring attention to this critical gap in fire service training, improving training programs to prepare firefighters for the stressors they will face in their careers.

II. LITERATURE REVIEW

Stress is a complex psychological and physiological response to a situation or event perceived as challenging or threatening. It is the body's natural reaction to various demands, often referred to as stressors. Stressors can be physical, emotional, or psychological. When faced with stressors, the body undergoes a series of changes to prepare for a "fight or flight" response, including increased heart rate, elevated blood pressure, heightened alertness, and the release of stress hormones like cortisol. Stress can be both beneficial and harmful. In small doses, it can motivate and help individuals respond to challenges. Chronic or excessive stress, however, can have adverse effects on mental and physical health, leading to conditions such as anxiety, depression, high blood pressure, and a weakened immune system. Managing and coping with stress is essential for overall well-being, and techniques can include relaxation, exercise, mindfulness, and seeking social support.

In firefighters, stress includes unique and often intense forms encountered in the course of duty. Firefighting is a demanding and high-risk profession, and the nature of the job exposes firefighters to various physical and psychological stressors. Some stressors firefighters encounter in the line of duty include time constraints, performance expectations, lack of adequate training, and Mayday situations. Firefighters must be trained to maintain the ability to think critically when faced with overwhelming stressors that could lead to their own death. The fire service should identify and adopt Stress Exposure and Stress Inoculation training techniques in other high-reliability professions.

A. STRESS

1. Healthy Stress

Stress is the body's response to challenges or demanding situations. Responses include physiological and psychological changes in the body, including increased heart rate, elevated blood pressure, heightened alertness, and the release of stress hormones like

cortisol.[81] Stress can be categorized as eustress (beneficial) or distress (detrimental).[82] An individual who experiences eustress builds resiliency, while an individual experiencing distress exhibits diminished performance. Positive effects of eustress include enhanced mental and physical functioning, improved problem-solving, and mental toughness.[83] The intentional inducement of eustress during firefighter training and operations improves psychological and physical performance. This occurs when firefighters feel their resources are capable of meeting the demands of the stressor.

When individuals encounter a stressor, they appraise their own personal ability to cope with the demands presented by the stressor. This is often conceptualized as a struggle between the demand and the resources to meet those demands.[84] The Lazarus Appraisal Theory divides the stress response into three steps: (1) appraisal of the stressor, (2) appraisal of resources to counter the threat, and (3) an evaluation to determine if the resources are sufficient to meet the stressor.[85] Two responses occur following this evaluation of demands and resources. The challenge state arises in reaction to stress when an individual believes their personal resources are adequate to cope with or surpass the stress posed by the situation. Conversely, the threat state is experienced when the perceived demands of the situation outweigh the available resources the person can employ to meet those demands.[86] The overwhelming feeling of the threat state leads to perceptual narrowing and RPD-based decisions made on limited or incorrect information and expertise.

The correlation between increasing stress intensity and its effect on performance can be illustrated graphically. The Yerkes Dodson Law describes the relationship between stress and functioning, frequently depicted as an inverted "U" shape, as shown in Figure 1.[87]

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[81] Bowen, "An Exploratory Case Study," 29.

[82] Clifton, Matsangas, and Shattuck, *Assessment of Stress Inoculation Training*, 2.

[83] Deppa and Saltzberg, *Resilience Training for Firefighters*, 41.

[84] Junger, "The Effects of Hypervigilance on Decision-Making during Critical Incidents," 8; Vicki R. LeBlanc et al., "The Impact of Stress on Paramedic Performance during Simulated Critical Events," *Prehospital and Disaster Medicine* 27, no. 4 (2012): 369, https://doi.org/10.1017/S1049023X12001021.

[85] Clifton, Matsangas, and Shattuck, *Assessment of Stress Inoculation Training*.

[86] Deppa and Saltzberg, *Resilience Training for Firefighters*, 41.

[87] Junger, "The Effects of Hypervigilance on Decision-Making during Critical Incidents," 14.

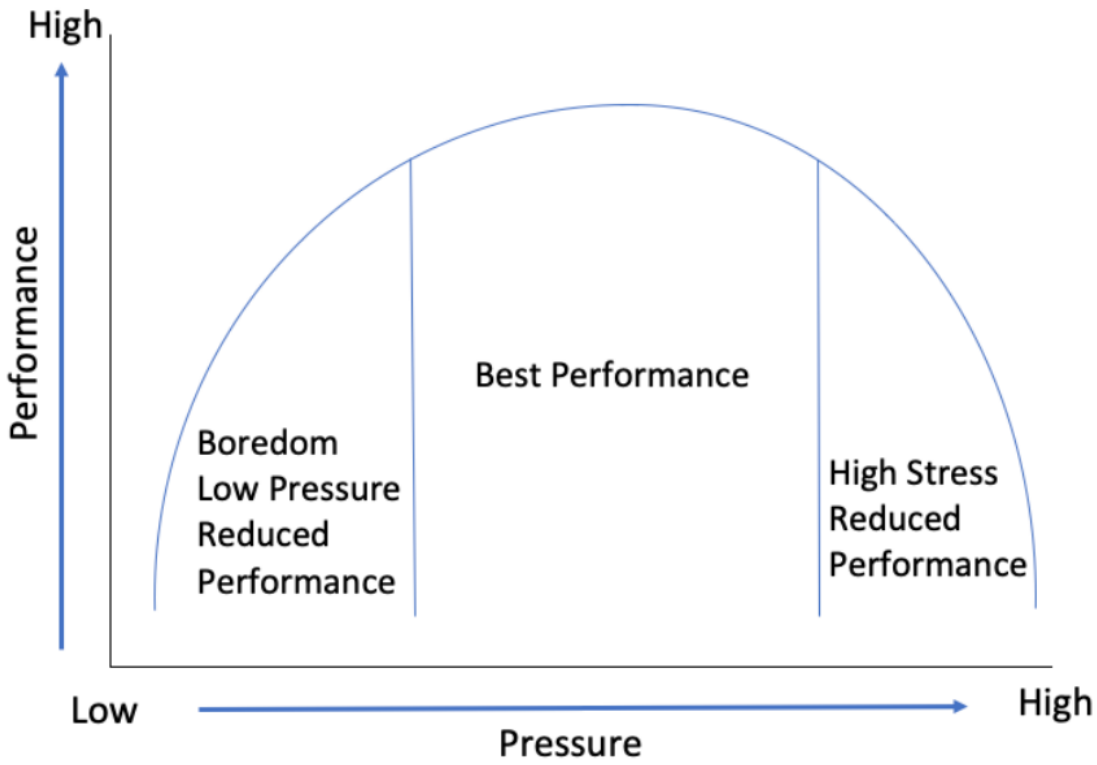

Figure 1. The Inverted-U theory[88]

As levels of stress increase, performance increases until an optimal level is reached. Beyond this point, however, increasing stress leads to the individual feeling overwhelmed, and performance begins to deteriorate. Research has shown this results from elevated levels of noradrenaline and dopamine. Although the initial increase of noradrenaline and dopamine improves decision-making, decision-making degrades once the stress exceeds the optimum point.[89] This degradation describes the *threat* state. An individual's perceived resources are insufficient to meet the stressful demand. In addition to the inverted "U" relationship, perceived stress increases when the task faced by the individual is more

88 "Inverted U Theory," Benchmark Six Sigma, 2021, http://benchmarksixsigma.com/forum/topic/36565-inverted-u-theory/.

89 Junger, "The Effects of Hypervigilance on Decision-Making during Critical Incidents," 13.

complex.[90] The complexity of emergency incidents and the decreasing time for decision-making both add to the stressors firefighters face.

During training, firefighters are consistently coached and guided by their instructors. As a result, they never complete this evaluative process of their own resources. Once training is complete and a firefighter is operational, they face the potential of encountering a Mayday situation and facing the stress of mortal peril without other individuals nearby to assist. When faced with this evaluation, if their own resources are found to be insufficient, they enter the *threat* state, and maladaptive functioning due to acute stress can occur. If this is not experienced in a controlled environment, individuals may not recognize they are experiencing cognitive limitations and have no experience returning from RPD-based decisions to classical analysis.

2. Acute Stress Reactions

Acute stress occurs when an individual experiences a stressful event for a brief period. Chronic stress occurs over an extended period and is the primary contributing factor for occupational (or operational) stress injuries. The signs and symptoms of these injuries vary widely from person to person and may include anxiety, depression, and post-traumatic stress disorder, among others.[91] The stress management models employed across the fire service are intended to recognize and treat occupational stress injuries. Acute stress has a much more immediate impact and can result in the crippling of an individual's advanced mental faculties.[92] When an individual experiences an acutely stressful event, the body's sympathetic-adrenal-medullary (SAM) system is activated, releasing adrenaline and noradrenaline. The harmful effects of the SAM system are well documented, including perceptual narrowing, prolonged reaction times, focusing on fewer or inappropriate cues,

[90] Emily Martin, "Inverted U Theory," SanzuBusiness Training, September 26, 2019, https://sanzubusinesstraining.com/inverted-u-theory/.

[91] Jesmin Antony et al., "Interventions for the Prevention and Management of Occupational Stress Injury in First Responders: A Rapid Overview of Reviews," *Systematic Reviews* 9, no. 121 (2020): 2, https://doi.org/10.1186/s13643-020-01367-w.

[92] Amy Arnsten, Carolyn M. Mazure, and Rajita Sinha, "This Is Your Brain in Meltdown," *Scientific American* 306, no. 4 (April 2012): 1, https://doi.org/10.1038/scientificamerican0412-48.

impaired problem-solving, and degradation of psychomotor skills.[93] The consequences of perceptual narrowing can be fatal for a firefighter in a mayday situation. When perception narrows, tunnel vision and auditory exclusion occur.[94] This results in both a visual and an auditory focus on a threatening stressor, creating the possibility of missing other details. For example, a firefighter focusing on the sight or sound of an approaching fire may not see or hear other firefighters or see escape routes nearby. In a profession heavily reliant on RPD processes, the effects of excessive stress critically hamper an individual's ability to receive information and process what information they are receiving. The cognitive impairment resulting from extreme stress also slows the ability to retrieve information from memory.[95] RPD is based on rapid information retrieval from memory to apply to the current situation; if that process is delayed, the chance of survival decreases. Scanning experiences to match the current situation slows, increasing the likelihood that a similar but different experience is applied to the present event. This leads to poor decision-making resulting from the failure to recognize crucial differences.

The body's SAM response induces these cognitive and physiological changes as a means of survival. An individual's heart rate increases, respiratory rate increases, and blood pressure increases, all leading to enhanced physical performance, providing strength to fight or run. These physiological changes are stress responses commonly called "fight or flight."[96] New research proposes a third stress response dubbed the "freeze" response. In situations where fleeing and freezing are perceived as ineffective, an individual may freeze and take no action.[97] This response is often observed when individuals are confronted with intense fear or trauma, especially when there is no perceived opportunity for escape.[98] This

[93] Clements, "The Effect of Stress Inoculation," 5; Clifton, Matsangas, and Shattuck, *Assessment of Stress Inoculation Training*, 5.

[94] Junger, "The Effects of Hypervigilance on Decision-Making during Critical Incidents," 9.

[95] Junger, 39.

[96] Junger, 9.

[97] Junger, 10.

[98] Jami Deloe, "PTSD Recovery: Dealing with the Freeze Response," *Trauma! A PTSD Blog* (blog), February 26, 2016, 1, http://www.healthyplace.com/blogs/traumaptsdblog/2016/02/ptsd-recovery-dealing-with-the-freeze-response.

freezing is referred to as tonic immobility. Tonic immobility is involuntary and exhibits profound motor inhibition and unresponsiveness to stimuli.[99] Stress is most likely to have adverse effects, including tonic immobility, when it overwhelms the individual's ability to cope, induces isolation, or feels involuntary.[100] When firefighters face a situation of mortal peril for the first time without assistance or guidance, all three of these conditions are met and may result in a fight, flight, or freeze response. With decreasing time before flashovers and structural collapses, time is critical, and even a brief episode of tonic immobility reduces the likelihood of surviving a Mayday event.

Law enforcement officers and firefighters have reported maladaptive functioning caused by acute stress in a variety of situations. Research shows acute, uncontrollable stress provokes the release of adrenaline and noradrenaline, resulting in diminished cognitive processes.[101] In effect, the influence of the prefrontal cortex is reduced, and the more primitive parts of the brain take over. In 2018, eighty officers involved in shooting incidents were interviewed. These officers reported increased heart rates, tunnel vision, temporal distortions, and other physiological and psychological effects.[102] The perceptual narrowing and time distortions reduce the effectiveness of cognitive functioning in use-of-force situations. A similar study conducted scenario-based training with ninety-one police recruits where rapid decisions needed to be made regarding the use of force. All participants reported cognitive impairments during the scenarios.[103] Astronauts experiencing hazardous spaceflight emergencies in training experienced distress, resulting in decreased situational awareness and reduced operational performance when the

[99] Carlos Eduardo Norte et al., "Tonic Immobility in PTSD: Exacerbation of Emotional Cardiac Defense Response," *Frontiers in Psychology* 10, no. 1213 (May 2019): 1, https://doi.org/10.3389/fpsyg.2019.01213.

[100] Deppa and Saltzberg, *Resilience Training for Firefighters*, 40.

[101] Arnsten, Mazure, and Sinha, "This Is Your Brain in Meltdown," 2.

[102] Arnsten, Mazure, and Sinha, 2.

[103] Bowen, "An Exploratory Case Study," 81.

environmental stressors exceeded their mental capacity.[104] This research supports the ability to induce cognitive impairments similar to actual critical incidents by introducing stressors in a training environment.

Although the impacts of acute stress are well documented, the impact of training and an individual's ability to perform under stress is less thoroughly studied. A review of performance under stress found individuals performing well-rehearsed tasks experienced less cognitive impairment when compared to individuals performing novel tasks.[105] Training with astronauts supports this same conclusion and shows overall stability can be maintained when confronted with varying stressors following graduated stress exposure during training.[106] This allostatic state resulted from repetitive rehearsal of the same task; however, the performance improvements did not transfer to new scenarios. Repetitive training may set firefighters up for failure when faced with novel stressors in the real world. It is imperative to expose firefighters to various scenarios so they learn to respond effectively when faced with stress and not just perform a muscle-memory-based response inappropriate for the situation they are facing.

3. Measures of Stress

As discussed above, stress reactions produce a range of physiological responses, including the production of adrenaline and noradrenaline, increased heart rate, increased respiratory rate, and increased blood pressure.[107] These physical responses can be monitored and measured while an individual experiences a stressful event. Studies during astronaut training show heart rate is a strong indicator of the physiological stress response

104 Tor Finseth et al., "Designing Training Scenarios for Stressful Spaceflight Emergency Procedures," in *2020 AIAA/IEEE 39th Digital Avionics Systems Conference (DASC)* (2020 AIAA/IEEE 39th Digital Avionics Systems Conference (DASC), Piscataway, NJ, 2020), 1, https://doi.org/10.1109/DASC50938.2020.9256403.

105 Junger, "The Effects of Hypervigilance on Decision-Making during Critical Incidents," 12.

106 Finseth et al., "Evaluating the Effectiveness of Graduated Stress Exposure in Virtual Spaceflight Hazard Training," 248–49.

107 Arnsten, Mazure, and Sinha, "This Is Your Brain in Meltdown," 2; Clements, "The Effect of Stress Inoculation," 5.

and can be easily monitored.[108] Furthermore, moderate increases in heart rate compared to extreme increases indicate adaptation to stress exposures in training for ship navigators.[109] This research suggests heart rates increase as stress levels continue to increase and can indicate the level of perceived stress.

B. STRESS AND EMERGENCY MANAGEMENT

1. Stress in the Fire Service

Firefighting is a stressful profession. As first responders, firefighters' regular duties include responding to fire-related deaths and injuries, vehicle accidents, natural disasters, terrorist attacks, child abuse, murders, suicides, and other similar horrific events.[110] These events invoke physical dangers and psychological stresses uncommon in most occupations. In 2015, the career information site CareerCast ranked firefighting as the most stressful profession in the U.S., followed by enlisted military personnel.[111] The military environment and a fire scene share many similar operational stressors. These include extreme temperatures, fatigue, uncertainty, lack of control, time pressure, heavy task loading, task complexity, information overloading, and threats to the individual's physical safety.[112] These operational conditions require rapidly predicting complex phenomena in high-risk situations with limited information while facing potentially fatal consequences. This is typical of high-reliability occupations and is associated with experiencing acute stress.[113] Other professions responding to life-threatening emergencies daily include police officers and emergency medical services (EMS) providers. All of these professions experience similar levels of stress and are subject to adverse effects of acute stress. Paramedics exposed to acute stress during a patient care scenario exhibited anxiety, impaired clinical performance, and the physiological stress responses discussed

[108] Finseth et al., "Manipulating Stress Responses during Spaceflight Training," 17.

[109] Neill, "Effects of Stress Inoculation Training," 12.

[110] Deppa and Saltzberg, *Resilience Training for Firefighters*, 4.

[111] Deppa and Saltzberg, 3.

[112] Clifton, Matsangas, and Shattuck, *Assessment of Stress Inoculation Training*, 1.

[113] Baumann, Gohm, and Bonner, "Phased Training for High-Reliability Occupations," 548; Finseth et al., "Manipulating Stress Responses during Spaceflight Training," 10.

previously.[114] Stress management research and training to manage stress utilized in these professions may be applicable to improving performance in the fire service.

2. Research on Stress in Emergency Management

Stress-related research, mainly focusing on post-traumatic stress disorder, has traditionally focused on military personnel. This is due in large part to the high rates of PTSD experienced by the military.[115] Recent research has expanded to include some first responder populations, including EMS providers and police officers. This research remained primarily focused on PTSD, and little attention has been paid to firefighters by the scientific community.[116] Some studies show promising results in preventing stress reactions in police officers, yet none of the eight studies reviewed by Antony in 2020 involving firefighters involved preventive stress training – all were rehabilitative approaches to stress treatment.[117] Other professions take a more proactive approach to training employees to manage stressful situations by incorporating Stress Exposure Training (SET) and Stress Inoculation Training (SIT). Airline pilot and astronaut training scenarios utilize SIT concepts when training for emergency procedures in simulators, and law enforcement academies utilize "shoot / no shoot" exercises to prepare officers to make split-second decisions in stressful scenarios.

C. STRESS IN OTHER PROFESSIONS: MANAGEMENT AND PREVENTION

1. Stress Inoculation in Other Professions

Stress Exposure Training (SET) involves the introduction of a stressor event in a controlled environment. The individual becomes desensitized to stress through repetition,

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[114] LeBlanc et al., "The Impact of Stress on Paramedic Performance," 372.

[115] Antony et al., "Interventions for the Prevention and Management," 2.

[116] Antony et al., 2; Emmanuel J. Finney et al., "Suicide Prevention in the Fire Service: The Houston Fire Department (HFD) Model," *Aggression and Violent Behavior* 21 (2015): 2, https://doi.org/10.1016/j.avb.2014.12.012.

[117] Antony et al., "Interventions for the Prevention and Management," 17; Ernesto Gomez, "Stress Inoculation Training for Law Enforcement Officers" (master's thesis, California State University Long Beach, 2019), 2, ProQuest (2384501135).

allowing for clear judgment and critical thinking during stressful situations. This practice started to be utilized in law enforcement training around 1980 based on research showing a reduction in the use-of-force incidents by officers desensitized to stress through training.[118] While law enforcement academies have to adhere to strict content in their curriculum, the method of delivery is open to interpretation and differs widely from one academy to another, including the incorporation of SET in their training programs.[119] This is very similar to the differences seen in fire service training programs – although many are designed to meet the NFPA 1001 recommendations, actual program design and delivery vary from jurisdiction to jurisdiction. The variations in law enforcement academies provide inconsistency in SET programs and risk officers receiving training inadequate to provide the critical thinking skills necessary when facing stressful situations.[120] Research conducted on law enforcement personnel shows SET can help build cognitive processes, enabling police recruits to deal with stressors more effectively.[121] Similarly, studies of soldiers experiencing the stress of fearing for their own life during survival school showed lower rates of maladaptive functioning in Special Forces soldiers who are considered "stress hardy" by the U.S. Army.[122] Repeated exposure to stressors during their training regimen inoculated the Special Forces soldiers to the harmful effects of acute stress.

2. Stress Inoculation Training Techniques

SIT is a form of Cognitive Behavioral Training developed around 1980. One of the core concepts is "inoculation," or immunizing an individual against the effects of stress. By building an individual's coping skills with mild stressors, their confidence and ability to manage more significant stressors will be improved, with gradual exposure to increasing

118 Bowen, "An Exploratory Case Study," 3.

119 Miller, "Improving Resilience among Law Enforcement Officers," 5.

120 Bowen, "An Exploratory Case Study," 3.

121 Gomez, "Stress Inoculation Training for Law Enforcement Officers," 56.

122 Charles A. Morgan III et al., "Symptoms of Dissociation in Humans Experiencing Acute, Uncontrollable Stress: A Prospective Investigation," *American Journal of Psychiatry* 158, no. 8 (2001): 1245, https://doi.org/10.1176/ajp.158.8.1239.

stress leading to a sense of mastery.[123] Building coping skills is a core difference between SET and SIT. The SIT concept has shown success, including improved responses to acute stressors in professions such as surgery, police work, and combat.[124] SIT, as a holistic approach, consists of three phases. The first is an education phase where individuals learn about stress's physiological and psychological effects and how to mitigate these adverse effects. The second phase incorporates the practice of stress mitigation techniques in a controlled environment, and the final phase introduces stressors in a training environment.[125] The U.S. Army investigated the effectiveness of Mindfulness training as a protective measure against cognitive impairment. Soldiers in high-risk and high-stress roles underwent eight weeks of Mindfulness training. In contrast to a control group without training, those who received Mindfulness training exhibited enhanced working memory performance during high-stress training sessions.[126] This proves the potential of proactive stress management training to improve cognitive processes in a stress-inducing situation. It is essential to differentiate SIT from Stress Exposure Training (SET), which involves the introduction of stress in the training environment but does not include all three phases of SIT.

SET involves practicing skills while stress is gradually introduced and operational performance is evaluated. When evaluating spaceflight emergency procedures, prior exposure to stressors improved performance when participants faced new stressors and new tasks.[127] The introduced stressors included virtual reality simulations of smoke and fire. An analysis by the U.S. Navy following major accidents at sea found that "the surface force does not have adequate training on human performance factors including fatigue, diet, and stress management."[128] Research into ways to induce stress during ship navigation involved using

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123 Donald Meichenbaum, "Stress Inoculation Training," in *Cognitive Behavior Therapy: Applying Empirically Supported Techniques in Your Practice*, ed. William O'Donohue, Jane E. Fisher, and Steven C. Hayes (Hoboken, NJ: John Wiley & Sons, 2005), 409.

124 Meichenbaum, 407.

125 Clifton, Matsangas, and Shattuck, *Assessment of Stress Inoculation Training*, 6.

126 Kevin A. Butler and Frank G. Foss, "Resilience at the Tip of the Spear: Identifying the Mindfulness Prescription for Special Operations Forces" (master's thesis, Naval Postgraduate School, 2021), 6, https://hdl.handle.net/10945/68699.

127 Finseth et al., "Designing Training Scenarios," 146.

128 Clements, "The Effect of Stress Inoculation," 6.

a Cold Pressor Test (CPT) while subjects were evaluated in a bridge simulator. The study concluded CPT is highly effective in inducing stress in a laboratory setting.[129] While this test is practical in a ship simulator, it is impractical for firefighters in full Personal Protective Equipment (PPE) and Self-Contained Breathing Apparatus (SCBA).

Stress inducement is prevalent in the modern military and some first responder training academies. As new recruits enter basic training, stress is applied through yelling, physical exertion, and mental testing. Identifying individuals who will have trouble experiencing the pressures of a law enforcement career and "weeding" them out of the academy is seen as a primary goal of stress exposure by the recruit instructors.[130] As recruits progress through training, practical evolutions progressively apply stress through smoke, fire, simulated rescues, time pressure, and both practical and written examinations. All these elements are imposed to induce stress in recruits and mitigate real-world stress more efficiently.[131] Although these elements are common in many academies, the degree and timing of implementation vary widely, and very little empirical evidence exists to support the effectiveness of this approach. The U.S. Marine Corps found excessive stress training can induce PTSD before recruits ever encounter combat.[132] Incorporating stress management theories during worst-case scenario training (the first phase of SIT) is critical in teaching individuals how to function under stress and preparing them for the real-world environment.[133] Academies that induce stress as a "weeding out" tool set their people up for failure due to a lack of education and preparation before stress-induced training begins.

Introducing elevated levels of stress during SET can result in two adverse outcomes. The individual may experience sufficient levels of anxiety to impact performance during and after a training session negatively. Additionally, the stress experience may interfere with acquiring the desired learning outcome.[134] Friedland and Keinan recommend three

[129] Clements, 6.

[130] Bowen, "An Exploratory Case Study," 77–78.

[131] McClernon, "Stress Effects on Transfer from Virtual Environment," 2.

[132] McClernon, 2.

[133] Junger, "The Effects of Hypervigilance on Decision-Making during Critical Incidents," 60.

[134] McClernon, "Stress Effects on Transfer from Virtual Environment," 50.

approaches to successfully incorporate SET: (1) graduated-intensity training, (2) customized training, and (3) phased training.[135] Graduated-intensity training addresses the adverse effects of sudden exposure to stress in SET. This approach gradually increases the stress subjects are exposed to through a slow "inoculation"[136] process without hindering task acquisition. This process, however, produces low effectiveness when subjects encounter new tasks due to the reflexive responses generated by repeated exposure to scenarios while increasing the stress intensity. Customized training entails adapting stress training to suit the unique needs of each individual. This approach depends on how each trainee perceives stressors and utilizes their resources, and it may not accurately reflect proficiency. On the other hand, phased training incorporates three components: acquiring skills, exposure to stress, and practicing under stressful conditions.[137] Friedland and Keinan's results show each element on its own offers a relatively poor outcome. Combining task acquisition and practice under stress, or all three elements, showed significantly better outcomes on a target detection transfer task.

3. Effectiveness

Law enforcement and military academies have incorporated SET or SIT for many years. A variety of stressors have been utilized, including amphetamines, cold, electrical shock, heat, noise, fatigue, and time pressures.[138] In a study using electrical shock to induce stress on an individual faced with a shoot/no shoot scenario, participants in the high-stress group received a mild electrical shock. In contrast, participants in the low-stress group received a buzz. Initially, participants in the high-stress group showed less accuracy; however, their accuracy improved more significantly over time than the low-stress group.[139] This shows individuals who train under induced stress can adapt to the stress and negate the impacts of the stressor. Additional research on police officers found the more realistic the training, the

[135] McClernon, 50.

[136] Friedland and Keinan use inoculation to describe the building of tolerance to gradually increasing stress, not to be confused with the Stress Inoculation Process of creating coping skills for managing stress.

[137] Nehemia Friedland and Giora Keinan, "Training Effective Performance in Stressful Situations: Three Approaches and Implications for Combat Training," *Military Psychology* 4, no. 3 (1992): 159, https://doi.org/10.1207/s15327876mp0403_3.

[138] McClernon, "Stress Effects on Transfer from Virtual Environment," 65–66.

[139] Bowen, "An Exploratory Case Study," 80–81.

closer the heart rate was to an actual use-of-force event.[140] This reinforces the concept of training in high-stress scenarios closely mimicking the stress levels felt during actual operational events.

In the study of ship navigators using the Cold Pressor Test (CPT) as the stressor, the stress-trained group's performance increased by 52%, while the control group increased by only 38%.[141] While this difference was not statistically significant, this does suggest training under stress improves performance under stress. Additionally, the median heart rate increase of the control group was 18% when faced with the criterion test. The stress-trained group only increased by 5%, suggesting stress training decreased physiological stress as well as performance.[142] The CPT is effective as a means of inducing stress, and stress-exposed individuals perform better when faced with a subsequent stressful task.

Adaptive stress training was used in astronaut training to improve performance during emergency events. When faced with a heavy smoke condition, individuals exposed to stress training retained control, while the group without exposure showed signs of a fight or flight response.[143] This shows adaptive systems can be useful for training for emergency situations and may be applicable to other high-reliability occupations such as law enforcement, firefighters, and other first responders.

When evaluating law enforcement training, officers who receive training by repetition alone show signs of poor decision-making when encountering stressful situations in the operational environment. Pure repetition leads to recognition-primed responses without an officer fully understanding the nuances of their current situation.[144] The ability to navigate the same scenario multiple times leads to a sense of overconfidence in their abilities, and these individuals exhibit hypervigilance and an inability to think analytically.[145] Functional

[140] Bowen, 182.

[141] Clements, "The Effect of Stress Inoculation," 43.

[142] Clements, 44.

[143] Finseth et al., "Evaluating the Effectiveness of Graduated Stress Exposure in Virtual Spaceflight Hazard Training," 248.

[144] Junger, "The Effects of Hypervigilance on Decision-Making during Critical Incidents," 54.

[145] Junger, 53.

training in high-stress environments is critical to prevent reactionary behavior without cognitive processing.

The research from Friedland and Keinan provides a path for the development of stress training. Phased approaches to stress training are both effective and efficient. The division of stress exposure and skill acquisition is insufficient for tasks where both factors will be encountered. A training plan incorporating task acquisition during stress exposure is essential for the knowledge, skills, and abilities to transfer to a stressful task not encountered in the training environment.[146] Their results indicate stress training works immediately and will transfer to other, similar tasks.

D. HYPOTHESIS

Based on the literature reviewed, the following hypotheses were predicted for the current study:

H1: Trainee firefighters will perform less effectively when required to complete a complex Mayday training scenario while experiencing tactical silence as a stress compared to those coached or guided by their instructors.

H2: Trainee firefighters will have higher average heart rates when required to complete a complex Mayday training scenario while experiencing tactical silence as a stress compared to those coached or guided by their instructors.

H3: Both groups will demonstrate improvement on a second attempt at a similar yet different task while experiencing tactical silence.

H4: Trainee firefighters will show a higher level of improvement on the second task if they experienced silence previously compared to those who received coaching or guidance on their first task.

[146] McClernon, "Stress Effects on Transfer from Virtual Environment," 137.

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III. RESEARCH DESIGN

A. EXPERIMENTAL DESIGN

This experiment used tactical silence to induce stress in participants navigating an obstacle course comprised of elements previously taught in the recruit training program. The elements used mimic real-world scenarios to the safest extent possible, reinforcing the understanding of dangerous situations firefighters may encounter in the operational environment. In real-world operations, firefighters may become separated from their crew and have no immediate support from another individual in their vicinity. Silence is a realistic stress element that could occur in the operational environment, as recommended by Finseth when developing training for astronauts.[147]

Under current training models, recruits are constantly challenged with new tasks to learn and obstacles to overcome, yet they never face the self-analysis of demands and resources described in the Lazarus appraisal state. Specifically, the recruit never has to determine if they personally have the resources to meet the challenge, as they can always rely on an instructor to guide or help them with the challenge they are facing. Consequently, they may never be pushed to the *threat* state and experience the fight, flight, or freeze response until they are in the operational environment and their life is truly endangered. As discussed previously, approximately one-half of successful rescues in a Mayday situation are accomplished by the endangered firefighter – the possession of internal resources to meet the demands of the environment is critical to survival.

The independent variable for this experiment was the use of silence from the instructional staff. The dependent variables were the time to complete the obstacle course and the stress induced on the participant, as shown by the average heart rate. Both the control group and the experimental group navigated the course twice. The control group was coached during their first trial and received no coaching on their second trial. The experimental group received no coaching on either attempt. The course was rearranged between the two attempts to avoid learning the course.

147 Finseth et al., "Designing Training Scenarios," 2.

B. PARTICIPANTS

Study participants were Recruit Firefighters enrolled in the recruit training program for the Anne Arundel County Fire Department in Millersville, Maryland. The recruit class included 63 members, randomly divided into three platoons prior to the start of the academy for scheduling purposes. Training delivered during the Recruit Academy followed the Maryland Fire and Rescue Institute (MFRI) curriculum, and individual class sizes were limited according to the criteria established by MFRI. All recruits successfully completed the following MFRI courses prior to participation in the study: Protective Envelope and SCBA (PEAS), Firefighter I, Firefighter II, Rescue Technician: Site Operations, and Firefighter Survival and Rescue. One platoon was excluded from the study due to scheduling differences (Firefighter Survival and Rescue was delivered prior to Firefighter II). Although Firefighter II is not a pre-requisite for Firefighter Survival and Rescue, the recruits in the excluded platoon did not have as many opportunities to operate in full personal protective equipment (PPE) and self-contained breathing apparatus (SCBA) as the recruits who completed the Firefighter II course. The recruits received forty-five hours of hands-on training dedicated to PPE and SCBA during their training. Additional time was spent in PPE and SCBA during other training such as practical ladder, hose, and search and rescue evolutions. Twenty-one hours were dedicated to search and rescue practical operations, including techniques to navigate a structure when dark/smoky conditions impair vision. The recruits also spent thirty-six hours in live fire training evolutions. The Firefighter Survival and Rescue (FSR) course provided an additional twenty-four hours of practical evolution focused on firefighter rescue, both self-rescue and the rescue of other firefighters who are injured or otherwise incapacitated. The evolutions in FSR emphasize self-rescue during Mayday situations, including disentanglement, wall breaching, low-profile movement, air management, following a hoseline, and navigating in a constricted area.

After completing the FSR course, the eligible recruits were provided a Consent to Participate in Research Form, which reviewed information about the study and expectations of participants. All individuals were required to provide written informed consent following the study protocol approved by the Naval Postgraduate School Institutional Review Board. One recruit did not return a form and was not included in the study. Eleven recruits consented

to participate in the research study (N=11). The platoon with six recruit volunteers was randomly assigned to the experimental condition by coin toss; this left the platoon with five recruit volunteers assigned as the control group.

C. EQUIPMENT AND INSTRUMENTS

During the Combined Skills Evolution, recruits were equipped with full structural firefighting PPE, including boots, pants, coat, hood, and gloves; all items were rated for structural firefighting in compliance with the applicable NFPA standards. Additionally, all participants were equipped with a Mine Safety Appliances (MSA) G1 SCBA, including a facepiece, harness, and 45-minute cylinder with sixty-five cubic feet of air capacity. Heart rate monitoring was conducted using Polar H10 wireless heart rate sensors connected via Bluetooth to an iPad carried by an instructor. Sampling of heart rate was conducted at one-second intervals. Each iPad was equipped with a stopwatch application, enabling the instructor to track the overall evolution time for each recruit. Before starting the course, each recruit facepiece was fitted with a Smoked Out Series face shield from BA Shields to simulate an environment where visibility is obscured by smoke without complete visual obscuration. An example of the face shield can be seen in Figure 2.

Figure 2. Smoked Out Series face shield used to obscure vision.

D. PROCEDURES

Various props used during the Firefighter Survival and Rescue course were arranged sequentially in the burn building to conduct the Combined Skills Evolution obstacle course.[148] All participants previously navigated each of these individual obstacles during their training but have not been presented with multiple obstacles in a back-to-back scenario. Other than the window used for ingress, all windows were covered and secured with plywood to prevent a participant from opening a window and potentially falling out of the building. Pallets, plywood, and other materials were used to create a path for navigation through the building and provide debris participants needed to navigate through, around, over, or under. At approximately the midpoint of the evolution, a nozzle and hoseline were laid on the floor. Recruits were previously taught to follow a hoseline out of a fire if they were disoriented. Although the racks used during live burns were utilized as obstacles during the Combined Skills Evolution, no live fires were ignited during this evolution.

Before commencing evolutions each day, instructors were briefed on the evolution and completed a walkthrough of the building. Each obstacle the recruits would encounter was discussed, along with potential hazards. Instructors were directed to stop the evolution for any recruit showing signs of severe exhaustion or an inability to continue the evolution. A pre-determined limit of forty minutes was also established to minimize the risk of fatigue-related injury. For the experimental group, the instructors were directed not to provide any feedback during the evolution unless the recruit performed an action that presented a high risk for injury. For the control group, the instructors were directed to provide coaching and guidance throughout the evolution, similar to training conducted in the Firefighter I/II and Firefighter Survival and Rescue courses. All instructors met (at a minimum) the *NFPA 1041: Standard for Fire and Emergency Services Instructor Professional Qualifications*, Chapter 5, and were certified as Maryland State Emergency Services Instructors by the Maryland Instructor Certification Review Board (MICRB).

[148] The "burn building" is a two-story concrete and masonry structure used for live fire training constructed in compliance with NFPA 1402: Standard on Facilities for Fire Training and Associated Props.

Instructors were directed to follow recruits through the course to monitor performance and safety.

All recruits participating in the Combined Skills Evolution were briefed before the start of the practical evolutions. After the briefing, recruits were assigned a random order to complete the evolution. Individuals participating in the study were each provided a chest strap to apply underneath their shirts. Before donning their turnout gear, a Polar H10 sensor was provided to each participant and attached to the chest strap. Recruits then donned their PPE and SCBA (without connecting to the air supply in the SCBA cylinder) in a staging area. Recruits entered the Combined Skills Evolution in a one-at-a-time manner, with approximately 15 minutes between each recruit. Immediately prior to entry, Participants were led from the staging area to the start of the evolution, a Smoked Out Series face shield was applied, and the recruit connected their mask-mounted-regulator to their facepiece, initiating the air flow from the SCBA cylinder. SCBA cylinders were preset at 3000 psi, providing approximately 30 minutes of air supply. This was done to induce a low air situation during the evolution to evaluate recruit responses to low air / running out of air.

At any point during the evolution, if a participant activated the emergency button on their radio or declared a Mayday, the lead instructor answered the radio with standard radio traffic defined in Section 8 of the AACOFD – AFD Combined Operations Manual: "Command to all units; a MAYDAY has been declared on the fireground, all units must maintain radio silence unless you have a life saving message."[149] This was followed by a transmission stating, "RIT has been deployed; continue efforts to extricate yourself until RIT arrives."[150]

Participants were led to a ladder and told they were separated from their crew and needed to find their way out of the structure. The ladder was approximately four feet long and entered a window of the burn building. The recruits then moved forward along a

[149] Anne Arundel County Fire Department, *Anne Arundel County Fire Department – Annapolis City Fire Department Combined Operations Manual*, Section 8: Rapid Intervention/Mayday, internal document (Millersville, MD: Anne Arundel County Fire Department, 05/06/2022).

[150] Rapid Intervention Team (RIT) is a crew assigned to an emergency incident to affect the rescue of a firefighter who becomes lost, trapped, disoriented, or otherwise unable to exit a structure without assistance.

constructed platform until a tipping point was reached, and the platform tipped downward to simulate a floor collapse. The area underneath the recruit was filled with six-inch square foam blocks to cushion their fall. The floor collapse prop is shown in Figure 3.

Figure 3. Floor collapse prop

Following the floor collapse, recruits navigated into the hallway of the burn building. The door was partially closed, forcing them to navigate through two narrowed passageways (approximately twenty-four inches wide) with inclined floors. A sample of these narrowed passages is shown in Figure 4.

Figure 4. Narrowed passageway

After navigating the previous two narrow passageways, the recruits encountered a third narrow passage, including numerous wires and cords that presented an entanglement hazard. This prop is shown in Figure 5 and was intended to simulate the collapse of a drop ceiling and the entanglement hazard presented by the metal ceiling tile grid.

Figure 5. Entanglement prop

Following the entanglement prop, the participants began ascending the stairs to the second floor of the burn building. While climbing the stairs, a snare was placed over the top of the SCBA cylinder. The snare was removed if the recruit declared a Mayday over the radio. Some also used a pair of cable cutters (provided before the evolution) to cut the wire and free themselves. The snare is shown in Figure 6.

Figure 6. Snare

At the top of the stairs, recruits were presented with a constricted tunnel, which they had to navigate. The pallet shown in Figure 7 was held in place above the tunnel when the recruits made entry but was moved out of the way to allow for the instructors' freedom of movement when necessary. At the tunnel's exit, a nozzle and hoseline were prepositioned and could be followed throughout the second floor as the participant navigated this section of the course. Shortly after exiting the tunnel, the participant crawled over an elevated platform (following the hoseline). The exit is shown in Figure 8.

Figure 7. Tunnel entry

Figure 8. Tunnel exit

As the recruits navigated the second-floor hallway following the hoseline, two instructors held a section of chain link fence that was unfolded and draped on top of the recruit to simulate a ceiling collapse. The section of fence is shown in Figure 9. The

instructors stood on the attached two-by-four boards to simulate the weight of the ceiling until the recruit declared a Mayday and reported the ceiling collapse. Once the Mayday was declared, the instructors stepped off the two-by-fours, allowing the recruit to crawl out from under the section of fence and continue navigating through the course.

Figure 9. Ceiling collapse prop

The next room encountered during the course had debris made from pallets and pine excelsior[151] for the recruits to crawl over and around. A metal rack with a pallet on top of it blocked the exit to the room. The participants needed to reconfigure their SCBA

[151] Pine excelsior is fine, curled wood shavings commonly used for packing fragile items in shipping crates but is also an accepted fuel for live fire training under NFPA 1403: Standard on Live Fire Training Evolutions.

into a low-profile configuration to pass under the rack and exit the room. The rack/pallet configuration is shown in Figure 10.

Figure 10. Low clearance prop

Once they crawled underneath the rack, the participants re-donned their SCBA and continued navigating the second floor. There were two additional rooms with excelsior, pallets, debris, and a metal rack to crawl over. Figure 11 shows one of these rooms. The hoseline continued through both of these rooms into the final room.

Figure 11. Pallet debris with hoseline

As recruits entered the final room of the course, the instructors closed the door behind them, confining them to the room. The end of the hoseline was cut, ensuring the recruit must find egress without simply continuing to follow the hoseline. A wood stud wall was constructed in one doorway, matching typical residential framing standards (joists were sixteen inches on center) with a sheet of drywall inserted in the wall, as shown in Figure 12.

Figure 12. Wall breach prop

After the recruit breached the wall, they located another door on their right-hand side. As they pushed on this door, an instructor assisted with opening it, ending the evolution. The instructors assisted the recruit with doffing their gear and escorted them to the established rehab area to rest and rehydrate.

Both experimental and control groups navigated the Combined Skills Evolution in this configuration. Before the second trial, the evolution was reconfigured to negate any learned response from the order or arrangement of props during the first attempt. The same props were utilized, but their locations were moved within the building, and the recruits started on the second floor and navigated their way down to the first (opposite of the first attempt). For the second trial, recruits encountered a section of missing floor, the low

clearance prop, ceiling collapse prop, snare, floor collapse prop, entanglement prop, and ended with the wall breach prop to exit the building. During the second attempt, no coaching or guidance was provided to any participant other than intervention if there was a significant risk of injury to the recruit.

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IV. RESULTS

Time to complete the course and heart rate were the dependent variables chosen to compare between the experimental and control groups.

A. TIME TO COMPLETE THE COURSE

During the first attempt at the course, the control group (N=5) completed the course in an average of 18.05 minutes (minimum 14.73 minutes, maximum 21.58 minutes). The experimental group (N=6) completed the course in an average of 26.03 minutes (minimum 18.37 minutes, maximum 38.32 minutes). The experimental group completed the course an average of 7 minutes, 59 seconds slower than the control group. During the second attempt at the course, the control group completed the course in an average of 16.33 minutes (minimum 11.58 minutes, maximum 20.60 minutes), while the experimental group completed the course in an average of 14.87 minutes (minimum 11.15 minutes, maximum 17.45 minutes). During this run, the experimental group completed the course an average of 1 minute, 28 seconds quicker than the control group. The average times to complete by group are shown in Table 1. The average group times, including minimum and maximum by attempt, are shown in Table 2.

Table 1. Average time to complete by group in minutes

Measure	Group	Attempt #1 Silent / Coached	Attempt #2 Silent	Difference
Time to complete (minutes)	Control	18.05	16.33	1.72
	Experimental	26.03	14.87	11.16
	Difference	-7.98	1.46	

Table 2. Time to complete by group in minutes

Group	Attempt	Average	Minimum	Maximum
Control	1 (coached)	18.05	14.73	21.58
Experimental	1 (silent)	26.03	18.37	38.32
Control	2 (silent)	16.33	11.58	20.60
Experimental	2 (silent)	14.87	11.15	17.45

Comparing the first attempt to the second attempt for each individual, all participants in the experimental group improved their times by an average of 11 minutes, 7 seconds (minimum 2:48, maximum 21:30). In comparison, the control group showed much less improvement in time to complete with an average improvement of 1 minute, 43 seconds (minimum -0:37, maximum 4:05). Notably, participant C1 took longer to complete the second trial than the first trial. Individual time to complete and time differences are shown in Table 3.

Table 3. Time to complete by individual in minutes

Group	Participant	Attempt #1	Attempt #2	Difference
Control	C1	14:44	15:21	-0:37
	C2	15:40	11:35	4:05
	C3	20:18	17:31	2:47
	C4	17:57	16:35	1:22
	C5	21:35	20:36	0:59
Experimental	E1	23:10	14:03	9:07
	E2	38:10	16:40	21:30
	E3	30:16	14:21	15:55
	E4	19:51	11:09	8:42
	E5	26:11	17:27	8:44
	E6	18:22	15:34	2:48

Statistical analysis of the results shows a significant difference in time to complete between the experimental group and the control group during the first attempt ($t(7) = 2.43$,

p = .023). During their second attempt at the course, there was no significant difference between the two groups (p = .21). This indicates a marked improvement in performance between the first and second runs for the experimental group. This difference was also significant (t(6) = 3.54, p = .006). The control group did not show a significant difference in performance between the first and second run (p = .20). Although the course was rearranged between the first and second run, the same skill elements were utilized, and it is notable that the experimental group showed a significant difference in times while the control group did not. The control group times averaged a 103-second difference, while the experimental group averaged a 668-second difference from the first run to the second run.

B. HEART RATE

During the first attempt at the course, the average heart rate of the control group was 157 beats per minute (minimum average 148, maximum average 166). The experimental group had an average heart rate of 165 beats per minute (minimum average 157, maximum average 171). Average heart rates by group are shown in Table 4. Peak heart rates reached 193 bpm in the control group and 192 bpm in the experimental group.

Table 4. Average heart rate by group

Measure	Group	Attempt 1 Silent / Coached	Attempt 2 Tactical Silence
Heart Rate (beats per minute)	Control	157	152
	Experimental	165	161

During the second attempt at the course, the control group's average heart rate was 152 pm with a minimum average of 144 bpm and a maximum average of 161 bpm. Peak heart rates reached 196 during the second evolution. The experimental group's average heart rate was 161 bpm, with a minimum average of 154 bpm and a maximum average of 173 bpm. Peak heart rates reached 190 during the second evolution. Individual heart rates

are shown in Table 5. Due to a loss of connectivity, heart rate data for participant E6[152] was not captured during the second attempt at the Combined Skills Evolution.

Table 5. Average heart rate by individual

Group	Participant	Attempt 1	Attempt 2
Control	C1	153	145
	C2	166	161
	C3	148	144
	C4	160	152
	C5	159	159
Experimental	E1	161	156
	E2	170	166
	E3	165	154
	E4	157	156
	E5	164	173
	E6	171	Not recorded[153]

Overall heart rates demonstrated similar trends between groups, decreasing an average of five beats per minute for the control group and four beats per minute for the experimental group. Similar patterns were also noted between the groups in the first and second trials. During the first trial, the experimental group's average heart rate was eight beats per minute higher than the control group. On the second trial, the average heart rate was nine beats per minute higher. Individual heart rate averages, minimums, and maximums are shown in Table 6.

[152] Experimental Group, Participant 6

[153] Heart rate data for this participant was not recorded due to a loss of Bluetooth connectivity.

Table 6. Heart rate average, minimum, and maximum by participant

	Attempt 1			Attempt 2		
Participant	**Min**	**Average**	**Max**	**Min**	**Average**	**Max**
C1	120	153	172	126	145	169
C2	125	166	181	134	161	172
C3	121	148	167	127	144	177
C4	127	160	182	124	152	178
C5	117	159	193	90	159	196
E1	127	161	181	136	156	171
E2	140	170	186	128	166	183
E3	128	165	182	128	154	177
E4	122	157	181	Not recorded		
E5	132	164	192	123	156	184
E6	126	171	192	88	173	190

Data sampling of heart rate was conducted once per second. As the recruits navigated the course, the construction features of the building occasionally interfered with the Bluetooth connection between the wearable monitor and the iPad. During the first attempt, an average of 1,400 data points were collected for each participant, with an average of twenty missed data points (1.44%). During the second attempt, an average of 1,008 data points were collected, with an average loss of thirty-six (3.57%) for each participant, not including the total data loss for participant E6. Although there was some data loss, the large sample volume supports the average heart rates shown in Table 4, Table 5, and Table 6.

Analysis of average heart rates between the two groups on the first run did not show a significant difference ($p = .10$). The second run showed an even lower correlation between the experimental group and the control group ($p = .27$). When examining differences between the first and second run for each group, neither group showed a significant difference (experimental $p = .17$, control $p = .33$). It is interesting to note the variance of heart rate on the second run for both groups was much higher than the first run as shown in Table 7. Mean and standard deviations for time to complete and heart rates are

shown in Table 8. There was also a decrease in average heart rate for the experimental group between the first and second run, while the control group showed an increase in average heart rate.

Table 7. Heart rate mean and variance by group and run

Group	Attempt	Mean	Variance
Experimental	1	53.67	51.87
	2	39.67	1,051.47
Control	1	44.4	163.3
	2	51.2	856.2

Table 8. Mean and standard deviation for time and heart rate by group

Group	Attempt	Time to Complete Mean (SD)	Heart Rate Mean (SD)
Experimental	1	1,560 (441.22)	53.67 (7.2021)
	2	892 (134.57)	39.67 (32.4264)
Control	1	1,083 (175.58)	44.40 (12.7789)
	2	980 (197.17)	51.20 (29.2609)

V. DISCUSSION

There is clear evidence of a significant shift in performance between the first and second attempts at the Combined Skills Course. During the first attempt, the group receiving no support took 44% longer to complete the course than the coached group. During the second attempt, this difference reversed, and the experimental group completed the course 10% faster than the group who were coached the first time. Had this been a true mayday during a live fire, the group with no support on the first attempt would have needed an additional eight minutes to escape the fire, more than sufficient time for a fire to reach flashover conditions, resulting in the firefighter's death. Performance on the second attempt was notably similar for both groups; however, there was no comparator group to compare both groups against to determine any actual performance improvement.

Heart rate as an indicator of stress did not differ substantially between the two groups or attempts. The average heart rate decreased by five beats per minute between the first and second attempts. This indicates that although stress experienced on the second run may be slightly lower, the level of physical exertion while navigating the course in full PPE and SCBA may elevate the individual's physiological functions to the point where it is difficult to determine the impact of psychological stress experienced by the participant.

A. RECOMMENDATIONS

1. Recommendations for Practice

This study strongly supports using a Combined Skills Evolution in firefighter training programs using silence as a mechanism for stress exposure training. While performance during the second attempt was markedly similar for the two groups, the difference in performance during the first attempt shows the need for firefighters to face situations in training where they receive little to no support from the instructional staff. Had these individuals faced this situation in an imminently dangerous environment, their chances of survival would have significantly decreased. Firefighters must recognize the challenges in their operational environment, recognize the stress induced by them, and continue to think critically when encountering high stress levels. Miller recommends similar training practices

for law enforcement officers, including recognizing physiological changes induced by stress and the effects of those changes.[154]

Currently, there are no national standards for firefighter training programs. In Maryland, the Firefighter I curriculum does not include many of the self-rescue obstacles presented as prerequisites or as part of the Combined Skills Evolution in this study. Completing the Firefighter I program is a widely recognized criterion for a firefighter to become an operational responder and participate in fire suppression activities, including interior structural firefighting. Without proper training in self-rescue, these individuals have minimal experience evaluating the fire scene before making tactical decisions and have no experience (classroom or real-world) with self-rescue. This may become a critical requirement without notice. The Firefighter Survival and Rescue program should be incorporated into the Firefighter I curriculum along with a practical evaluation where the students face a stressful situation with no support or guidance from an instructor.

Other professions, such as the airline and spaceflight industries, the military, and law enforcement, have recognized the benefits of Stress Exposure and Stress Inoculation Training programs. The inducement of stress through tactical silence provides similar opportunities for the fire service to improve the performance and survivability of firefighters.

2. Recommendations for Further Research

Further research in both Stress Exposure and Stress Inoculation techniques in the fire service is strongly recommended. This study utilized silence as a means of exposure to stress, but there may be other mechanisms to induce stress realistically. The inducement of stress in a controlled manner is challenging due to the nature of fighting activities and the mobility required to perform job tasks. Additionally, the physiological stress of wearing PPE and SCBA complicates the ability to measure psychological stress presented in the training environment. The use of Virtual Reality systems in firefighter training is just starting to be explored. The ability to present an individual with a life-threatening challenge in a controlled

[154] Miller, "Improving Resilience among Law Enforcement Officers," 85.

environment warrants evaluation as a potential tool to increase the variability of training opportunities as an alternative to pre-configured structures with limited potential for variation.

The results of this study may not be transferrable to the fire service at large. The candidates were volunteers from a single recruit class and represented a small portion of the overall class (16%). Additional research should be conducted with larger groups to evaluate further performance improvements realized by individuals completing tasks without instructional support. Although analysis of the heart rates did not show any significant differences, comparison of the experimental group to the control group on the first run may have indicated a significant difference with a larger sample size ($p = .10$). While instructor interaction with candidates during the silent portions of the study was extremely limited, there were instances where an instructor needed to stop an unsafe action. For example, one candidate attempted to pull the plywood covering off a window on the structure's second floor. The instructor stopped these actions by stating, "That's a dangerous area," but did not provide additional guidance. Although interaction was limited, the candidate would have recognized they were not truly alone and may not have experienced the same *threat/challenge* evaluation as other candidates who did not receive any interaction. This may be prevented by changing the means of securing the structure to prevent unsafe actions or obtaining a purpose-built prop for this type of training.

For this experiment, heart rate was used as the only measure of stress. Due to equipment limitations, baseline heart rates for each candidate were not gathered for analysis, limiting the comparison to the minimum and maximum heart rates recorded while performing the evolution. Future research should establish baseline heart rates for each candidate to accurately measure the overall increase in heart rate as a measure of stress in the training scenario. Additionally, other means of measuring stress should be explored as well. Although heart rate can be an effective indicator of stress, the physiological stress of the activity is sufficiently high to marginalize the heart rate changes induced through psychological stress. Other studies of stress in the military have combined physical stress elements interrupted by cognitive function evaluations, such as math problems. These evaluative measures should be explored as means to accurately determine cognitive functioning when a firefighter faces life-threatening challenges.

All the elements above are related to Stress Exposure Training or stress measurement. To profoundly affect the survivability of firefighters in a Mayday situation, Stress Inoculation Training, which is currently used in other professions, must be explored for adaptability to the fire service. This training should include stress recognition and management techniques introduced before stressors to increase cognitive functioning during stress exposure training.

B. SUMMARY AND CONCLUSION

Firefighters work in a dangerous and rapidly changing environment where poor decision-making can result in catastrophic consequences, including a firefighter fatality. Trends towards quicker, more cost-effective building construction have resulted in significantly faster fire growth, decreasing the time from ignition to flashover and structural collapse. The ever-increasing call volume reduces the time firefighters have available to train, limiting their experience to scenario variability. Firefighters operate in a time-compressed environment and are forced to make decisions rapidly with little information from the fire scene and limited expertise to support the Recognition-Primed Decision model. If a firefighter experiences a Mayday situation, there is little time to escape, and their greatest chance of survival is self-rescue. Training programs are responsible for preparing firefighters to face the overwhelming stress of a mayday situation so they can evaluate their situation and think critically to increase their chances of survival. When an individual's resources are insufficient to meet situational demands, they are more prone to experience a fight, flight or freeze response, decreasing their chances of survival. Current fire service training models utilize an instructor-guided approach through all training phases, creating unrealistic expectations of guidance and support when firefighters operate in a real-world environment. Trainees are not forced to evaluate their personal resources, as the instructors are always readily present, allowing the trainee to draw on the instructor's resources to meet the presented challenge. This study found significant differences in time to navigate an obstacle course when fire recruits were coached by their instructions compared to recruits who received no instructional support. To provide realistic training scenarios, future training programs should incorporate evolutions where trainees must function without instructor support and experience their own determination of ability for success.

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