

ORIGINAL RESEARCH

Resilience Training Program Reduces Physiological and Psychological Stress in Police Officers

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ABSTRACT

Research suggests that police work is among the most stressful occupations in the world and officers typically suffer a variety of physiological, psychological, and behavioral effects and symptoms. Officers operating under severe or chronic stress are likely to be at greater risk of error, accidents, and overreactions that can compromise their performance, jeopardize public safety, and pose significant liability costs to the organization. Therefore, this study explored the nature and degree of physiological activation typically experienced of officers on the job and the impact of the Coherence Advantage resilience and performance enhancement training on a group of police officers from Santa Clara County, California.

Areas assessed included vitality, emotional well-being, stress coping and interpersonal skills, work performance, workplace effectiveness and climate, family relationships, and physiological recalibration following acute stressors. Physiological measurements were obtained to determine the real-time cardiovascular

impact of acutely stressful situations encountered in highly realistic simulated police calls used in police training and to identify officers at increased risk of future health challenges.

The resilience-building training improved officers' capacity to recognize and self-regulate their responses to stressors in both work and personal contexts. Officers experienced reductions in stress, negative emotions, depression, and increased peacefulness and vitality as compared to a control group. Improvements in family relationships, more effective communication and cooperation within work teams, and enhanced work performance also were noted.

Heart rate and blood pressure measurements taken during simulated police call scenarios showed that acutely stressful circumstances typically encountered on the job result in a tremendous degree of physiological activation, from which it takes a considerable amount of time to recover.

Autonomic nervous system assessment based on heart rate variability analysis of 24-hour electro-

cardiogram (ECG) recordings revealed that 11% of the officers were at higher risk for sudden cardiac death and other serious health challenges. This is more than twice the percentage typically found in the general population and is consistent with epidemiological data indicating that police officers have more than twice the average incidence of cardiovascular-related disease.

The data suggest that training in resilience building and self-regulation skills could significantly benefit police organizations by improving judgment and decision making, decreasing the frequency of on-the-job driving accidents and the use of excessive force in high-stress situations. Potential outcomes include fewer citizens' complaints, fewer lawsuits, decreased organizational liabilities and increased community safety. Finally, this study highlights the value of 24-hour heart rate variability (HRV) analysis as a useful screening tool to identify officers who are at increased risk, so that efforts can be made to reverse or prevent the onset of disease in these individuals.

The research on policing suggests that it is in fact one of the most stressful occupations in the world.^{1,2} The operational duties of police work, by their nature, may at any time place officers in life-threatening situations, in which the decisions they make can truly mean the difference between life or death for both themselves and others. Many of these situations, such as major disasters, traffic or shooting incidents, may well come under the category of traumatic stress. In addition to the intensity of the acute stress experienced in the moment, the feelings that officers carry with them after such emotionally charged incidents represent a more enduring source of stress.^{3,4} Constant exposure to society's interpersonal violence, shift-work, negative or confrontational interactions with individuals, a sense of personal endanger-

ment, fear of revenge from criminals, and subservience to an ambivalent, watchful public produce emotional repercussions that can affect police officers on a chronic basis.^{2,4-10}

In addition to the operational stressors inherent in police work, studies have shown that factors related to organizational structure and climate can be an even greater source of stress for the police officer.^{2,10-13} Shift schedules that disrupt sleep patterns and social life, authoritarian management styles, poor interpersonal relationships with supervisors, interdepartmental politics, lack of adequate planning and resources, lack of promotion and transfer opportunities, excessive paperwork, lack of autonomy in performing duties and lack of recognition for work accomplishments are among the stressors faced by members of the police force.^{4,10,11,14-16}

Without effective self-regulation, the various acute and chronic stressors of police work impose a significant burden on physical and psychological health, leading to numerous adverse physiological, emotional and behavioral outcomes.^{2,4,6,9,14,16} Following acutely stressful incidents encountered in the line of duty, bodily systems must recover from an extreme degree of physiological arousal. Over time, repeated stress can lead to the chronic activation and dysregulation of the body's stress response systems, and the eventual depletion of autonomic nervous system reserves. Police officers have been shown to have higher blood pressure and stress hormone levels than clerical workers.^{16,17} In the long term, this physiological strain may have a significant harmful impact on health, leading to the high rates of stress-related illness known to exist in the police profession.^{2,4,16,18} Research has shown that police officers are over twice as likely as people in other occupations to develop cardiovascular disease.^{2,4,19} Police have also been found to die from cancer at a higher rate than the general population.²⁰

At the psychological level, the stress of police work may result in chronic negative emotions such as anger, anxiety, or depression, which can eventually lead to psychological burnout and emotional exhaustion.^{2,6,7,10,16,21} Posttraumatic stress disorder (PTSD) is also a severe consequence of exposure to extremely stressful incidents of violence or major disaster among police officers.^{2,22-24} The high rate of alcohol use among police is one reflection of unmanaged emotional stress.^{4,18,22,25,26} Other research has confirmed that the mortality rate from suicide is nearly 3 times higher in police than in other municipal employees.^{20,27} Finally, the repercussions of unmanaged stress in police clearly extends to officers' families, where it is reflected in poor relationships with spouses and children and the notably high rates of marital disruption and divorce known to exist within this profession.^{9,27-29}

The depleting physiological and psychological effects of stress may also cause work performance to deteriorate, leading to reduced efficiency and motivation in performing job duties, poor morale, excessive absenteeism, and premature retirement. One study conducted in the United Kingdom found that an average rate of 11 working days per officer was lost through absence due to sickness and that approximately 25% of these absences could be attributed specifically to stress.¹⁴ A recent study on sleep disorders with 4957 police officers in the United States and Canada found that 40.4% screened positive for some kind of sleep disorder, also resulting in increased rates of absenteeism and other daytime functional impairments.³⁰ For police forces, 26% of medical retirement is due to psychological ill health.³¹ The inability to effectively manage stress has its most dangerous consequences in the line of duty. Police work often places officers in situations where reaction speed, coordination, and the capacity to make rapid decisions and accurate judgments under pressure are critical, and mental and emo-

tional stress can significantly impair these abilities.^{27,32} In the extreme, stress can cause officers to lose balance and composure to the degree that they employ inappropriate or excessive force in dealing with subjects.^{30,33} Recent years have seen widely publicized incidents of police brutality and homicides committed by individual officers throughout the country. Errors made in the line of duty can have grievous consequences not only for the officers and the particular suspects they encounter, but also in the public's perception of an entire department and even the entire profession.²⁷ The consequences of poor stress management can include automobile accidents, injury, death, lawsuits, loss of credibility, and even city-wide riots in reaction to officer behavior in highly charged situations.

It has been argued that special consideration should be given to occupational stress among police forces, as its potential negative consequences affect society in more direct and critical ways than stress reactions in most other occupations.^{27,34,35} Police officers operating under severe or chronic stress may well be at greater risk of error and overreaction that can compromise their performance and public safety.³¹ However, the police force is perhaps one of the organizations within which the stress experienced by officers receives the least acknowledgment.²⁷ Some have suggested that law enforcement is a professional environment that encourages emotional detachment from others as well as disassociating from their own feelings.^{18,27,36,37} The unrealistic expectations imposed by this culture discourage officers from admitting to stress reactions and symptoms. Thus, while police receive ample training in the theoretical knowledge and technical skills required to perform their jobs and take effective action in an emergency situation, most receive little if any training in how to sustain their resilience and the self-regulation skills needed to help them prepare for and quickly regain psychological and physiological equilibrium after the sometimes intense challenges of their work. Similarly, they are generally not provided with tools to help them manage the thoughts and emotions they may process internally long after involvement in an incident. The unusually stringent demands for self-control and composure compounded by the unavailability of effective strategies for inner self-regulation become an added stressor in its own right for police.^{6,27,33}

It is clear that practical resilience building and stress management techniques are needed not only to help officers remain more balanced during and after the acute stressors of their jobs, but also to take action to better manage and seek real solutions to the chronic stressors related to organizational and family issues.^{27,31}

In this investigation, a sample of police officers underwent Coherence Advantage training, which includes information about what resilience is and a series of research-based self-regulation techniques developed by the Institute of HeartMath (IHM) to help officers sustain their resilience, reduce stress reactions, and enhance performance. The effects of this program on

both physiological and psychological recovery from acute stressors as well as chronic stressors were explored.

PURPOSE

The aim of the investigation was to: (1) determine the nature and degree of physiological activation produced by different stressful situations and activities likely to be encountered by officers in the line of duty as measured by heart rate variability and blood pressure changes during simulated scenarios used in police training; (2) identify officers at increased risk of cardiovascular disease by means of autonomic nervous system assessment; (3) provide training in practical resilience building and self-regulation techniques to a sample of officers and assess the impact of this training on physiological activation and recalibration following simulated police calls, physical health and vitality, well-being, work performance, work effectiveness and climate, and family relationships.

METHODS

Participants

A total of 65 participants (64 sworn police officers and 1 city manager) from 7 police agencies in Santa Clara County, California, were recruited for this study. The agencies represented were Campbell, Los Altos, Los Gatos, Milpitas, San Jose State University, Santa Clara, and Sunnyvale Public Safety. The participants were 55 males and 10 females, with a mean age of 39 years (age range: 24-55 years). The group was comprised of 43 patrol officers, 12 detectives, and 9 officers currently serving in administrative duties. Of the 64 sworn officers 16 had 1 to 5 years' experience, 20 had 6 to 15 years' experience, and 28 had 16 to 30 years' experience serving on the force. The average level of experience for the group was 14.4 years. Participants were randomly divided into an experimental group ($n = 29$) that was to receive the Coherence Advantage training and a waiting control group ($n = 36$) that received the training once the study was completed. Care was taken to ensure that there was an approximately equal distribution between the 2 groups of officers of different levels of experience, from different agencies and of both genders.

Study Design

This study took place over a 16-week period. Data collection occurred at 3 different time points: baseline (at the start of the study), at 5 weeks on the first scenario day (pre-training), and at 16 weeks on the second scenario day (post-training). Baseline physiological and psychological measurements were collected for all participants at the start of the study. Pre and post physiological and psychological measurements were collected for a subgroup of officers involved in the simulated police call scenario portion of the study at Moffett Airfield, Sunnyvale, on the days the scenarios were conducted. For those officers who were not involved in the scenarios, pre and post psychological measurements were col-

lected at the same time points at their respective agencies. Experimental group participants were trained in the HeartMath Coherence Advantage program at the Milpitas Police Department in 3 separate classroom sessions lasting 4 hours each spaced at approximately equal intervals over a period of 1 month. All of the experimental group officers had access to emWave desktop heart rhythm coherence training devices after the initial training. The first training session was conducted 3 weeks after the first scenario day, and the last training session was completed 4 weeks before the second scenario day. The waiting control group received the same training after the study was completed.

A subgroup of the officers (12 experimental group participants and 11 control group participants) participated in the scenario portion of the study. The simulated police call scenarios were conducted at Moffett Airfield, Sunnyvale, in conjunction with Sunnyvale Public Safety. A total of 3 different scenarios were conducted over the course of the study. Two of the simulations (a building search and a high-speed car pursuit) were run on the same day, 5 weeks after baseline measurements were taken and before the experimental group received the training, and 1 scenario (a domestic violence episode) was conducted 11 weeks later, after the training was completed. Physiological and psychological measurements were collected from the participating officers on the days of the scenarios. In addition, participants were asked to rate each simulation according to how stressful it was for them. Training officers from Sunnyvale Public Safety office completed an evaluation of the participants' performance in the scenarios.

The Scenarios

The scenario portion of the study was run by the Sunnyvale Public Safety office, which regularly puts its officers through this type of training at least once a year. The scenarios are designed to simulate as closely as possible real police calls that officers tend to encounter on the job. In the scenarios, the officers and trained role players carry specially designed firearms known as "simmunitions." These are the same firearms that officers use on the job but have been modified so that it is impossible for live rounds to fit in their chambers. They contain special paint cartridges instead of bullets.

The approximate duration of each simulation in this study was 5 to 10 minutes, and 3 to 5 trained role players were involved in each scenario. Before each scenario, officers went through a "staging" procedure in which they were briefed on the nature and known details of the suspected crime, as they would be in a real police call. Following each simulation, the officers went through an after-action debriefing in which they were asked a series of questions about the events that occurred during the scenario. Each scenario was observed by a researcher who recorded the timing of events and measured the officers' blood pressure immediately after the scenario ended. A brief description of each of the scenarios follows.

Building search. In this scenario, officers receive a call regarding a silent alarm at a warehouse. Officers are required to work with a back-up officer (a trained role player) to search the dimly lit facility for the suspect. When the suspect is spotted by the officer, he claims to be an employee and reaches inside his jacket for identification. In this scenario the suspect does not have a weapon and follows the officer's commands. The scenario ends when the officer brings the suspect under control by handcuffing him. This scenario was designed as a low-stress trial in which the officers can become familiar with the scenario protocols.

High-speed pursuit. In this scenario, officers engage in a high-speed car chase. The course was set up on a runway at Moffett Field and was designed to approximate a city area (ie, the street widths and corners were the same as in a typical city district). While driving, officers receive a radio call and are given specific information regarding the crime and suspect. While chasing the suspect's vehicle with siren on, officers are in continual communication over the radio with the dispatcher. The suspect (a trained role player) engages in various maneuvers, including jumping out of his car at one point and running toward the officer's vehicle while pointing a gun at the officer's car. The scenario ends when the suspect's car pulls over and the officer orders him to get out of his vehicle. In the debriefing session, officers are asked questions that require them to remember the information they were given by the dispatcher and to assess the safety of their driving during the scenario.

Domestic violence. In this scenario, officers receive a call regarding a disturbance at a domestic address. With a back-up officer (a trained role player) they are required to investigate. At the scene (a civilian household) officers encounter an injured woman who is crying continuously and holding a bloody towel to her head. When questioned, she claims she has fallen and hurt herself. Officers then encounter the suspect (the woman's husband), who has a weapon at his side that is not visible to the officer. As the suspect is being questioned by the officer, he pulls out his weapon in clear sight and points it at his wife. The suspect does not comply with the officer's commands to put down the weapon. After approximately 30 seconds, the suspect points the weapon at the officer and fires, if the officer does not shoot him first. If the officer fires first and hits the suspect, they complete the scenario by handcuffing him. If the officer is shot, the scenario ends at that point.

The Coherence Advantage Stress Resilience and Performance Enhancement Program

The goal of the Coherence Advantage program is to build and sustain the resilience of individual officers and diminish the symptoms of operational stress, thereby significantly reducing the development of more serious and long-lasting stress injuries. To be effective, this must be done in a manner that addresses such critical issues as leadership support and model-

ing, stigmatization, scalability, program sustainability, and needs of family members. The Coherence Advantage program provides self-regulation skills³⁸ that are practical, easy to learn and employ, self-empowering and adaptable to multiple situations, cost-effective, replicable, and that increase job performance and effectiveness and allow officers to more intelligently utilize and recoup their energy. When properly utilized, the self-regulation skills lead to a measurable shift in physiological functioning to an optimal state called physiological coherence.^{39,40}

We introduced the term *physiological coherence* to describe the degree of order, harmony, and stability in the various rhythmic activities within living systems over any given time period.⁴¹ This harmonious order signifies a coherent system whose efficient or optimal function is directly related to the ease and flow in life processes. By contrast, an erratic, discordant pattern of activity denotes an incoherent system whose function reflects stress and inefficient utilization of energy in life processes. Interestingly, we have found that positive emotions such as courage, integrity, appreciation, and compassion, as opposed to stressful emotions, such as anxiety, anger, and fear, are reflected in a heart rhythm pattern that is more coherent.⁴²⁻⁴⁴ There is abundant evidence that emotions alter the activity of the body's physiological systems, and that beyond their pleasant subjective feeling, heartfelt positive emotions and attitudes provide a number of benefits that enhance physiological, psychological, and social functioning.⁴⁵⁻⁴⁷

It is important to note that although changes in heart rate often co-vary with emotions, our research has found that it is the pattern of the heart's rhythm that is primarily reflective of stress and emotional states, especially emotions that do not lead to large autonomic nervous system (ANS) activations or withdrawals.^{39,41,48} These changes in rhythmic patterns are independent of heart rate; that is, one can have a coherent or incoherent pattern at higher or lower heart rates. Thus, it is the pattern of the rhythm (the ordering of changes in rate over time), rather than the rate (at any point in time) that is most directly related to emotional dynamics and physiological synchronization. Also, the coherent state is fundamentally different from a state of relaxation, which requires only a lowered heart rate and not necessarily a coherent rhythm.³⁹

Physiological coherence, also referred to as heart coherence or cardiac coherence, is a functional mode, measured by HRV analysis wherein a person's heart rhythm pattern becomes more ordered and sine wave-like, at a frequency of around 0.1 Hz (10-second rhythm).³⁹ The term *physiological coherence* embraces several related phenomena—auto-coherence, cross-coherence, synchronization, and resonance—all of which are associated with increased order, efficiency, and harmony in the functioning of the body's systems. When one is in a coherent state, it reflects increased synchronization and resonance in higher-level brain

systems and in the activity occurring in the 2 branches of the ANS (sympathetic and parasympathetic), as well as a shift in autonomic balance toward increased parasympathetic activity.

Psychologically, coherence reflects increased emotional and perceptual stability and alignment among the physical, cognitive, and emotional systems, which underlies the quality of many cognitive functions and thus optimal performance. Several studies have since indicated that heart rhythm coherence is indeed associated with significant improvements in cognitive performance.^{39,49,50} Significant outcomes have been observed in discrimination and reaction-time experiments and more complex domains of cognitive function, including memory and academic performance.^{39,51} Coherence and resilience are closely related as each has the quality of being both a process and an outcome as they rely on physiological and psychological processes that create resilient outcomes. In addition, both are states rather than traits that vary over time as demands, circumstances, and level of maturity change.⁵² In this program, the ability to build and sustain resilience is related to self-management and efficient utilization of energy resources across 4 domains: physical, emotional, mental, and spiritual (Figure 1). Physical resilience is basically reflected in physical flexibility, endurance, and strength, while emotional resilience is reflected in one's ability to self-regulate and the degree of emotional flexibility, positive outlook, and supportive relationships. Mental resilience is reflected in our ability to sustain focus, attention, and mental flexibility and to integrate multiple points of view. Spiritual resilience is typically associated with our commitment to core values, intuitions, and tolerance of others' values and beliefs.

By learning techniques that allow us to shift our physiology into a more coherent state, the increased

physiological efficiency and alignment of the mental and emotional systems accumulate resilience (energy) across all 4 energetic domains. Having a high level of resilience is important for not only recouping from challenging situations but for preventing unnecessary stress reactions (frustration, impatience, anxiety) that often lead to further energy and time waste and deplete our physical and psychological resources. For these reasons, we define resilience as the capacity to prepare for, recover from, and adapt to stress, adversity, trauma, or tragedy.

Heart Rhythm Coherence

HRV is widely considered a measure of neurocardiac function that reflects heart-brain interactions and ANS dynamics. All HRV measures are derived from the assessment of the naturally occurring changes in beat-to-beat heart rate. HRV is much more than an assessment of heart rate as it reflects the complex interactions of the heart with multiple body systems.³⁹ An optimal level of variability within an organism's regulatory systems is critical to the inherent flexibility and adaptability or resilience that epitomizes healthy coherent function and well-being. While too much instability is detrimental to efficient physiological functioning and energy utilization, too little variation indicates depletion or pathology.⁵³ The amount or range of overall HRV is related to age, with younger people having higher levels.⁵³ Low HRV is an independent predictor of future health problems, including all-cause mortality,⁵⁴ and it is associated with numerous medical conditions.⁵⁵⁻⁵⁹ HRV is also an important indicator of psychological resiliency and behavioral flexibility as well as the ability to effectively adapt to changing social or environmental demands.⁶⁰ In addition, resting levels of HRV are associated with individual differences in cognitive performance on tasks

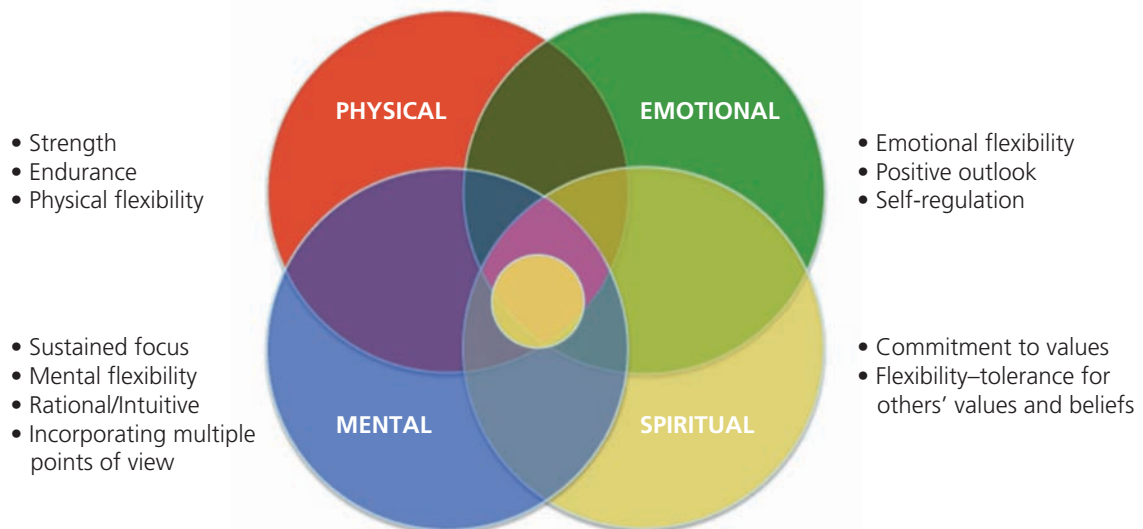


Figure 1 Dimensions of resilience.

requiring utilization of executive functions.⁶¹

Heart rhythm coherence is reflected in the HRV power spectrum as a large increase in power in the low frequency (LF) band (typically around 0.1 Hz) and a decrease in power in the very low frequency (VLF) and high frequency (HF) bands.^{39,48} A coherent heart rhythm can therefore be defined as a relatively harmonic (sine wave-like) signal with a very narrow, high-amplitude peak in the LF region of the HRV power spectrum with no major peaks in the VLF or HF regions.

Heart coherence is a highly efficient functional mode that is associated with efficient utilization of energy resources and numerous health-related benefits. These include (1) resetting of baroreceptor sensitivity, which is related to short-term blood pressure control and increased respiratory efficiency⁶²; (2) increased vagal afferent traffic, which is involved in the inhibition of pain signals and sympathetic outflow⁶³; (3) increased cardiac output in conjunction with increased efficiency in fluid exchange, filtration, and absorption between the capillaries and tissues⁶⁴; (4) increased ability of the cardiovascular system to adapt to circulatory requirements; (5) increased temporal synchronization of cells throughout the body⁶⁵; and (6) increased synchronization in the reciprocal activity of the branches of the ANS.³⁹ Thus, coherence results in increased system-wide energy efficiency and metabolic energy savings.⁶⁴⁻⁶⁶

Through the Coherence Advantage program, officers learn a set of skills that enable them to “Take Charge” and self-regulate their mental, emotional, and physical systems. The program utilizes a set of proven techniques (Heart Focused Breathing, Freeze Frame, Inner Ease, Prep, Shift and Reset, and Getting In Sync) and technology (emWave) for achieving coherence, the psychophysiological state of optimal performance. With practice, one is able to shift into a more coherent physiological state before, during, and after challenging or adverse situations, thus optimizing mental clarity and emotional stability. In such a state, officers are able to more quickly find their “center,” gain new perspectives, and counter ineffective and maladaptive thoughts, feelings, and behaviors. With practice, these skills and techniques can lead to profound short- and long-term changes in perception, physiology, mental clarity, and emotional balance. Practicing these “coherence-building” skills offers a wide range of benefits, including increased emotional awareness, resilience, vitality, overall well-being, cognitive flexibility, and enhanced problem-solving, as well as reducing depression, anxiety, and symptoms associated with more serious stress injuries.

The program is a classroom-based training designed to build and sustain the officers’ resilience to field related stressors and challenges. The program is intended to strengthen operational stress resiliency through research-based tools and techniques that provide an effective approach for countering such conditions as hyper-arousal, sleep disturbance, anxiety, anger, depression, and relational conflicts.

The stated objectives of the program are as follows.

1. Leverage your ability to think clearly under pressure and discern appropriate solutions to problems.
2. Increase your ability to maintain situational awareness.
3. Diminish symptoms of operational stress such as sleep disturbance and fatigue.
4. Improve reaction times and coordination.
5. Increase personal resilience and stress tolerance.

The use of interventions utilizing self-regulation techniques and HRV coherence feedback technology to reduce stress has significantly improved key markers of health and wellness. These include immune function,^{67,68} ANS function and balance,^{41,48} and reductions in stress hormones.⁶⁹ A study of California correctional officers with high workplace stress found reductions in total cholesterol, glucose, and both systolic and diastolic blood pressure (BP), as well as significant reductions in overall stress, anger, fatigue, and hostility to be associated with projected savings in annual health care costs of \$1179 per employee.⁷⁰ Another workplace study of employees with a clinical diagnosis of hypertension showed significant reductions in BP and a wide range of stress measures.⁷¹ A study conducted at Stanford University of patients with congestive heart failure showed significantly improved functional capacity and reduced depression,⁷² and a study of diabetes patients found improved overall quality of life and glycemic regulation, which correlated with use of the self-regulation techniques.⁷³

A number of significant outcomes were found in 2 recent workplace pilot studies of utility line workers and employees of an online travel company. These studies focused on reducing stress and metabolic syndrome risk factors with the self-regulation techniques combined with HRV coherence feedback. In both studies, there were significant reductions in Organizational Stress (life pressures, relational tensions, work-related stress), Emotional Stress (anxiety, depression, anger), and Stress Symptoms (fatigue, sleep headaches, etc) and significant increases in Emotional Vitality. Both studies also showed reductions in the number of participants who were classified as having metabolic syndrome. In the utility company cohort, total cholesterol and LDL cholesterol were significantly reduced, and the travel company cohort had significant reductions in both systolic and diastolic BP and triglycerides (manuscript in preparation). In a study undertaken with pastors from the Reformed Church of America who were spread across the United States, the HM techniques were taught by a certified personal resilience mentor in six phone sessions. Participants also used a handheld coherence feedback device (emWave) to support learning self-regulation techniques. In addition to a number of significant improvements in stress and well-being measures, an independent analysis of data revealed that the experimental group showed an overall decrease in healthcare costs of 3.8% (resulting in an

annual cost savings of \$585 per participant), while the control group had a 9% increase in healthcare costs. The largest reduction in costs was related to improvements in hypertension.⁷⁴

Heart Rate Variability Coherence Feedback

Learning the self-regulation skills can be facilitated with the use of heart rhythm coherence feedback monitors. A number of HRV coherence training systems are available and have been used increasingly in many healthcare, law enforcement, corporate, military, and educational settings. Officers were provided with emWave devices (HeartMath LLC, Boulder Creek, California), which use a pulse sensor as a noninvasive measurement of the beat-to-beat heart rate. The emWave monitors display the heart rhythm in real time and calculate the level of heart rhythm coherence achieved. HRV coherence feedback has been shown to significantly improve outcomes in populations with PTSD,^{75,76} depression,^{77,78} asthma,^{66,79,80} congestive heart failure,^{72,81} hypertension,⁷¹ anxiety, fibromyalgia,⁸² and insomnia.⁸³

MEASURES

Psychological Measures

Personal and Organizational Quality Assessment (POQA) survey. This 85-item, validated, and normed assessment provides a broad overview of the individual's emotional stressors and social attitudes, vitality and physical symptoms of stress, and measures of workplace effectiveness.⁸⁴ All participants in the study ($n = 65$) completed the POQA survey at 3 time points: baseline, pre-training (5 weeks after baseline) and post-training (16 weeks after baseline).

Program impact assessment. This semi-structured interview was administered by a clinical psychologist to the subgroup of experimental ($n = 12$) and control group ($n = 11$) participants who took part in the scenarios. The interview was conducted on the day of the final scenario, 4 weeks after the completion of the training program. This assessment was designed to determine the impact of the training on 4 major life areas: coping skills, family relationships, work performance, and interpersonal skills. Officers were asked to rate to what extent they noted an improvement over the previous 6 weeks in 32 specific aspects of psychosocial functioning pertaining to these major areas (eg, insight into my psychological well-being; ability to manage my moods; tendency to assert my opinions, feelings, and desires with family members; tendency to respond to those I am close to with empathy versus criticism; ability to adapt to changing work environments and schedules; ability to stay calm and clear when faced with the unknown; feeling accepted and supported by supervisors; extent to which I attempt to resolve work conflicts constructively) Those officers who had received the training were asked to rate to what extent they attributed observed changes to their integration of the techniques in their day-to-day lives.

In addition, they were asked to openly discuss changes that they attributed to having received the training in their ability to cope with emotional distress, in home life and relationships, in their work performance, and in their interpersonal relationships at work. The approximate duration of the interview was 10 to 15 minutes.

Scenario stress levels. Following each scenario, participating officers were asked to rate the intensity of the stress they felt during the simulation on a scale of 1 to 10 (10 = maximum stress). They were also asked to state what was the most stressful part of the scenario to them and why.

Physiological Measures

Heart rate variability. Participants' autonomic function was assessed by the analysis of HRV over a 24-hour period. The normal resting heart rate in healthy individuals varies dynamically from moment-to-moment. HRV, which was derived from the ECG, is a measure of these naturally occurring beat-to-beat changes in heart rate and is an important indicator of health and fitness. HRV is influenced by a variety of factors, including physical movement and sleep and mental activity and is particularly responsive to stress and changes in emotional state.⁸⁵ The analysis of HRV can provide important information relative to the function and balance of the autonomic nervous system, and decreased HRV is a powerful predictor of future heart disease, increased risk of sudden death and all-cause mortality.⁸⁶⁻⁹⁰ In this regard, HRV is becoming increasingly used as a noninvasive screening tool to identify at-risk individuals.⁹¹ In this study, HRV analysis was performed for 3 main purposes: (1) to compare average heart rate during the officers' daily activities vs during the intense stress of the scenarios; (2) to obtain a detailed, real-time record of the beat-to-beat changes in officers' heart rates as they occurred in response to different activities performed and emotions experienced during the scenarios; and (3) to analyze officers' autonomic nervous system function and health and determine if there were individuals in the group who were depleted and at higher risk of disease or premature mortality.

Analysis of HRV was performed from 24-hour ambulatory ECG (Holter) recordings on the subgroup of 27 officers. Three-channel Holter recorders (Del Mar Avionics, Irvine, California) were used for the data collection. Officers wore the recorders for 24 hours at 3 time points in the study (baseline, first scenario day/pre-training, and second scenario day/post-training). The recorders were connected when the officers arrived at the baseline data collection or scenario training site. At that time, participants were given a log in which they were asked to record the times of major activities in which they engaged and any significant changes in physical activity or emotional states they experienced throughout the day and night. During the scenarios, officers' activities were observed and logged by an experimenter. All analysis was carried out at the

HeartMath Research Center using DADiSP/32 digital signal processing software. Autonomic function was assessed in keeping with the International Task Force Report, which standardized the nomenclature, analysis methods, and definitions of the physiological and pathological correlates of HRV measures.⁸⁸

Blood pressure. Blood pressure was measured at baseline for all study participants, as well as before and immediately after each scenario. For the baseline and pre-scenario measures, 3 left-arm readings were obtained at intervals of 2 minutes apart and the average of the last 2 readings was used as the reported value. For the post-scenario measure, 1 reading was obtained as soon as the scenario ended.

Performance Measures

Scenario evaluations. Following each scenario, an evaluation of the participants' performance in the simulation was completed by the training officer. For all 3 scenarios, participants were rated on a 5-point scale ranging from "poor" to "excellent" in the following 4 general categories: ability to maintain focus during scenario, ability to make appropriate decisions, ability to communicate clearly during the after action de-briefing, and ability to regain composure/balance after the scenario. Additionally, for the high-speed pursuit scenario, officers answered a series of questions that assessed their ability to remember relevant information communicated to them by the dispatcher during the simulation and required them to self-assess their driving performance and safety. For the domestic violence scenario, participants were evaluated by the training officer using a 5-point scale ranging from "poor" to "excellent" in 9 additional categories pertaining specifically to that scenario. These were approach, contact/information collection, use of contact and cover officers, use of cover, use of triangulation, positioning of involved parties, appropriate escalation of force, appropriate weapons used, and arrest and control. The training officer also provided a written evaluation of each participant's performance for this scenario.

Scenario impact assessment. Following the domestic violence scenario, participants entered a brief semi-structured interview with an experimenter in which they were asked to self-assess changes in their performance in and responses to the scenarios that they had experienced over the course of the study. Areas covered included quality of job performance during the simulation, feeling centered throughout the simulation, concern about evaluations of those observing the simulation, quickness with which they felt they were returning to how they normally feel after the simulation, and quickness with which they felt they were returning to how they normally feel after the current simulation compared to the last one they encountered. Participants who had been trained in the Coherence Advantage program were asked to rate to what extent they attributed changes in these areas to their integration of the interventions. They also were

asked to openly comment on specific changes they were aware of in their response to the simulation that they attributed to having received the training. The interview lasted approximately 5 minutes.

RESULTS

Due to personal or work-related circumstances, 7 of the 65 original participants could not complete the study. Therefore, the final analysis was carried out on 59 participants: 28 experimental group participants and 31 control group participants. All of the officers involved in the scenario portion of the study completed the study.

Program Impact Assessment Results

Responses to the Program Impact Assessment interview were analyzed using *t*-tests for independent samples. Results indicated marked improvements in coping skills, family relationships, work performance, and interpersonal skills in the trained group as compared to the control group (Figure 2). At the end of the study period, in comparison to the control group, officers trained in the Coherence Advantage program reported significantly increased work performance (ability to adapt to changing work environments, ability to stay calm when faced with the unknown, feeling supported by supervisors, ability to resolve work conflicts) and were more likely to interact with their families with greater patience and understanding; they spent more time with those that they care about; and they were better able to stay calm when faced with the unknown in their jobs.

Participants' comments in the interviews indicated that using the HeartMath techniques gave them greater conscious awareness of their stress and emotions and a

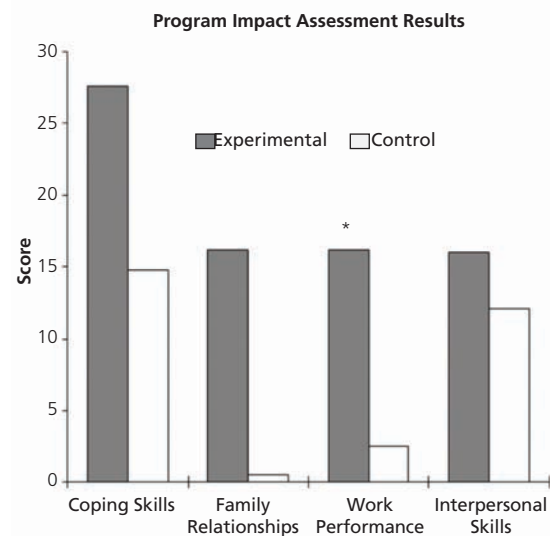


Figure 2 Program impact interview results. Coping skills, family relationships, work performance, and interpersonal skills were assessed by means of a semi-structured interview conducted 4 weeks after the completion of the Coherence Advantage program training. *Statistically significant: $P < .05$.

greater understanding that their own stress or well-being is truly a product of their perceptions. They also found they had a greater capacity to deal with stressful situations in a more balanced way rather than becoming overwhelmed by them. By using the self-regulation techniques, they were able to take a timeout to gain perspective on a problem or issue before reacting emotionally and to more easily make inner perceptual and attitudinal shifts. Many of the officers felt that these improved coping skills reduced their stress and increased the effectiveness with which they were able to perform their jobs. Trained participants also noted that using the techniques resulted in less competition and greater cooperation within their work teams, improved listening, and more effective communication among team members. These improved listening skills also extended to the officers' interactions with their families, enabling them to manifest greater care and compassion for their loved ones. One commuting officer commented that practicing the Freeze Frame technique in the car enabled him to arrive at work in a better frame of mind and shift to a more appropriate attitude before going home, which enabled him to spend quality time with his spouse. Overall, the trained officers indicated that the training benefited them most by increasing their ability to manage their moods (83%), improving their capacity to listen

patiently to family members and be more understanding of their concerns (75%), and enabling them to gain greater insight into their own psychological well-being (58%). The specific areas in which the training had the least impact were the ability to integrate intuition into actions at work (8%), the tendency to discuss personal life matters with co-workers (8%), and the tendency to discuss with coworkers emotionally difficult situations encountered on the job (17%).

Personal and Organizational Quality Assessment Results

Analysis of covariance (ANCOVA) was used to compare the responses to the Personal and Organizational Quality Assessment (POQA) survey for the 2 groups. Results reported in Table 1 and Figures 3 and 4 show that as compared to the control group, participants in the experimental group exhibited considerable reductions in distress ($P < .05$), negative emotions ($P < .05$), depression ($P < .01$) and marginally significant increases in peacefulness ($P < .56$), and vitality ($P < .56$) over the study period. The experimental group had a significant increase in reported rapid heartbeats ($P < .05$). Notably, distress was reduced by 20% in the trained officers, whereas it declined by only 1% in the control group. Depression declined by 13% among the trained officers while it increased by 17% in the control group

Table 1. Personal and Organizational Quality Survey Between Groups Comparison

	Experimental Group (N=28)		Control Group (N=31)		Mean Sq.	F	<i>p</i> <
	Adj Mean	SEM	Adj Mean	SEM			
Global Negative Emotion	1.71	0.09	2.03	0.09	1.40	5.72	0.05
Anger	2.10	0.12	2.24	0.11	0.30	0.81	ns
Distress	1.94	0.12	2.33	0.12	2.05	5.14	0.05
Depression	1.23	0.09	1.58	0.08	1.77	8.18	0.01
Sadness	1.63	0.12	1.90	0.12	1.10	2.58	ns
Fatigue	2.31	0.15	2.55	0.14	0.73	1.23	ns
Positive Emotion	4.26	0.09	4.15	0.09	0.18	0.79	ns
Peacefulness	4.11	0.12	3.78	0.12	1.59	3.81	= 0.056
Vitality	4.26	0.10	3.99	0.09	1.01	3.79	= 0.056
Social Support	4.29	0.10	4.11	0.10	0.46	1.52	ns
Mental Clarity	4.34	0.10	4.13	0.10	0.64	2.23	ns
Job Satisfaction	4.24	0.09	4.38	0.09	0.29	1.25	ns
Goal Clarity	4.11	0.10	4.16	0.09	0.04	0.16	ns
Productivity	4.33	0.09	4.45	0.08	0.19	0.96	ns
Communication Effectiveness	3.76	0.10	3.86	0.10	0.13	0.48	ns
Sleeplessness	1.96	0.16	2.20	0.15	0.82	1.23	ns
Anxiety	2.34	0.15	2.37	0.14	0.01	0.02	ns
Body Aches	2.31	0.17	2.30	0.16	0.00	0.00	ns
Indigestion	1.67	0.13	1.94	0.12	0.99	2.31	ns
Rapid Heartbeats	1.91	0.14	1.44	0.13	3.27	6.31	0.05

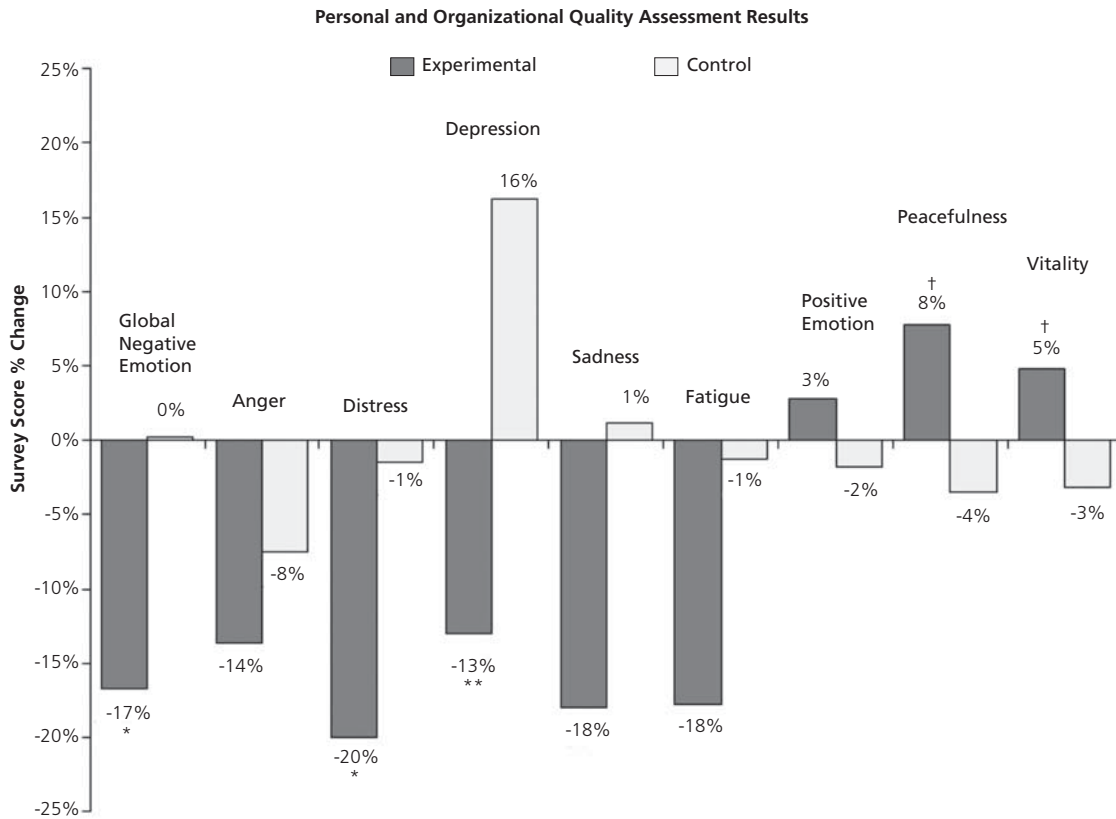


Figure 3 Improvements in stress and emotional well-being. Compares the differences between the average pre- and post-training scores for each variable measured by the POQA. As compared to the control group, participants trained in the Coherence Advantage program exhibited significant reductions in distress, depression, and global negative emotion and increases in peacefulness and vitality. The "global negative emotion" score is the overall average of the individual scores for the anger, distress, depression, and sadness constructs. Note that the control group experienced a marked rise in depression over the same time period. † $P < .1$, * $P < .05$, ** $P < .01$.

in the same time period. There was an 18% reduction in fatigue in the trained participants. Sleeplessness decreased by 17% in the trained group while it increased in the control group by 6%.

Scenario Stress Levels

On a 1-to-10 scale, the participants rated the domestic violence scenario as the most stressful (8.5), followed by the high-speed pursuit scenario (7.3) and finally the building search (6.2) as the least stressful of the scenarios. A single factor analysis of variance (ANOVA) with Bonferroni corrections for multiple comparisons found that the domestic violence scenario was significantly more stressful ($P < .001$) than the building search scenario.

Scenario Performance Evaluations

Figure 5 summarizes the average scenario evaluation rating results for experimental and control group participants in the 4 general areas that were evaluated for all 3 scenarios: ability to maintain focus during scenario, ability to make appropriate decisions, ability to communicate clearly during the de-briefing, and ability to regain composure/balance after the scenario. It is of note that the experimental group tended to score lower in these areas than the control group in the 2

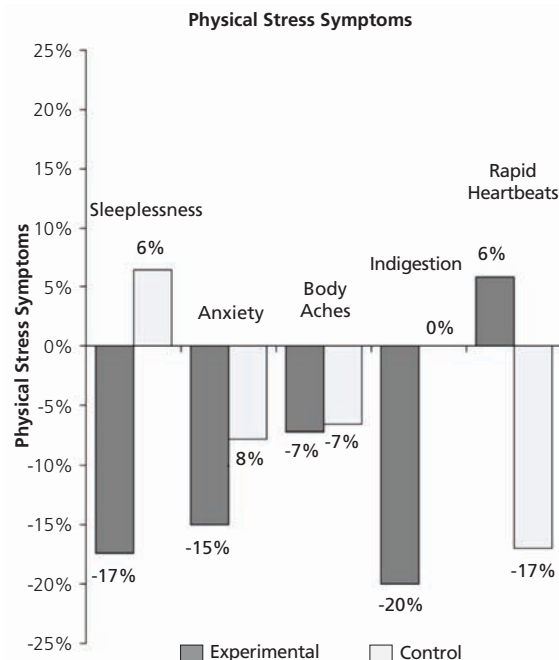


Figure 4 Changes in physical stress symptoms. Shows the changes in 5 physical symptoms of stress for all participants at the start of the study and 16 weeks later (4 weeks after the completion of the training).

General scenario evaluation results: Group Comparison

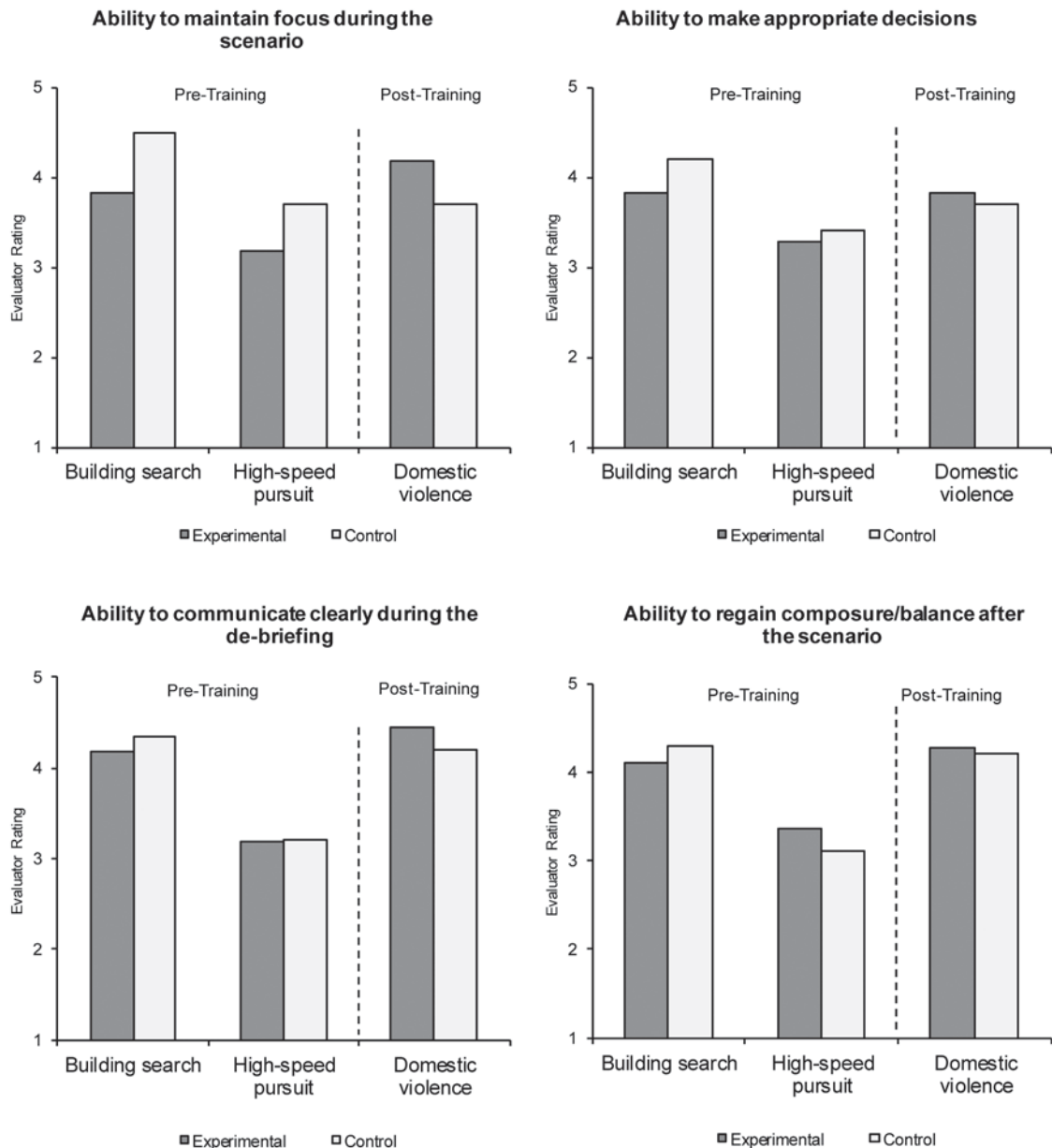


Figure 5 Summarizes the average scenario evaluation rating results for experimental and control group participants in the 4 general areas that were evaluated for all 3 scenarios: ability to maintain focus during scenario, ability to make appropriate decisions, ability to communicate clearly during the debriefing, and ability to regain composure/balance after the scenario. It is of note that the experimental group tended to score lower in these areas than the control group in the 2 scenarios that were conducted prior to the training (the building search and high-speed pursuit); however, after they received the training, this trend reversed: the experimental group scored higher than the control group in all key areas in the final scenario (domestic violence), which participants reported to be the most stressful overall.

scenarios that were conducted prior to the training (the building search and high-speed pursuit); however, after they received the training, this trend reversed: the experimental group scored higher than the control group in all key areas in the final scenario (domestic violence), which participants reported to be the most stressful overall.

Specific questions participants were asked after the high-speed pursuit scenario indicated that 30% of

the officers remembered the suspect's name that the dispatcher told them, 78% remembered the name of the business at which the suspect worked, 86% felt they drove with due regard during the scenario, and 74% answered that they drove within the limitations of the vehicle or their own driving ability.

The evaluation results across all subjects for the 9 specific areas assessed in the domestic violence scenario found that on average, participants scored highest in

the use of appropriate weapons and contact/information collection. The poorest average performance was seen in the positioning of involved parties, use of cover, and use of triangulation. In most of the skills evaluated, there was a fairly wide range of ability demonstrated among the different participants, which most likely reflects their widely differing levels of experience in this type of scenario training.

Effects of the HeartMath Techniques on Coping Performance

Of the officers trained in the Coherence Advantage program who underwent the final (domestic violence) scenario, 83% noted in their interview that they saw clear improvements in their performance that they attributed to their use of the techniques. Of this group, 80% felt that using the Freeze Frame technique immediately after the scenario enabled them to shift and reset after the high stress and return to how they normally feel significantly more quickly as compared to the previous scenarios before they had been trained. In contrast, only 36% of the control group noted any improvement in how quickly they were able to recalibrate after the final scenario. Several of the officers indicated that they also planned to use the technique on the way home from the scenario to gain a deeper level of inner balance. Sixty percent also used Freeze Frame before or during the scenario and commented that they felt more centered throughout the scenario as a result of their integration of the techniques. Overall, participating officers' comments indicated that using the Freeze Frame technique before entering the scenario helped them stay more calm, focused, and confident during the scenario and using the technique after the scenario enabled them to more rapidly and deeply recover both physiologically and psychologically from the intense stress they experienced.

Physiological Results

Heart rate. A primary indicator of stress and autonomic nervous system activation is increases in heart rate. Figure 6 shows the average heart rates (HR) of all the officers by group before, during, and after each of the scenarios. The stress and activity of the scenarios produced profound and significant elevations in heart rate during the scenarios, with the average heart rates ranging from 117 to 145 beats per minute (BPM), which is between 40 and 55 BPM above the officers' normal average daytime heart rates. The mean inter-beat intervals (IBI) before, during, and after each scenario were analyzed using a repeated measures ANOVA with scenario as the within-subject factor and experimental and control as between-group factor (Tables 2 and 3). In all 3 scenarios, mean IBI decreased (increased HR) significantly during the scenario ($P < .001$ in all cases). Mean IBI increased (decreased HR) significantly after the scenarios ended ($P < .001$ in all cases). The group (experimental and control) by time (before, during, and after) analysis found no significant differences between the 2 groups over time in the building search and high-speed pursuit, meaning the group average IBI paralleled each other through these 2 scenarios. There was a significant difference between the 2 groups in the domestic-violence scenario. The mean IBI decrease (HR increase) during the scenario was significantly greater in the experimental group ($P < .05$). The post-scenario increase in IBI (HR decrease) did not significantly differ between the groups. The largest increases in heart rate were seen in the domestic violence scenario, with an average increase of 55 BPM above the daytime average. This was closely followed by the building search scenario, with a mean increase of 52 BPM above the normal daytime average, and then the high-speed pursuit with an increase of 40 BPM above the daytime average.

In addition to the average heart rate analysis, the

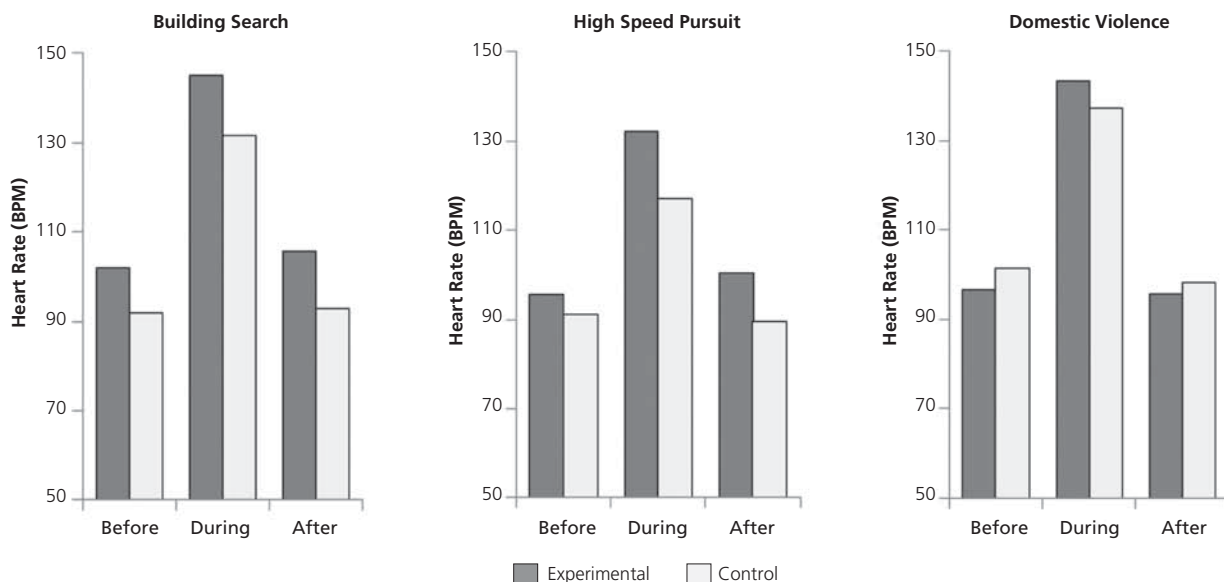


Figure 6 Mean Heart Rate by Group before, during, and after the scenarios.

Table 2. Mean IBI's Before During and After Scenarios

Time	HR (BPM)	IBI (ms)	SEM (ms)	Within-Subjects Contrasts			p <
				Time	Mean Sq.	F	
Building Search							
1 Before	96.7	620.79	23.56	1 vs. 2	723655.64	132.49	0.001
2 During	137.9	434.94	12.81	2 vs. 3	616401.71	113.86	0.001
3 After	98.9	606.46	25.82				
High Speed Pursuit							
1 Before	93.4	642.18	28.54	1 vs. 2	532121.25	99.90	0.001
2 During	124.3	482.82	16.99	2 vs. 3	478686.10	96.54	0.001
3 After	94.6	633.97	26.94				
Domestic Violence Scenario							
1 Before	99.1	605.37	17.86	1 vs. 2	661035.64	281.28	0.001
2 During	140.3	427.75	14.27	2 vs. 3	758110.15	81.42	0.001
3 After	97.1	617.96	30.87				

Repeated Measures ANOVA (Time)
 IBI, inter-beat-interval
 HR, Heart Rate
 ms, milliseconds
 BPM, Beats per minute

ambulatory ECG recordings allowed us to monitor the beat-to-beat changes in heart rate that occurred in response to the different activities in which officers engaged during the scenarios. In all 3 simulations, a large and very rapid increase in heart rate was evident as the officer shifts from a preparatory mode (staging) to the actual action of the scenario. Substantial increases are seen as the scenarios reach their most stressful peak. For the majority of the post-scenario heart rates (recovery period) the officer's heart rate begins to decrease rapidly as soon as the simulations are over; however, it then remains substantially elevated relative to baseline

for an average of 1 hour and 5 minutes before returning to baseline values. In several cases, heart rate did not recalibrate to baseline for more than 2 hours.

Figure 7 shows a typical example of the change in heart rate experienced by an officer before, during, and after the domestic violence scenario. In this example, the officer then used the Freeze-Frame technique to shift and reset, which resulted in an immediate further reduction in heart rate back to baseline.

Blood pressure. Figure 8 shows the average blood pressures (BPs) for all participants at baseline and immediately after the 3 scenarios. A paired t-test showed that in all participants post-scenario, systolic and diastolic BP was significantly increased from their baselines ($P < .001$ in all cases,

Table 4). The baseline average BP value taken on a day on which the officers were not involved in scenarios was 124/76 mmHg. The officers' average BP was 166/98 mmHg after the building search, 145/96 mmHg following the high-speed pursuit, and 175/95 mmHg after the domestic-violence scenario, indicating average increases of 40 mmHg for systolic and 20 mmHg for diastolic pressure.

The most extreme increases in systolic blood pressure were seen in the domestic-violence scenario. There was considerable variation in the degree of blood pressure increases among the individual participants. In 5 of

Table 3. Group Mean IBI's Before, During, and After Scenarios

Time	Experimental			Control			TIME	Mean Sq.	F	p <
	HR (BPM)	IBI (ms)	SEM (ms)	HR (BPM)	IBI (ms)	SEM (ms)				
Building Search										
1 Before	101.9	589.10	32.52	92.0	652.48	34.11	1 vs. 2	2383.34	0.44	ns
2 During	145.0	413.92	17.68	131.6	455.97	18.54	2 vs. 3	6541.31	1.21	ns
3 After	105.7	567.77	35.63	93.0	645.16	37.37				
High Speed Pursuit										
1 Before	95.8	626.60	39.38	91.2	657.77	41.30	1 vs. 2	3904.65	0.73	ns
2 During	132.3	453.59	23.45	117.2	512.06	24.59	2 vs. 3	1193.43	0.24	ns
3 After	100.5	597.19	37.18	89.5	670.75	38.99				
Domestic Violence										
1 Before	96.7	620.23	24.65	101.6	590.50	25.85	1 vs. 2	11941.81	5.08	0.050
2 During	143.3	418.74	19.70	137.4	436.75	20.66	2 vs. 3	6283.90	0.67	ns
3 After	95.8	626.27	42.61	98.4	609.65	44.69				

Repeated measures (Group * Time)
 IBI, inter-beat-interval
 HR, Heart Rate
 ms, milliseconds
 BPM, Beats per minute

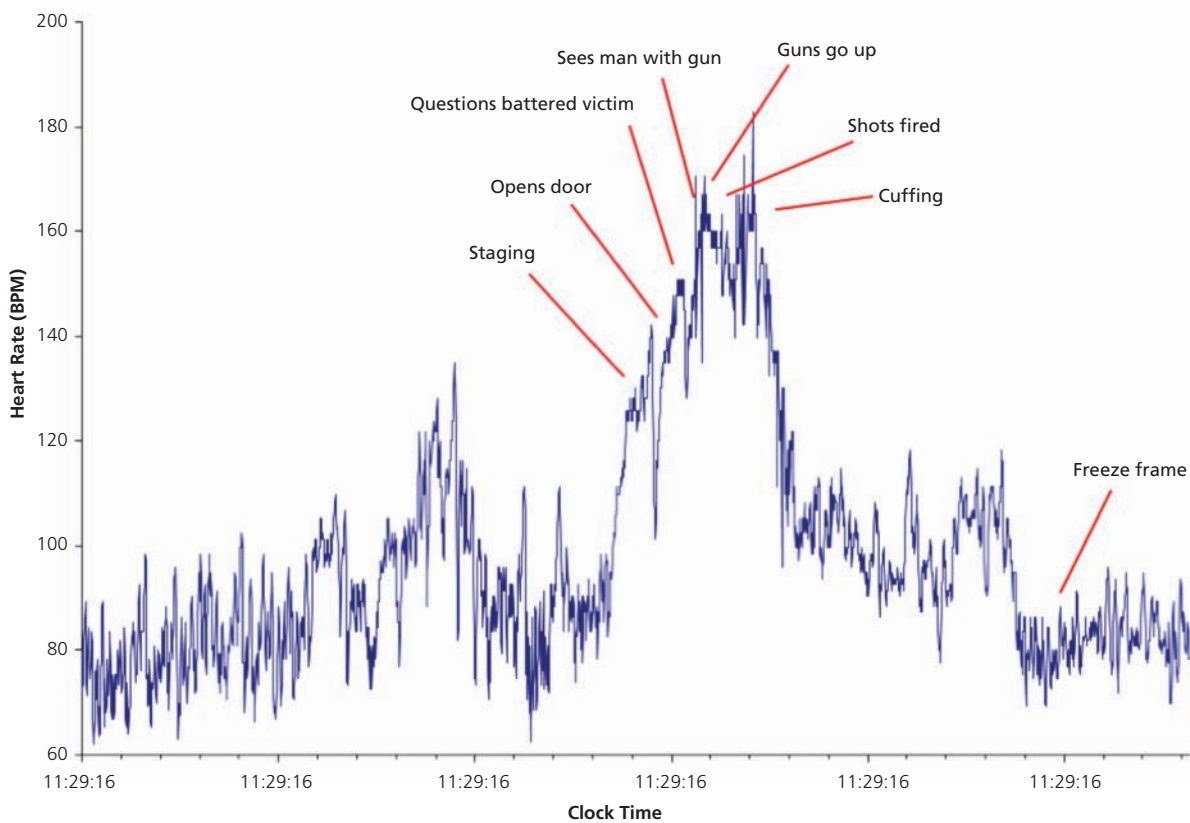


Figure 7 Heart rhythm of 1 officer using the Freeze Frame Technique to shift and Reset after the domestic violence scenario. This graph provides a typical example of an officer from the experimental group’s ability to shift and reset after the domestic-violence scenario. Note that when the scenario ends, the officer’s heart rate initially decreases but remains elevated in a range above the normal baseline. When this officer used the Freeze Frame technique, there was an immediate further reduction in the heart rate back to baseline.

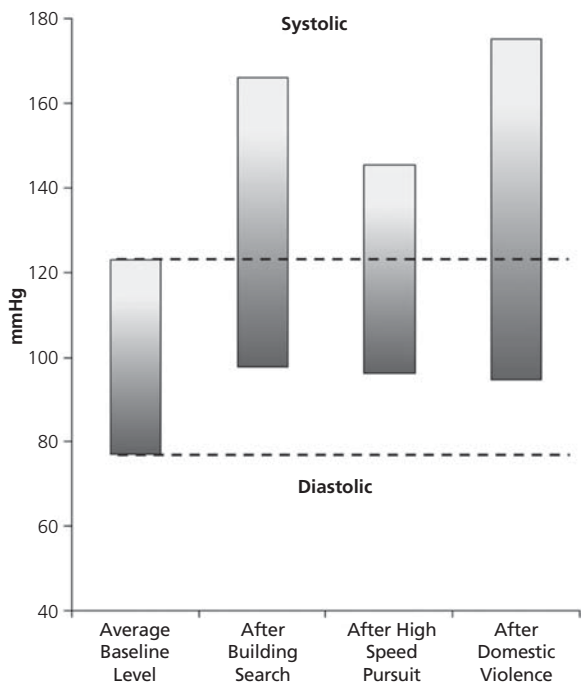


Figure 8 Average blood pressure during the scenarios. This graph shows the average systolic and diastolic blood pressure for all participants during each of the scenarios including an average baseline reading taken on a normal workday. The stress and activity of all 3 scenarios produced significant elevations in blood pressure.

the officers, systolic blood pressure rose to more than 200 mmHg, indicating increases in the range of 80 to 120 mmHg above their starting values. The largest increase in systolic pressure was from 122 to 243 mmHg (an increase of 121 mmHg). The smallest change measured was from 137 to 152 mmHg (an increase of 15 mmHg).

Figure 9 shows the average changes in systolic and diastolic blood pressure for all the participants by group before and after each of the scenarios. An ANCOVA analysis was used to compare post scenario BP change from baseline between the groups (Table 5). Baseline levels were used as the covariates to correct for any differences in baseline values. The only significant difference was in diastolic BP during the high-speed pursuit with the control group having a significantly greater pressure ($P < .01$).

Risk assessment. From the HRV analysis of each participant’s baseline 24-hour electrocardiogram, 6 key measures of autonomic nervous system function commonly used in risk assessment were calculated. For a more detailed explanation of these measures and their clinical relevance, see reference.⁹¹ Of the 27 officers whose HRV was analyzed, 3 (11%) were found to have low HRV for their age and are therefore considered to be at higher risk for cardiovascular disease and premature mortality. Figure 10 illustrates the scatter plots showing all participants’ values for each of the 6

Table 4. Scenario Blood Pressure Effects

	Baseline			Scenario			Paired Differences					df	p <
	Mean	SD	SEM	Mean	SD	SEM	Mean	SD	SEM	t			
High-speed pursuit													
Systolic BP (mm Hg)	121.33	12.83	2.80	145.29	12.20	2.66	23.95	14.53	3.17	7.55	20	0.001	
Diastolic BP (mm Hg)	75.38	7.66	1.67	96.33	10.01	2.18	20.95	9.30	2.03	10.32	20	0.001	
Building search													
Systolic BP (mm Hg)	121.33	12.83	2.80	166.14	18.33	4.00	44.81	19.70	4.30	10.42	20	0.001	
Diastolic BP (mm Hg)	75.38	7.66	1.67	97.81	18.89	4.12	22.43	16.80	3.67	6.12	20	0.001	
Domestic violence													
Systolic BP (mm Hg)	123.57	11.74	2.56	175.14	29.91	6.53	51.57	26.29	5.74	8.99	20	0.001	
Diastolic BP (mm Hg)	78.50	7.90	1.72	94.67	19.37	4.23	16.17	15.96	3.48	4.64	20	0.001	

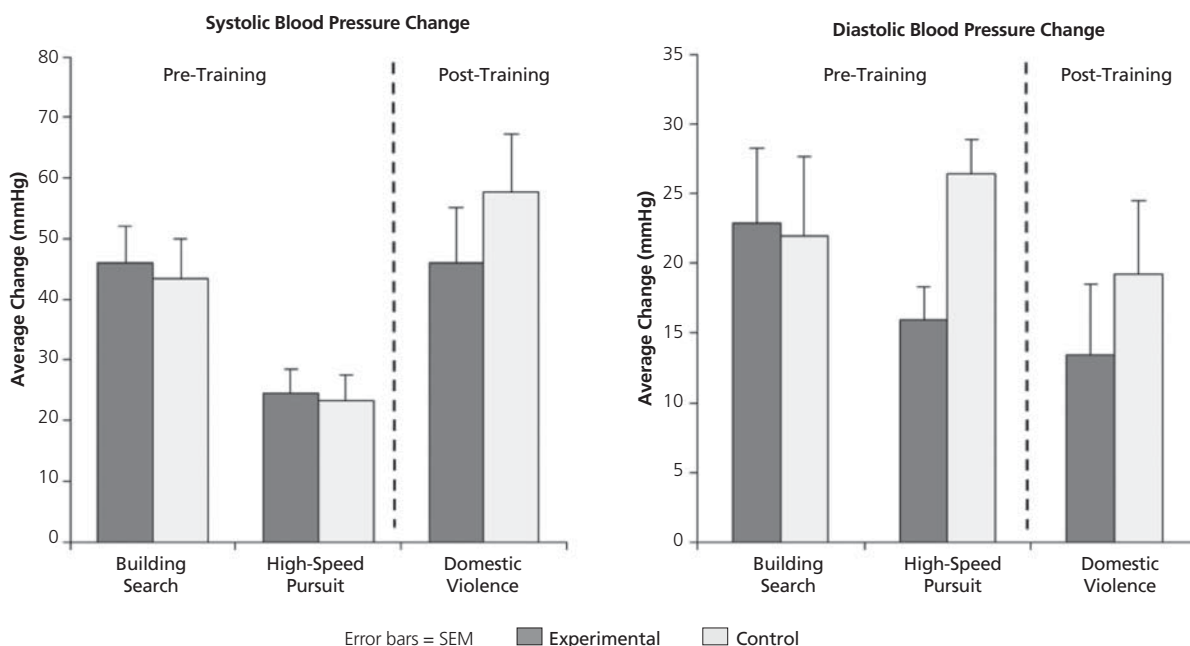


Figure 9 Average increases in blood pressure during the scenarios by group. These graphs compare the average increase in systolic and diastolic blood pressure during the scenarios. Values shown represent the mean difference between the blood pressure readings taken before the scenarios and those taken immediately afterward.

measures analyzed. Average values for normal healthy individuals according to age are indicated by the center dotted line on each graph, and normal reference ranges (95% confidence intervals) are delineated by the upper and lower solid lines. Note that for several of the measures (very low-frequency, low-frequency and high-frequency power) 3 of the officers' values fall outside the normal reference range for their age groups.

DISCUSSION

The data collected in this investigation clearly illustrate the high degree of physiological arousal elicited by the acutely stressful circumstances to which police can be exposed in their work. It should be emphasized that the heart rate and blood pressure changes measured in this study occurred in response to scenarios that the officers knew were only simulations; thus it is highly likely that the degree of physi-

ological activation officers undergo when exposed to real danger is even more profound. Of the different types of police calls simulated in this study, the domestic violence scenario was rated as the most stressful by the participants and also produced the greatest increases in heart rate and systolic blood pressure.

The heart rate recordings show that it takes the body a considerable amount of time to recalibrate from such stressors. In this group of officers, on average, their heart rates remained elevated well above baseline for more than an hour after the scenario had ended. This finding is consistent with other studies that assessed officers heart rates which on duty and recovery time after typical incidents.²⁶ Consideration of the intense physiological arousal that police officers endure in response to acute stress is of significance given the high rates of stress-related illness, particularly cardiovascular disease, in police.^{2,4,18,19,70} Police are known to have

Table 5. Between Group Scenario Blood Pressure Change

	Experimental group (N=11)		Control group (N=10)		Mean Sq.	F	p <
	Mean	SEM	Mean	SEM			
Building search							
Systolic BP (mm Hg)	46.00	6.04	43.51	6.37	24.95	0.07	ns
Diastolic BP (mm Hg)	22.88	5.42	21.94	5.70	4.33	0.01	ns
High-speed pursuit							
Systolic BP (mm Hg)	24.48	3.92	23.37	4.13	5.02	0.03	ns
Diastolic BP (mm Hg)	15.98	2.32	26.43	2.43	532.01	9.35	0.01
Domestic violence							
Systolic BP (mm Hg)	45.97	9.12	57.73	9.66	476.70	0.65	ns
Diastolic BP (mm Hg)	13.44	5.09	19.17	5.36	143.55	0.55	ns

more than twice the incidence of cardiovascular disease as the general population, and one study determined that being employed in law enforcement places one at a greater risk of developing cardiovascular disease than having high blood pressure, diabetes or being overweight or smoking.^{19,92} In recent years, emotional stress has become increasingly recognized as a critical risk factor in cardiovascular morbidity and mortality.^{4,86,93,94} While the body has built-in homeostatic feedback systems that enable it to recalibrate from stress-induced physiological responses, it has been shown using animal models that emotional responses to stress, if repeated consistently over time, can be sufficiently powerful to override the body's feedback systems and lead to chronic disease. In this way, initially reversible physiological adjustments to stressors can eventually lead to exaggerated and persistent activity of the sympathetic nervous system and irreversible structural changes to the cardiovascular system, resulting in chronic hypertension or other pathophysiological conditions.⁹⁵⁻⁹⁷ Chronic sympathetic activation can also result in eventual exhaustion of the autonomic nervous system, which has a body-wide impact, predisposing one to illness and increasing the risk of premature mortality.^{60,89,98}

Along these lines, the results of the HRV analysis revealed that 3 of the 27 officers tested fell below the normal ranges for their age groups in several key measures of autonomic nervous system function and balance, placing them at increased risk of cardiovascular disease, sudden death, and premature mortality from all causes.^{89,99} The number of high-risk individuals identified in this study equaled approximately 11% of the sample, which is 2.2 times the ratio that would be expected to be found in an average population. This is remarkably consistent with the epidemiological findings indicating that police officers have 2.3 times the risk of cardiovascular disease as compared to the general population.¹⁹ This study's findings therefore suggest that 24-hour HRV analysis can be a useful screening tool to identify at-risk individuals in organizational settings. Over many years of conducting 24-hour HRV analysis, we have observed that low HRV is often accompanied by fatigue and is frequently found in indi-

viduals who encounter prolonged or chronic stress. Encouragingly, it has been demonstrated that consistent practice of the self-regulation techniques can help increase HRV and restore healthy autonomic function.⁵¹ We therefore recommend that once at-risk individuals are identified, they be given personal training in resilience

building and energy self-regulation techniques to help them reduce stress responses in order to increase their resilience and improve their health.

HRV is also a marker of the efficiency of the body's neural feedback mechanisms and reflects the individual's capacity to effectively organize physiological and behavioral resources in response to environmental demands.⁶¹ As with many of the body's regulatory systems, the greater the range of variability, the healthier the individual and the greater one's physiological and behavioral flexibility to respond to external challenges. Thus, individuals with low HRV have reduced capacity to effectively adjust and respond to stressful stimuli.¹⁰⁰ Low HRV is also associated with decreased cognitive functions, especially on tasks that require executive control.⁶¹ This is particularly relevant as police officers are continually confronted with numerous and diverse challenges that require a wide range of behavioral responses. It is therefore important to restore natural physiological variability in officers with low HRV in order to increase the likelihood that they will have a greater range of behavioral flexibility.

Overall, this study's findings point to the importance of achieving quick and deep recalibration following intense stress. The ability to shift and reset is also of prime importance at the psychological level, as stress hormones released during a stress response are now known to suppress the function of higher brain centers concerned with concentration, inhibition of inappropriate responses or distractions, effective planning, decision making, morale reasoning and other forms of rational thought.³² There is also evidence that cortisol, the principal glucocorticoid hormone released under stress, inhibits memory retrieval.¹⁰¹ For the police officer, the ability to think rationally under stress, to concentrate, plan ahead, remember and organize crucial information, make effective decisions and control inappropriate emotion-triggered reactions is critically important and in some cases can determine the difference between life and death for oneself and other parties.

This study's findings are encouraging, as the results of the interviews with the officers involved in the scenarios provide evidence that use of the self-regulation skills they learned in the Coherence Advantage program

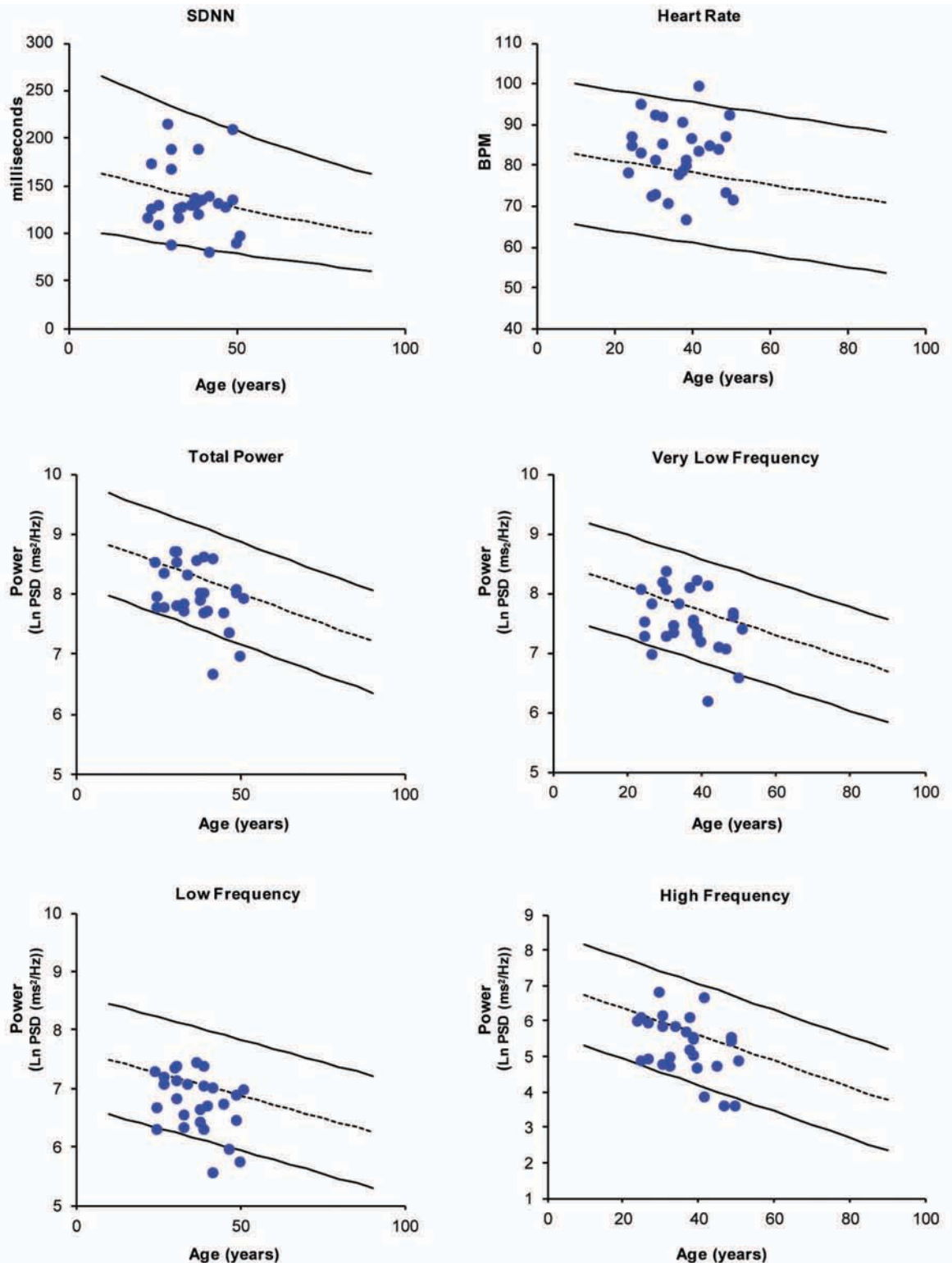


Figure 10 Heart rate variability assessment. This set of graphs summarizes the HRV results for all officers analyzed. From the analysis of 24-hour ECG recordings, 6 key measures of autonomic nervous system function commonly used in risk assessment were calculated. The scatter plots show values for all participants for each measure. Average values for normal healthy individuals according to age are indicated by the center line on each graph, and normal reference ranges are delineated by the upper and lower 95% confidence intervals lines. Note that for several of the measures (5-min VLF, 5-min LF, and 5-min HF) 3 of the officers' values fall below the normal reference range for their age groups. This low heart rate variability places these individuals at increased risk of cardiovascular disease, sudden death, and premature mortality from all causes. In this sample of police officers, 11% were found to be at high risk, which is more than twice the ratio expected in a typical sample of the general population. This finding is consistent with results of epidemiological studies that show that police officers have greater than double the average incidence of cardiovascular disease found in the general population.

enabled the majority to recalibrate more quickly and deeply to a state of increased physiological and psychological balance following the simulations. Officers who used the Freeze Frame technique before the scenarios also noted that it helped them feel more centered, coherent, and confident in the midst of these stressful situations. These benefits are also reflected in the evaluations completed by the scenario training officers. The trends showed that in the 2 scenarios conducted prior to the training, the experimental group members scored lower on average than the control group members in their ability to maintain focus, make appropriate decisions, communicate clearly during the debriefing, and regain balance after the scenarios. In contrast, in the domestic-violence scenario, which was conducted after the training, the experimental group scored higher than the control group in all of these categories. This is also of consequence, as the domestic violence simulation was considered by participants to be the most stressful of all the scenarios. Notably, a similar pattern was observed in the blood pressure trends, which showed that the experimental group had a higher average systolic blood pressure than the control group during the scenarios that occurred prior to the training but had a lower average systolic blood pressure in the scenario that was conducted after the training. Diastolic blood pressure values for the experimental group were also lowest during the final simulation as compared to the scenarios that were conducted before the training.

Responses to acute stress are readily felt and generate strong feedback in our systems, driving us to regain physiological and psychological balance through both automatic mechanisms and conscious actions. In contrast, life's chronic stressors, including job pressures, strained interpersonal relationships, communication difficulties and unmanaged negative thought and emotional patterns can be more insidious and ultimately even more harmful as they can sustain a background level of emotional imbalance that causes a chronic physiological activation (hyper-arousal) and hyper-vigilance. With time, the body and psyche "adapt" to this less-than-optimal functional state, which continually drains resilience, obscures mental clarity, causes performance to deteriorate, and produces wear and tear on our internal systems, promoting physiological responses that accelerate aging and disease progression.¹⁰² It is therefore particularly encouraging that the techniques in this study had a measurable effect on participants' ability to effectively manage the chronic stress in their lives. Results revealed significant reductions in global negative emotion, stress, and depression as well as increases in peacefulness and vitality over the 6 weeks of the study. Anger, sadness, and anxiety also were reduced, as were several physical stress symptoms. Shifting a system into a more coherent mode requires effort and energy, especially when first becoming familiar with the state and overcoming the inertia of our well established baseline modes. However, there is evidence

that the ongoing practice of coherence-building techniques facilitates a *restructuring process* in the neural architecture where coherence becomes established as a new, stable baseline reference or norm. Self-regulation of emotions and stress responses then becomes increasingly familiar and, eventually, automatic.^{39,40,51,71}

One of the most prominent effects of the integration of the self-regulation skills among the trained officers was greatly improved listening and communication. The program assessment interviews indicated that these improved communication skills had a significant impact both within work teams and in officers' relationships with their spouses and families—2 key areas in which a typical lack of effective communication is a significant and well-recognized source of stress in the lives of many police officers.^{14,18,27} In this study, results indicated that the officers' improved communication and ability to listen more effectively to one another resulted in less competition, greater cooperation and team cohesiveness, and increased work efficiency. In particular, officers in supervisory positions expressed a greater readiness and capacity to listen with greater sincerity and care for their staff members and noted how this created an improved work environment and greater cooperation. It is likely that these benefits contributed to the significant increase in overall work performance seen over the course of the study. Officers' implementation of their improved communication skills at home also produced significant benefits, with 75% of the participants noting an improvement over the course of the study in their capacity to listen patiently to family members and to understand their concerns. Officers' comments suggest that sincerely applying this increased care and sensitivity in their personal relationships could help dissipate a significant amount of the underlying stress in this key area of their lives.

The greatest and, in our view, most important effect of the self-management training was seen in the participants' increased ability to manage their moods and emotions, which is a fundamental key to sustaining resilience. Eighty-three percent of the participants noted an improvement in this area. This is of particular significance, as research on human stress and resilience has clearly shown that it is our internal mental and emotional *reactions* to external situations and events that are the most fundamental *source* of the "stress" we experience. Notably, in studies of job stress in police officers, the individuals' confidence in their ability to self-regulate their negative emotions was shown to effectively buffer the negative physiological and psychological effects of occupational stress.^{27,103} Officers who believed they could not control the negative emotions they experienced proved to be more vulnerable to the negative consequences of occupational stressors and reported increasingly severe distress as the frequency of occupational stressors rose. On the other hand, officers who were confident in their own ability to manage their negative moods were less likely to experience

physiological and psychological distress, even if they were exposed to high levels of potential stressors.

The self-regulation skills are specifically designed to target stress at its source by helping individuals reduce or transform negative mental and emotional responses before they occur and as they are experienced and shift and reset more quickly when they do occur. In this study, providing officers with practical, easy-to-use tools to better recognize and eliminate stress responses in the moment significantly increased participants' awareness of their stress as well as their confidence in their own ability to effectively manage stress reactions. Results suggest that the application of these improved emotional management skills reduced the stress officers felt in a variety of areas of their lives, including significant relationships and interactions at work and at home, as well as helping them to achieve deeper levels of internal balance during and after acutely stressful situations.

Key Benefits of the Coherence Advantage Training

- Increased awareness and self-management of stress reactions
- Reduced distress, anger, sadness, and fatigue
- Reduced sleeplessness and physical stress symptoms
- Increased peacefulness and vitality
- Reduced competition, improved communication, and greater cooperation within work teams
- Improved work performance
- Greater confidence, balance, and clarity under acute stress
- Quicker recalibration following acute stress
- Improved listening and relationships with family

One advantage of the Freeze Frame technique is that it is specifically intended for use in the midst of challenging situations. This is particularly relevant for members of the police force, whose jobs often demand that they be able to maintain inner balance, composure, and mental clarity in the midst of performing their duties, frequently under highly stressful circumstances. Further, our experience with numerous individuals indicates that with practice, the self-regulation skills essentially become “automatic” and can therefore be effectively implemented in moments of crisis without any time lost. An additional advantage of the skills used in this study is that they are quickly and easily learned and can yield immediate benefits if used sincerely. It is of note that significant improvements in several areas that are commonly recognized as major sources of stress in police were achieved in this study in as little as 1 month's time after the completion of the training.

In several large-scale implementations of the Coherence Advantage program in a number of military contexts with deploying troops, which occurred after

the completion of this study, a number of important factors that impact the success of the programs ability to increase resilience and achieve the intended benefits have been learned. The first is that leadership support is critical for success. It is important that leadership is taught separately before the lower ranks and those leaders openly model and supports the program. Secondly, it is best to conduct resilience training early in the training cycle. We found that participants are much more likely to use the skills and emWaves on the job when they have learned and used them during training cycles. The third important factor is the family. Often, one of the biggest sources of stress comes from issues occurring at home. This has been addressed through workshops specifically for families and a phone-based Personal Resilience Mentoring Program.

However, the most important factor is the implementation of a robust sustainability component following the initial training. CAPT Laraway, the Navy's Operation Stress Control Officer said,

I cannot overstate how valuable the ongoing mentoring of these groups has been. I had the opportunity to visit with our sailors in Afghanistan last fall and the leadership told me that the program is clearly helping the sailors that use it and they had a number of compelling examples. A common theme was improved sleep, and ability to sustain their composure in high stress interactions with the detainees.¹⁰⁴

No matter how effective the tools and technologies may be, their potential to increase resilience and performance and reduce symptoms of operational stress cannot be realized if they are not utilized on a regular basis. As with any new skill, it takes practice and repetition before they become automatic responses, especially in challenging situations. In our experience, the most effective approach to facilitate the ongoing use and grounding of the skills is by providing participants with ongoing support from a leader/mentor. The primary objective of the mentoring component is to provide the team or unit leaders with the necessary knowledge and tactics to effectively lead personnel in sustaining and expanding the use of self-regulation and healthy energy-management skills.

The intent is for squad leaders to have the primary mentoring role, but the program includes what we call a “chain of support,” where all levels of the leadership are being mentored and supported.

Other important elements of the Coherence Advantage program that have been implemented in numerous military contexts to more effectively sustain the use of the resilience skills are (1) pocket flip-books, (2) follow-up lessons, (3) weekly emails, and (4) HeartMath books on anger and stress management. The short weekly emails and follow-up lessons reinforce and build on the skills and applications taught in the classroom training program.

CONCLUSIONS AND FUTURE DIRECTIONS

Police officers as an occupational group endure particularly high levels of stress. The accumulated physiological, psychological, and behavioral wear and tear of stress in policing can be severe and includes high rates of suicide, alcohol use, cardiovascular diseases, and other stress-related illnesses. Chronic anxiety, depression, psychological burnout, and disrupted family relationships are other common manifestations of prolonged stress in police officers. In the line of duty, the inability to maintain one's resilience and effectively manage one's stress responses can significantly impair judgment and decision-making abilities and in the extreme can result in the inappropriate application of force, driving accidents, injury, and death. These consequences can severely compromise public safety and can lead to citizen unrest, lawsuits, and high liability costs to police agencies. The numerous and severe effects of stress in the police profession clearly point to the need for effective resilience building and stress-regulation strategies for this population.

The results of this investigation provide convincing evidence that the application of practical stress and emotional self-regulation skills can reduce damaging physiological and psychological responses to both acute and chronic stress in police and positively impact a variety of major life areas in a relatively short period of time. Officers who practiced the self-regulation skills experienced marked reductions in negative emotions, fatigue, and physical stress symptoms as well as increased peacefulness, physical vitality, and improved work performance. In particular, significant improvements occurred in communication difficulties at work and in strained family relationships, 2 prominent sources of stress for police. Results suggest that the skills provided in this program were effective in reducing the most fundamental source of participants' stress responses by giving them greater ability to manage stress-producing perceptions and negative emotional reactive patterns.

This study also provides important insight into the physiological impact of acute on-the-job stress as experienced in real time by police officers as measured by cardiovascular responses to simulated police call scenarios. The acute stress of the scenarios produced rapid and pronounced increases in heart rate and blood pressure, from which it took officers a considerable amount of time to recover. The training helped officers maintain greater clarity and inner balance under the pressure of these high-stress situations and also enabled them to shift and reset more quickly afterwards, both psychologically and physiologically.

While additional research is needed to explore the longer-term effects of the program employed in this study, the results of this initial investigation suggest that in the long-term, gaining increased levels of emotional self-management could potentially benefit police officers in a wide range of capacities. These potential benefits include enhanced work-life balance;

a reduction in the high rate of domestic problems, particularly divorce; improved work climate and organizational effectiveness; reduced cardiovascular morbidity and improved overall health; and reduced early retirement for stress-related causes. In addition, providing training in practical self-regulation strategies could help alleviate some of the major organizational burdens faced by police forces. For example, officers who are competent in self-management skills are likely to maintain their composure and make better decisions when confronted with challenges in the line of duty, resulting in reduced use of excessive force, fewer accidents, fewer citizens' complaints, fewer lawsuits, and reduced liability costs at the individual agency level.

The continued and accelerated rise of stress and unrest in society is likely to mean an increasing workload for police in the future. The need for officers to maintain their resilience through these challenging times likely will generate an increased emphasis on training in self-regulation for those employed in law enforcement. The integration in police training of programs providing officers with practical and effective self-management skills has enormous potential to result in more comprehensive training for officers in skills enabling them to perform their jobs with greater effectiveness and ultimately provide better protection to the citizens whom they serve.

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