Mind-Body Skills for Regulating the Autonomic Nervous System

Defense Centers of Excellence for Psychological Health and Traumatic Brain Injury

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Executive Summary

BACKGROUND

Since the beginning of Operation Enduring Freedom and Operation Iraqi Freedom, more than two million U.S. troops have been deployed. The operational tempo associated with these conflicts, in conjunction with extended and multiple deployments, exposure to nontraditional combat (e.g., urban settings and use of improvised explosive devices), and shortened dwell time between deployments, has placed unprecedented stress on service members as well as their families.[1-3] With the complex, varied and prolonged operational demands of these missions, it is crucial that the military continue to develop and refine strategies for promoting and sustaining the health and resilience of service members. A systems perspective on health and resilience seeks to establish good functioning and balance across all body systems (e.g., homeostasis and harmony) through integration of beneficial health and mind-body practices.

This review focuses on promising integrative practices (also referred to as mind-body practices) for regulating stress via the autonomic nervous system (the ANS). The practices reviewed are focused more specifically on integrative mind-body techniques designed to help regulate and manage stress, emotions and arousal (i.e., strategies for lowering anxiety when it is too high or for increasing arousal when it is too low). Routine pharmaceutical and psychological interventions are often a last resort for helping people manage stress and their emotions. Consideration of the spectrum of mind-body approaches to help mediate and manage stress before it becomes too intense to self-manage provides a preventative approach to strengthening resilience and prevention of psychological health difficulties.

Rather than providing a comprehensive review of all integrative mind-body techniques that may prove promising, the review focuses on a sample of 13 techniques and limits its focus to strategies and programs that have been used in military contexts and can be incorporated into existing resilience promoting programs or trainings, or that can be learned and taught by line leaders, peers, and support agencies in a non-clinical context. Each of the techniques featured were selected based on their popularity and interest within military and veterans hospital settings, along with their potential for peer-to-peer based practice and dissemination. In addition, founders or trainers of practices featured in the present report were directly contacted for input regarding the research and theoretical basis of their techniques, as well as to ensure accuracy of information presented.

The advantages and disadvantages of the 13 integrative techniques reviewed in this paper were compared on the basis of their training features, ease of use (practice features and practice requirements), settings for use, trainability and level of evidence (or demonstrated effectiveness in clinical research trials). Techniques reviewed were broadly categorized as

falling within three domains of integrative practice: (1) breath exercises; (2) manipulative body-based tension release exercises; and (3) mindfulness, meditation and guided imagery techniques. The review promotes an integrative approach, recognizing that no technique provides an absolute or assured benefit, that some work well in combination with other integrative and conventional techniques, and some will be effective in some individuals and not others.

Literature Review

Breath

Research suggests that breathing can be affected by experiences and circumstances. When faced with a distressing moment, the body becomes over-stimulated and stops breathing as deeply or as slowly. Fortunately, breathing is controllable. Breathing exercises may be selectively used not only to help manage emotions and regulate stress, but also to help increase energy and maintain optimal arousal needed for greater focus and performance. Because breathing exercises can often be quickly learned and provide immediate feelings of relief, they can also be easily incorporated into existing trainings or treatments. Further research is needed to determine possible longer term benefits of breath practice as well as to examine which components of breath exercise might allow for the most efficient stress and anxiety relief. Breath techniques that are comparatively reviewed in this report include paced breath, diaphragmatic breathing, iBreathe/Breathe2Relax (a computerized breath practice device) and Sudarshan Kriya Yoga.

Manipulative Body-Based (Tension Release) Practices

Manipulative body-based practices (tension release exercises) have become increasingly popular in both military and civilian settings. Stress and anxiety are reflected physically in many ways. Techniques such as yoga and muscle manipulation have been studied for their effects on stress and anxiety. Research suggests that these techniques have positive effects on stress management and anxiety disorders, such as post-traumatic stress disorder (PTSD). These techniques work to reverse stress postures and regulate accumulated stress hormones. It is also believed that posture and tension-release techniques specifically balance nervous system functions. Further research is needed to gain a better understanding of the ways in which specific tension exercises and yoga postures might differentially affect mood and arousal. Manipulative body-based techniques comparatively reviewed in the present report include yoga postures (also known as “asanas”), Tension and Trauma Release Exercises (TRE) and the Trauma Resiliency Model (TRM).

Mental Focus Practices (Mindfulness, Meditation, and Guided Imagery)

Mindfulness practice is regarded as a potential means for greater relaxation, attention control, working memory functioning and lessening of distressing thoughts. Several meta-analytic reviews indicate that routine mindfulness practice can reduce symptoms of

depression and anxiety. Additionally, recent research indicates that mindfulness may be helpful to promote feelings of well-being and for increasing attention control and cognitive flexibility. There is a need for more rigorous randomized clinical trials in the area of mindfulness to prove beneficial findings conclusive. In particular, there is a need to compare the potentially effective components of popular mindfulness techniques to one another as well as to compare mindfulness to other more traditional approaches to therapy and wellness enhancement (e.g., exercise, therapy and psychopharmacology). Mindfulness techniques comparatively reviewed in this report include Mindfulness Based Stress Reduction (MBSR), Mindfulness Mind-Fitness Training (MMFT) and one meditation technique called Yoga Nidra (iRest). Although many forms of meditation and prayer targeting relaxation exist, for this paper, only Yoga Nidra (iRest) was reviewed.

Related to mental practices, guided imagery is regarded as potentially effective for managing stress, anxiety and depression as well as for pain management and performance enhancement. While studies investigating the use of guided imagery across these areas appear promising, on the whole, many studies examined combined imagery techniques with other interventions such as hypnosis, cognitive-behavioral therapy and relaxation techniques, which make it difficult to definitively conclude that guided imagery was an active component in improvement. More research is needed to investigate types of imagery techniques that may be effective and to assess the relative effectiveness of specific techniques across applications.

Mind-Body Programs

A confluence of techniques for regulating the ANS may prove to be more effective than one integrative mind-body skill in isolation. Several are offered in a non-clinical context for military populations, as delivered from the Center for Mind Body Medicine and the Benson-Henry Institute for Mind Body Medicine at Massachusetts General Hospital. Integrative mind-body programs offer the user the opportunity to access a host of approaches typically within one location making scheduling and access easier. Although the two programs reviewed share a common theme and some similarities in approach, a critical review reveals distinct differences in application.

Biofeedback

Because the ANS regulates a number of biological processes, measuring biological functions regulated by the ANS can provide an indicator of arousal levels and feedback that might be used to regulate as well as monitor arousal. Portable biofeedback tools are available to measure and monitor ANS functions, in particular heart rate variability (HRV). HRV reflects the healthy alternating balance of sympathetic and parasympathetic effects as increased HRV is associated with improved cognitive performance. Individuals can be trained to increase the degree of HRV and biofeedback devices could be important tools for training individuals to regulate various aspects of ANS functioning. A table of portable ANS measures

and user-friendly biofeedback tools can be found in Appendix D of the present report.

Conclusion

The results of this review suggest that integrative practices designed to regulate the ANS and improve mood, stress regulation and arousal are promising. However, in order for surveyed practices to achieve greater recognition and use in the mainstream military health community, there is a need to compare the relative effectiveness of techniques to each other, as well as to other more mainstream stress and energy management practices, such as exercise, counseling or psychopharmacology. Finally, there is a need for more studies that examine promising integrative practices within the context of "real world" military operational settings.

Disclaimer

All practices, programs, and products reviewed in this report are presented for critical review and are not officially endorsed by the Defense Centers of Excellence for Psychological Health and Traumatic Brain Injury (DCoE). One goal of this paper is to provide an integration of the latest resources and supporting evidence. Consequently, we plan to provide revised versions of this paper in the future with updated information.

The practices reviewed in this report have not yet undergone formalized medical evaluation procedures. Before practicing the techniques highlighted, it is advised that service members check first with their primary health care provider to ensure there are no contraindications or potential safety concerns. It is recommended that techniques be taught by trained practitioners who are licensed by a recognized national organization and who abide by the organization's standards.

Introduction and Background

Maintaining the health of the force continues to be a high priority for the Defense Department (DoD). In the Chairman of the Joint Chiefs of Staff (CJCS) Guidance for 2011, Adm. Mike Mullen reaffirmed that the health of the force remains one of the top priorities that direct the military's course. Mullen stressed the need for a "holistic" approach to caring for service members and their families.[4]

In response to Mullen's request for holistic approaches to health care, a priority at the Defense Centers of Excellence for Psychological Health and Traumatic Brain Injury (DCoE) is to identify and fully leverage a comprehensive range of health practices that accord with Mullen's Health-Of-The-Force strategic vision for Total Force Fitness. The DoD-wide integration of the Total Fitness Model is evolving and DoD is working to identify best practices that contribute to its success and to share and make visible identified best practices across the services. As part of the mission to promote holistic and comprehensive approaches to health, this paper puts forward a number of integrative mind-body health practices for review. Integrative practices presented focus on interactions between body and mind to enhance control over emotions, stress management and arousal. The review focuses on integrative practices over other practices, because mind-body practices have been speculated to be more effective for helping individuals achieve control over stress, arousal and emotions than more traditional talk-based or task-based treatments alone.[5]

Based on a systematic investigative review of the various terms used in the field of complementary and alternative medicine, this paper uses the term "integrative" to describe the combination of different health and wellness approaches that traverse the domains of mind-body, complementary, integrated and conventional medicine modalities and practices. The term integrative is consistent with Mullen's vision of holistic health, as integrative medicine recognizes that health is more than the absence of disease and that a multi-disciplinary approach to health promotion often provides the maximum therapeutic benefit.[6] In the context of this review, the term "integrative mind-body practices" is used more narrowly to describe the combination of different health and wellness approaches to ANS regulation from the domains of complementary and alternative medicine.

This review focuses specifically on a sample of integrative mind-body programs and techniques that may prove useful for regulating stress and emotions in order to better meet mission demands. While there has been much research conducted and literature published assessing and reviewing conventional clinically-based therapies for counseling, less attention has been given to integrative mind-body practices, despite their growing use within both military and civilian settings. This review emphasizes mind-body exercises that have been used in military settings, have garnered interest among the services and DoD because of their potential for complementing and enhancing performance of military operations, and based on promise, proven effectiveness, portability and/or ease of use.

Interventions were also selected for review, because they can be practiced and taught by non-licensed health professionals. A caveat is that many of the techniques outlined in this report require specialized training certification before techniques may be safely trained to others. Integrative mind-body techniques outlined in the present report are offered for consideration due to their dissemination possibilities and are presented as possible tools for use by line leaders, wellness support facilities or for incorporation into existing or emerging resilience training or programs.

Finally, it is anticipated that some of these techniques could be given special consideration for incorporation into expanding peer-to-peer, or buddy-aid approaches to promoting health and resilience. Due in part to a current health care provider shortage and fears of stigma that can thwart help-seeking behavior, peer-to-peer programs are emerging across DoD as a promising avenue for preventative health as well as for optimizing health and resilience.[7] The ability of non-licensed health professionals or laypersons to be trained in practices that can be used peer-to-peer in combat environments is also being increasingly explored as a way forward for primary prevention.[7] Because all programs surveyed in this report can be taught to non-health care professionals, they may be incorporated into existing or emerging peer-based training programs.

Practices for Regulating the Autonomic Nervous System (ANS)

EMOTIONS, AROUSAL AND THE ANS

The autonomic nervous system (ANS) is the branch of the nervous system that works without the brain having to send a signal to activate it.[8] It involves the unconscious regulation of the organ and system functions that maintain basic operations within the body—for example, heart rate, digestion, respiration rate, salivation, blood pressure, perspiration and diameter of the pupils. The ANS is a functional unit within the nervous system and can be seen as the branch of the nervous system that manages all of the body's internal functions.[9,10] It is the unconscious nature of the ANS that enables us to operate many systems within the brain without interfering with everything else we think about on a daily basis, including our emotions.[11]

The autonomic nervous system has two components: sympathetic (SNS) and parasympathetic (PNS). The SNS prepares the body to fight or flee in stressful situations, while the PNS prepares the body to rest and digest in relaxing situations.[12] These sub-branches both supply nerves to each structure of the brain and balance each other's actions.[10] The SNS is primarily dominant in states of stress and fear. Signs of SNS activation include increased heart rate and respiration, cold and pale skin, dilated pupils and raised blood pressure. In contrast, the PNS is primarily activated in states of rest and relaxation. Signs of PNS dominance include decreased heart rate and respiration, warm and flushed skin, normally reactive pupils and lowered blood pressure. Because PNS and SNS states are associated with distinct body activities, a variety of biofeedback instruments, such as those that measure heart rate, body temperature, blood flow, pupil dilation and breathing are often used to indicate the body's ANS arousal state.

Stress and stress vulnerability can be broadly defined as either the absence of adequate balance between the ANS and the PNS during resting states or the improper predominance of one over the other in particular situations. For example, it would be dysfunctional to have PNS predominance during times requiring high energy and arousal, such as when under threat or attack. Equally, it would be dysfunctional to have SNS predominance during times of relaxation, such as when readying for sleep.

Research in affective neuroscience (the study of correlates between the brain and emotion) has identified central nervous system (CNS) components that generate emotion. This research suggests that both positive and negative emotions involve a mix of cortical (e.g., frontal, temporal and parietal) and subcortical (e.g., basal ganglia, thalamus, amygdala and hippocampus) regions of the brain.[10,13] Evolving alongside this research, over the past three decades, emerging neurophysiological research has sought to identify the ANS generators of emotion.[11,14]

Mounting research over the past three decades suggests a relationship between emotions and changes in the ANS.[15-23] There is some evidence that different emotions may be distinguished based on a complex pattern of sympathetic and parasympathetic activation.[24,25] However, this literature is emerging and there are relatively few studies that have simultaneously examined brain activity and ANS responses while experiencing emotions,[14,23] making specific pathways and conclusions about ways in which the mind, the ANS and emotional experiences may relate difficult to determine. Nonetheless, research exploring connections between the ANS and emotions via associated networks in the CNS continues to expand,[23,26] and researchers continue to look for some of the specific ways that mood and emotions may be connected simultaneously to the brain (i.e., the mind) and to the ANS (i.e., the body), in addition to how interventions designed to directly manipulate the ANS and body may impact moods and cognitive abilities.

Porges' Polyvagal Theory provides an organizing principle by which we might better understand how some individuals, especially those who experience trauma or high levels of stress, experience a dysfunctional imbalance between PNS and SNS responses. The Polyvagal Theory suggests that there is a modulating or regulating role played by the vagus, or 10th cranial nerve. The vagus, which connects to various brain regions and interacts with the SNS and PNS, serves as a brake or modulator between the systems and across the brain. Thus, it influences behavioral mobilization in response to social interactions and interoceptive visceral awareness.[27,28] Interoception refers to sensitivity to stimuli originating inside the body, a type of bodily perception that contributes to how someone "feels." Thus, it is tied to mind and body and integral to one's sense of "being" or well-being and emotions.[27,28] Conditions of extreme stress can break down this highly sensitive means for stabilizing the human organism. In a sense, when the vagus fails to modulate, the brain relies on phylogenetically older parts of the brain (fight or flight) to regulate response. The person loses the ability to distinguish friend from foe, or adjust behavior based on social interaction and the environment. The loss of modulated interoception, that is, the ability to rely on "gut feelings" or correctly interpret social cues, is diminished and they are no longer able to manage the visceral feedback they are receiving.

In addition to the ANS's role in the affective experience, arousal may be the link between basic emotions and linkages to CNS and ANS connections.[23] This is to say that emotions are an integration of multiple cortical and sub-cortical regions and several sympathetic and parasympathetic response systems.[13,23,29] Furthermore, neural processes associated with arousal are complex. They are thought to be a physiological and psychological state involving both cortical regions of the brain (e.g., emotion and thought centers) as well as sub-cortical regions, including the ANS.[30] As such, maintaining optimal levels of arousal would ideally include harnessing a combination of cortical interventions (e.g., techniques designed to stimulate positive thoughts and enhance emotional motivation) as well as more subcortically targeted, or body-focused, interventions designed to keep the ANS and body alert and aroused, but calm enough not to become distracted.[26]

Given the role that the autonomic and related sub-cortical brain functions have in motivation, performance and emotional states, some have criticized some traditional Western psychotherapy approaches to mood and arousal regulation for paying insufficient attention to the often involuntary and unconscious sub-cortical aspects of human emotion and motivation.[5] It must be noted that psychodynamic approaches do address unconscious and humanistic psychology (e.g., gestalt therapy) and exposure-based approaches (e.g., cognitive-behavioral therapy, prolonged exposure therapy) to list only a few, and biofeedback address bodily awareness . That said, critics point out that while many conventional Western approaches to managing emotions and stress tend to be heavily reliant on verbal interaction only, many mainstream practices in Eastern cultures root their healing and emotion management traditions in body-based techniques (e.g., yoga, meditation, breath techniques and acupuncture). These techniques either bring awareness to the body or directly manipulate the body to bring about desirable mood and energy states.[5] Several of these body-based interventions have been speculated to stimulate sub-cortical processes, such as the ANS, to bring about optimal energy, emotional or arousal states.[5,15,31]

Although several traditional Eastern practices have become popular in the West, critics argue that the emphasis of Western psychology on verbal interaction only has kept even Eastern approaches on the fringe of mainstream psychology and psychological teaching.[5] Perhaps, in part, due to cultural biases, Eastern practices have remained marginalized, despite empirical findings that several traditionally Eastern-based interventions (including breathing, yoga and mindfulness practices) are effective in helping regulate stress, emotions and a wide variety of mental health conditions.[31-36]

It is postulated that these practices have the capacity to affect various physiological parameters associated with the ANS, primarily through reduction in arousal as measured by galvanic skin response, heart rate and heart rate variability, blood pressure, metabolic activity and neuroendocrine and hormonal activity.[31-36]

An especially promising avenue for the use of integrative skills techniques may be in the area of PTSD recovery.[5] An important component of overcoming trauma is learning to regulate one's physiological arousal in response to reminders and to fully engage in one's present experience, as practiced in exposure-based interventions. Currently, exposure-based interventions and psychopharmacological approaches for regulating anxiety and emotions have predominated, but various mind-body approaches have shown promise to positively affect a variety of disorders, including anxiety, depression, headaches, chronic pain and insomnia. The clinical literature on the treatment of PTSD and other stress and anxiety disorders consistently suggests that being able to regulate affective arousal is critical to coping with the traumatizing experience. The well-documented lack of affect modulation in many traumatized individuals requires that we explore techniques to help people manage their ongoing physiological arousal in response to traumatic reminders and ongoing life stresses.

This review surveys promising integrated practices for regulating the ANS. The evidence for each practice, along with outline of next steps in determining their validity and utility is presented. The review encompasses a survey of breath, meditation and manipulative body-based techniques, as well as exercises that have been used in military settings.

Breath Techniques for Regulating the ANS

Breath practice is central to the ancient healing practices of yoga, qigong, Ayurveda and other meditation disciplines. While most functions of the ANS are involuntary (e.g., blood pressure, sweating, pupil dilation and digestion), respiration can be directly manipulated. As such, breath is the only function of the ANS over which humans can exert direct control.[15,37]

Although the research linking specific breath techniques to ANS arousal levels is slow to emerge, it has been hypothesized that breath practices can affect the ANS in either direction, meaning toward increased arousal or relaxation, depending on the breath technique used and pace of breathing practiced.[15] Unlike many ANS functions, breathing is under both voluntary and involuntary control via complex feedback mechanisms involving autonomic visceral networks, as well as the limbic system (the seat of emotions) and associated cortical regions of the brain including the pre-frontal cortex (the seat of planning and executive control) and the neuroendocrine system[38] (which regulates health and immunity to viruses). Research has increasingly demonstrated that conscious control of breath and routine breath practice may be particularly effective at facilitating feelings of calm and focus during times of excessive anxiety and stress[38-40] (SNS hyper-arousal).

A review of some of the particular breath practices that appear to hold promise for helping regulate arousal, emotion, stress and anxiety are surveyed below.

Paced Breathing Paced respiration is defined as inhaling and exhaling at a predetermined rate. Typically, participants are asked to coordinate their breathing rate with lights, sounds or metronome-like devices. It has been theorized that increased states of arousal and attention can be brought about using a faster pace of breath[41] and that feelings of calmness can be induced through practicing a slower pace of breath.[15,42] As Clark and Hirschman elucidate, "It is thought that respiratory activity exerts a significant regulatory effect on cardiac activity and that because high heart rate and high respiration is often linked to anxiety, by slowing down heart rate and respiration, one can lower anxiety, or, in reverse, by speeding up respiration pace, one can accelerate heart rate and, possibly, increase arousal."[42]

Though there is some indication that fast-paced breathing may help increase arousal and attention,[15,41] there are few studies to validate these findings. In contrast, a growing number of studies support the conclusion that slow-paced deep breathing can be used to effectively manage feelings of anxiety[32,33,43-46] (to include PTSD symptoms) as well as stress.[46-48] The theory behind these findings is that when we are relaxed and calm we naturally breathe slowly and deeply. Thus, practicing slowed breathing can bring autonomic SNS over-activation (hyper-arousal) back toward parasympathetic dominance to achieve more balanced levels of arousal.[15,49]

In support of the theory that breathing can be used to restore ANS balance during times of high anxiety, several studies have used physiological measures to indicate linkages between slow-paced breathing and the ANS.[42,46-48,50,51] Researchers found that when respiration was paced below participant baseline rates, the ANS was more balanced in individuals prone to anxiety (SNS hyper-arousal) as evidenced by less electro-dermal responsiveness at multiple time points over an extended period.[50] Further studies suggest that regular practice of slow breathing can increase resting heart rate variability,[46-48] which has been found to be associated with greater feelings of calmness and parasympathetic activity. Mounting research indicates that slow breathing holds potential to help regulate anxiety as well as facilitate improvements in cognitive functioning, especially during times of anxiety and excessive stress.[46-48,52]

While few studies examine how much breathing practice is needed to achieve results, one study indicates that beneficial effects of slow breathing can be experienced in as little as 20 minutes spaced over two days, even in populations with high, chronic anxiety. In a study by Clark and Hirschman,[42] 36 alcohol-dependent inpatients scoring high in trait anxiety were randomly assigned to practice 20 minutes of slow breathing divided into two 10-minute practice sessions. As expected, following breathing practice, paced subjects evidenced significantly greater reductions in self-rated tension, state anxiety and skin conductance levels (indicated less hyper-arousal and SNS activity) compared to the control subjects. While study conclusions are limited due to small sample size, they suggest that relatively small amounts of slow breathing practice may be highly effective at lowering anxiety and arousal, even in severely anxious populations. Further studies are needed to validate how much breathing practice is needed to achieve optimal results or more lasting SNS control.

In addition to its stipulated ability to manipulate autonomic arousal and help regulate excessive anxiety, some researchers have speculated that paced breathing can be used to manipulate mood states.[15] In support of this theory, one researcher found that by having participants practice breathing at different rates (and at various levels of depth and pace regularity), breathing pace could be found to account for up to 40 percent of the variance in the experience of emotions such as anger, fear, joy and sadness, with faster-paced breathing contributing to more agitated emotions.[15] Though these findings are to be considered preliminary due to poor study design and small sample size, the suggestion that emotional experiences can be induced by changing breathing pace and patterns is an intriguing suggestion that points to a potentially fruitful area for future research.

Sudarshan Kriya Yoga (SKY)/Warrior Breath A yoga breathing technique called Sudharshan Kriya Yoga (SKY) involves four types of controlled cyclical breathing patterns.[32,53] In SKY yoga, participants are instructed to close their eyes and engage in several breathing techniques through the nostrils for 60 minutes while focusing on the chant “So Hum,” as well as on their breath and the sensations it produces in the body. During the practice, three different breathing cycles are used: slow (8–14 cycles per minute), medium (30 per minute), and rapid (150–180 per minute), ending with a set of slow cycles and a 5-minute

period of backrest. The practice of SKY is preceded by eight to 10 cycles of ujjaya breathing (slow-paced deep breaths with resistant constriction at the base of throat), and eight to 10 cycles of bhastrika breathing (fast-paced forceful breaths through the nose).

Studies indicate that regular practice of SKY can increase mental focus, heighten alertness[54] and may be particularly effective for the treatment of depression and depressive symptoms.[55,56] There is also some indication that SKY may be effective for the treatment of PTSD,[33] though fewer studies are available to demonstrate SKY's effectiveness for the treatment of anxiety related disorders. SKY proponents argue that SKY has a greater number of health benefits and works faster to reduce anxiety than other breathing techniques due to the intensity of the breathing exercises practiced.[32] In terms of mechanisms of action, several studies indicate that, as is the case with slowed breathing exercises, SKY (in conjunction with ujjaya and bhastrika breath exercises) may increase parasympathetic (vagal) tone as demonstrated by increased base heart rate variability, slow base heart rate and decrease anxiety symptoms with practice.[32,53]

It is plausible that the slowed breathing component within SKY practice may alone account for these findings. It is also possible that the fast-paced breathing component of SKY may serve to arouse, rather than calm the ANS, and thus accounts for reports of increased alertness and decreased feelings of depression in SKY practitioners. More studies that investigate connections between SKY and autonomic indicators are needed to determine whether SKY practice generally induces more or less ANS arousal and anxiety, as well as to further elucidate the biological and neurological processes involved in SKY practice. Research further examining the autonomic and biological correlates of SKY practice in individuals with PTSD is underway at the Laboratory for Affective Neuroscience at the University of Wisconsin, Davidson under the direction of Drs. Emma Sampala and Richard Davidson (personal communication, July 23, 2010).

SKY is typically taught through the Art of Living Foundation, which holds a patent on the technique. Although studies have not yet been conducted to determine how much practice is needed for maximum benefit, training instructors recommend 30 minutes per day of SKY practice for 40 days. The SKY technique can be learned through introductory courses taught by certified instructors over 2-3 days. A version of the course called "Warrior Breath" recently debuted in several veterans hospitals across the country for the treatment of PTSD. The veteran version of the course is taught over 6-7 days in 3-4 hour sessions per day (J. Osborne, Personal Communication, July 14, 2010). The Warrior Breath version of the course focuses on slow-paced ujjaya breaths and incorporates shorter periods of SKY practice than is typically taught in introductory courses. This modified program has not yet been empirically tested.

Caution: *While SKY has been practiced by many individuals, the practice has not been fully evaluated or medically approved. Critics of SKY argue that rapid breathing cycles involved in the SKY routine may induce respiratory alkalosis, an experience akin to hyperventilation,*

caused by an imbalance of carbon dioxide in the body.[57] *Further research is needed to determine the validity of these criticisms as well as to determine if SKY is appropriate for all individuals. If critics are correct, the SKY technique may be contraindicated for individuals with panic disorder as well as for individuals with cardiac conditions or seizure disorders.*[57]

Diaphragmatic Breathing The diaphragmatic breathing technique consists of slow, controlled respirations to aid in reducing sympathetic arousal[58] and decreasing muscle tension throughout the body. A common pattern of dysfunctional breathing in individuals with increased stress or anxiety is the tendency to breathe in the chest area.[58] Chest breathing is one of the chief characteristics of hyper-arousal of the sympathetic nervous system, which, during high stress or anxiety, becomes a part of the physiological anxiety response.[58] Diaphragmatic breathing may contribute to reversing this anxiety response by forcing a pattern of diaphragmatic breathing which is typically associated with parasympathetic activity and feelings of relaxation and calm.[58,59]

While diaphragmatic breathing can be self-taught or learned through instructional CDs or videos, applications are being developed to speed up the learning process and to help individuals pay closer attention to their breath and its physiological effects. While still in development, the *Breathe*™ application, also called "*Breathe2Relax*," is a particularly promising portable skill rehearsal tool for diaphragmatic breathing. The portable program can be used as a standalone stress reducer.

In terms of features, the *iBreathe*/*Breathe2Relax* application is divided into four major multimedia program areas. Overall, these content areas include: (1) learning about the fight or flight stress response via an interactive video demonstration; (2) learning about the benefits of controlled diaphragmatic breathing and how to breathe with the diaphragm; (3) skill rehearsal/practice (the user is guided through a diaphragmatic breathing exercise for approximately 3-4 minutes); and (4) tracking progress (users can rate and track their pre/post stress ratings across practice sessions on a graphical dashboard). In the tracking log, moreover, users can tag personalized notes to breathing practices to help identify triggers that contribute to feelings of stress or anxiety. Release of the *iBreathe/Breathe2Relax* product is expected in May of 2011 (J. Alford, personal communication, July 7, 2010).

Overall, diaphragmatic breathing takes just minutes to learn. As with slow-paced breathing, there is some indication that continued practice may strengthen parasympathetic tone and provide quick relief during times of anxiety and hyper-arousal.[32] Technologies such as *iBreathe/Breathe2Relax* and biofeedback devices that teach individuals to pay closer attention to their breathing and to more regularly monitor connections between breathing, stress and mood may further boost the effectiveness of diaphragmatic breathing techniques. Studies involving the use of technology to accelerate or encourage the positive benefits of breathing practice are presented as a potentially rich area for further investigation and research.

Breathing Techniques: Conclusions and Future Areas of Research

Research tracing the effects of breathing manipulation techniques and breathing paces on the ANS has been slow to emerge. Many research studies cited in the above review have used small samples and outdated methodologies. Furthermore, few studies have been conducted to compare breathing techniques or to determine how much practice is needed to achieve optimal benefit. Nonetheless, there is mounting evidence that breathing practice, particularly slow-paced breathing and diaphragmatic breathing, can strengthen parasympathetic tone and help regulate anxiety and arousal. Innovative technologies, such as *iBreathe*, or "Breathe2Relax," may help maximize these effects, as well as be used by clinicians and researchers to help track more long-term benefits of breathing practice. Table 1 provides a summary of breathing techniques reviewed and their different features and mechanisms of action.

Table 1. Comparative Summary of Breath Practices

Program or Model	Training features	Proposed Mechanisms and Goals	Evidence Rating	Practice Features	Trainer Requirements	Practice Settings
Slow-Paced Breathing	Group, individual or self-instruction with multi-media aid, 10-30 mins. daily.	Reverse fast-paced breathing associated with anxiety. Practice increases parasympathetic tone and reduces anxiety.	II-1	20 minutes for some effects, 20-30 minutes daily for 90 days typically recommended.	No certification required.	Anywhere.
Fast-Paced Breathing	Group, individual or self-instruction with or without multi-media aid, 10-30 mins. daily.	Accelerate breathing as a way to increase focus, energy and autonomic arousal.	III	Unknown.	No certification required.	Anywhere.
Warrior Breath (SKY)	Small group format. 3-4 hrs. daily for 6-7 days.	Strengthens parasympathetic (vagal) tone. Increases alertness and decreases feelings of anxiety and depression.	II-2	30-60 minutes for some effects, 30 minutes for 60 days is recommended.	Completion of SKY 1 & 2 (2-3 full days each). Supervised SKY trainings.	SKY is likely best suited for CONUS operations. It has not been tested in theater.
Diaphragmatic/ iBreathe/ Breathe2Relax	Group, individual or multi-media format. 20 minutes daily.	Reverse shallow chest breathing associated with anxiety and hyper-arousal to increase feelings of calm and relaxation.	II-1	Unknown.	No certification required.	Anywhere.

Grade	Level Of Evidence Rating Descriptions
I	Evidence obtained from at least one properly randomized, controlled trial.
II-1	Evidence obtained from well-designed controlled trials without randomization.
II-2	Evidence obtained from well-designed cohort or case-control analytic studies, preferably from more than one center or research group.
II-3	Evidence obtained from multiple time series with and without the intervention. Dramatic results in uncontrolled experiments (such as the results of the introduction of penicillin treatment in the 1940s) could also be regarded as this type of evidence.
III	Opinions of respected authorities, based on clinical experience; descriptive studies and case reports; or reports of expert committees.

In summary, more studies comparing the effects of breathing practices as well as the varying mechanisms of action and physiological and cognitive impacts are needed to understand how best to use breathing practice to bring about desired emotional and arousal states. Standardized measures for comparing a technique's impact on ANS functioning would prove valuable for determining the strength of findings for each of the breathing techniques reviewed and their comparative effectiveness.

Manipulative Body-Based Practices: Posture and Tension-Release Techniques for ANS Regulation

Stress and anxiety are reflected in the body in numerous ways. Basic physiological responses to stress include changes in the relative activity of the sympathetic and parasympathetic nervous systems, such as in the extreme fight or flight response, during which the pupils dilate and cortisol production increases. Much research has been dedicated to study the effects of stress on emotion and behavior and how this is encoded in facial expressions, postures and muscle stiffness.[60] Some compelling lines of research seek to relate certain physical postures, pressure points and patterns of physical activity to emotional states. Conversely, compelling research relates how one might use postures and physical movements to create specific emotional states that can be measured via ANS activity (reciprocity). One classic example is the use of voluntary facial expressions, such as smiling, resulting in ANS activity associated with happiness.[61-63]

For thousands of years, various mind-body techniques have been used in different cultures to treat and maintain physical and mental health. In recent years, researchers have begun trying to quantify the effects of several of these practices with modern biological measuring devices. Body-focused techniques, such as yoga and muscle manipulation therapies, have been studied as effective standalone or adjunctive treatments for stress and anxiety disorders.[5,35,64]

There are multiple theories to account for perceived positive effects of yoga and stretch exercises on stress and anxiety. Stretch exercises are thought to help mitigate accumulated stress hormones and as well as reverse stress postures and anxiety postures.[65] Yoga and body-based techniques may also serve as a kind of mindfulness exercise that serve to build awareness of symptoms of stress in the body while distracting the mind away from stress-evoking thoughts. Lastly, it is theorized that whereas cardiovascular exercise is thought to regulate SNS more strongly, techniques such as yoga and other tension-release exercises may have a greater influence on the PNS.[66]

Below is a more detailed description of yoga as well as promising tension release exercises.

Yoga Most yoga practices combine three elements: physical poses (asanas), controlled breathing and a short period of deep relaxation or meditation at the end of the yoga treatment. Reviews of yoga practice suggest that yoga can reduce the impact of exaggerated stress responses and may be helpful for both anxiety and depression.[35,64,67] In terms of the psycho-physiological effects of yoga, emerging research indicates that yoga may influence PNS tone and decrease stress hormones.[34,35,64] Moreover, some research suggests that back-bends and other chest-opening postures may be particularly effective at countering postures associated with depression and anxiety, as these postures have been found to be particularly associated with positive mood states.[68]

In 2004, Khalsa conducted a meta-analytic review of 181 research articles on yoga-based techniques for the treatment of medical or psychiatric conditions. Khalsa concluded, "A general feature of these practices is their capability of inducing a coordinated psycho-physiological response, which is the antithesis of the stress response. This 'relaxation response' consists of a generalized reduction in both cognitive and somatic arousal as observed in the modified activity of the hypothalamic pituitary axis and the autonomic nervous system."[35] Khalsa reported at least eight studies that indicate that yoga "represents deep relaxation of the autonomic nervous system without drowsiness or sleep and a type of cerebral activity without highly accelerated electrophysiological manifestation."[35] Khalsa's review, however, did not describe methods used to demonstrate a connection between yoga practices and ANS regulation, nor did the review include a description of which yoga practices and poses might prove most beneficial for regulating the ANS.

A second meta-analysis of eight published clinical studies that tested yoga as an intervention with respect to anxiety and anxiety disorders conducted by Kirkwood et al.[64] supported the use of yoga for the reduction of symptoms of anxiety and obsessive compulsive disorder, indicating that yoga may be useful to help bring balance to the ANS, particularly for individuals prone to anxiety or hyper-arousal. While studies are intriguing, unfortunately many of the studies reviewed in their meta-analysis contained low sample sizes and methodological inadequacies, rendering the conclusiveness of such findings uncertain.[64]

Though evidence directly testing a connection between the ANS and yoga is very limited, in a study of healthy elderly people the effects of asana yoga postures as well as yoga breath techniques (including the SKY breath technique) were compared to aerobic exercise training.[69] Study results found that those who received 6 weeks of yoga training, 3 hours per week, had a significant increase in heart rate variability and vagal tone compared to those in the aerobic activity group.[69] Study results suggest that yoga may be more effective than aerobic exercise at influencing the PNS, and may, for this reason, prove especially beneficial for regulating stress and mood, even in non-anxious populations.[69] In addition to these findings, other studies similarly indicate that yoga holds potential for positively regulating arousal as indicated by changes in heart rate variability,[70,71] as well as feelings of depression.[71] Due to small sample sizes and poor study design in much of the research surveyed, however, more studies are needed to validate these findings. Despite its widespread use in stress reduction, no large-scale clinical trial has been conducted of the practice of yoga for managing symptoms of anxiety associated with PTSD. In theory, because PTSD is associated with physiological arousal and decreased heart rate variability, it is likely that yoga could be an effective treatment of the emotion control difficulties that often accompany PTSD.

Yoga is now offered widely in civilian as well as veteran and active-duty medical and community settings. Instruction typically lasts from 60 to 90 minutes, and a course typically

requires once per week practice for 6-8 weeks. Certification for yoga instruction varies greatly depending on the instructor's rate of learning and the type of yoga taught. Typically, yoga teacher training programs require at least 200 to 500 hours of training prior to certification. Non-licensed health professionals are eligible to train as instructors.

In summary, despite indications that yoga may be useful for regulating emotional states such as anxiety and depression, as well as arousal, more studies are needed to validate findings. In addition, few studies have been conducted to examine the neurobiological mechanisms that may be relevant to Yoga's impact on the ANS. Additionally, the differential benefits and emotion impact of specific yoga poses have not yet been adequately studied. It is possible, as an example, that a subset of yoga posture, such as back bends or chest opening exercises, may primarily account for some of the positive relaxation and anxiety reduction benefits of yoga that have been observed. Lastly, in order to more fully assess the effectiveness of various yoga poses, studies are needed to control for potentially confounding aspects of typical yoga routines. More specifically, because most yoga practices combine physical poses (asanas) with controlled breathing exercises as well as a short period of deep relaxation at the end of the yoga treatment, studies that investigate the therapeutic impact of traditional yoga routines fail to demonstrate asana postures alone account for positive findings.

Trauma Resiliency Model (TRM) The Trauma Resiliency Model (TRM) is a biologically-based treatment primarily designed to target the body's reflexive and defensive ways of responding to fear and associated hyper-arousal of the SNS. The body's responses to fear are targeted primarily through increasing body awareness during times of arousal and anxiety and working to reverse the body's engrained and automatic fear responses. TRM was inspired by Jane Ayres' Sensory Integration Theory, Dr. Eugene Gendlin's Focusing, and Dr. Peter Levine's Somatic Experiencing (SE) model. TRM is based on the theory that responses to threats are biologically based and primarily autonomic and that cognitive and psychological aspects of trauma arise secondary to biological responses to fear. In line with this theory, TRM treatment assumes that when clients learn to stabilize the physiological symptoms of trauma and anxiety, the emotional, cognitive and behavior manifestations of trauma symptoms are also reduced. The approach asserts that when TRM skills are learned and the nervous system is rebalanced, more traditional talk-based approaches to trauma treatment may be more effective (E. Miller-Karas & L. Leich, personal communication, July 16, 2010).

TRM training sessions teach concrete skills to reduce hyper- and hypo-arousal and employ a methodology that emphasizes tracking sensations in the body associated with stressful or traumatic memories as well as those associated with uplifting or calming memories or thoughts. Shifting between awareness of these two opposite physical, emotional and physiological states is thought to help restore the body's natural balance between the sympathetic and parasympathetic branches of the autonomic nervous system. While in this "Resilient Zone," service members are taught to restore balanced functioning of thoughts,

feelings and physiological responses to stressful or traumatic triggers. TRM training also includes a skill to complete defensive gestures or postures of fight and flight that were thwarted during the traumatic event.

TRM treatment can be used in individual, group and community settings. It was first developed for use by crisis care workers to help victims who have been faced with natural disasters and catastrophic events. It has more recently been adapted to help treat veterans with PTSD and veterans with trauma and co-morbid pain management difficulties (in a variant of the treatment known as "the Trauma Resiliency Model - Veterans & Warriors.") TRM is also currently being used in-theater, but has not yet been formally studied for use in this context (E. Karas & L. Leich, personal communication, July 16, 2010). TRM is offered in two levels and requires 3 days of training at each level. TRM-C, the version of TRM that focuses on creating resiliency-informed communities, uses five of eight TRM skills taught and is designed for use by non-clinicians such as peer-to peer counselors and military chaplains.

Once learned, TRM skills can be self-practiced via smart phones through an application titled *iChill*. More specifically iChill provides: 1) information on the biology of trauma and its impact on the autonomic nervous system; 2) step-by-step TRM stabilization skills; and 3) allows the individual to rate how 'resourced' or calm they feel following skill practice. The application also allows users to input voices of loved ones as well as photos that evoke positive or relaxing (i.e., PNS-evoking) emotions to help balance ANS hyper-activity. The effectiveness of the iChill application is currently being piloted with a small group of deployed Army chaplains (E. Miller-Karas, personal communication, December 21, 2010). Results of the study are due for completion in 2011.

In terms of research to support TRM, following hurricane Katrina, Leitch, Vanslyke and Allen[72] compared coping capacity and trauma symptoms across 91 disaster agency workers who were taught TRM skills and 51 agency workers who did not receive any training. Study results indicated that agency workers who received TRM training had fewer PTSD symptoms up to 3 and 4 months following assessment than did the non-treatment group. In terms of future research, Dr. Tara Victor, a therapist at the Veterans Affairs Medical Center of Los Angeles, CA, is currently piloting TRM as a group therapy for patients with co-morbid chronic pain and PTSD (personal communication, June 23, 2010). In an interview, Dr. Victor explained that in addition to self-assessment measures to track pain and trauma symptoms, she plans to collect biological data and autonomic indicators (i.e., heart rate variability and skin conductance) (personal communication, June 20, 2010). Study results are due to be completed in the summer of 2011.

Tension and Trauma Releasing Exercises (TREs) TREs are a series of techniques designed to produce trauma healing and stress reduction by using six simple exercises designed to evoke body tremors. It is believed that when evoked, the tremors begin to release deep chronic muscular tension held within the core abdomen, or "energetic center," in the body.

When tremors are evoked, the shaking is thought to reverberate throughout the body, traveling along the spine and releasing deep chronic tension from the sacrum to the cranium. By directing focus to the body, TRE is also thought to provide the opportunity to temporarily reduce anxiety-provoking physiological sensations and associated emotions and thoughts that contribute to stress symptoms.

TRE holds appeal because the techniques can be easily self-taught through a short instructional video, and individuals who practice the technique claim to feel immediate anxiety relief. For some, it is recommended the technique be used in conjunction with therapy because it may release emotions and memories associated with past trauma. Although no research investigating the efficacy of TRE exists, it appears promising for its ease of use, reducing hyper-arousal and reports of its immediate benefit. Further research into the techniques is merited.

Caution: Because TRE has not yet been clinically researched, caution is recommended before considering it for wide-scale use. Critics of TRE caution that exercises may be contraindicated in individuals with musculoskeletal conditions or those with unstable cardiac conditions. It is recommended that service members check with a health care provider before engaging in TRE practice.

Conclusions and Future Areas of Research

Given a relative lack of research using biological measures to study the effects of tension release exercises, theories as to how tension release practices affect the ANS remain largely speculative. Research correlating self-reporting experiences with biological measures is needed to gain a better understanding of the ways in which specific tension exercises and yoga postures might differentially affect mood and arousal. A second general limitation is the relatively small amount of research that exists containing randomized controlled studies to demonstrate effectiveness. Moreover, very few studies have been done to determine which, if any, specific postures, areas in the body or movements may prove particularly beneficial for releasing trapped stress, enhancing energy or reversing anxiety postures. Finally, because most TREs reviewed require individuals to concentrate attention on the body during practice, or contain other potentially therapeutic adjuncts to practice, it remains difficult to rule out whether positive benefits documented are attributable to other aspects of a training program.[36]

Despite the fact that biological mechanisms have not yet been fully understood, evolving research indicates that manipulative body-based tension-release techniques such as asana yoga, TRE and TRM may help release stress hormones and reverse postures and physiological states associated with chronic stress and anxiety, ultimately proving helpful for restoring energy balance. Table 2 provides a summary of manipulative body-based techniques reviewed as well as their differential features and mechanisms of action.

Table 2. Comparative Summary of Manipulative Body-Based/Tension-Release Practices

Program or Model	Training features	Proposed Mechanisms and Goals	Evidence Rating	Practice Features	Trainer Requirements	Practice Settings
TRM	Small group format, 3 full days; modified TRM being piloted for individual and group therapy.	Restore ANS balance by detecting and reversing physiological responses to trauma reminders. Used to reduce reactivity to trauma reminders.	II-1	7-14 days for some effects, 15 min. of daily practice while anxious is recommended.	Successful completion of TRM 1 & 2 + four supervised TRM trainings.	TRM is currently being practiced in CONUS, O-CONUS and in theater.
TRE	Self-instruction through 50 minute videotape.	Discharging trapped stress by inducing tremors in muscle groups. Used to reduce anxiety and trauma symptoms.	III	Effects are reported to be immediate.	No certification required.	Anywhere.
Yoga (Asana) Postures	Small group format, 1-2 hour sessions.	Discharge trapped stress, reverse stress postures that maintain anxiety. Yoga can be used to decrease stress, anxiety, depression and increase feelings of relaxation.	I	Some immediate relief anecdotally reported. Recommended practice length is variable.	Months to years depending on trainer and type of yoga taught.	Yoga is best suited for CONUS operations. Yoga has not been tested for in theater use.

Grade	Level Of Evidence Rating Descriptions
I	Evidence obtained from at least one properly randomized, controlled trial.
II-1	Evidence obtained from well-designed controlled trials without randomization.
II-2	Evidence obtained from well-designed cohort or case-control analytic studies, preferably from more than one center or research group.
II-3	Evidence obtained from multiple time series with and without the intervention. Dramatic results in uncontrolled experiments (such as the results of the introduction of penicillin treatment in the 1940s) could also be regarded as this type of evidence.
III	Opinions of respected authorities, based on clinical experience; descriptive studies and case reports; or reports of expert committees.

Mindfulness, Meditation and Guided Imagery

With roots in Buddhism, mindfulness is a practice to gain awareness in the present moment. Multiple definitions of mindfulness have prevented a clear understanding of the term and have also hindered research progress.[73] An increasingly utilized definition arrived at by an interdisciplinary team of researchers concluded that most mindfulness practices contain two components: self-regulation of attention and a noticing as well as "acceptance" of present-moment experiences.[73] In mindfulness, the ability to regulate attention is typically developed through practicing sustained observation of particular stimuli as they occur in the present moment while training the mind not to become distracted.[74] In contrast, the "acceptance" component of mindfulness typically involves noticing and accepting internal and external sensations as they arise in the present, "rather than judging, ignoring or minimizing them, particularly when they are unpleasant."[74]

An underlying principle behind mindfulness practice is that our most stressful and distressing thoughts are those that are too narrowly focused and heavily fixated on the past or on desired or feared future states. As such, it is maintained that by learning to more fully attend to and accept sensations in the present moment, negative emotions can be mitigated and a broader range of possible solutions to problems might be found.[75,76] It has been hypothesized that through mindfulness practice, individuals can learn over time to respond to stressful situations more flexibly and adaptively, as opposed to turning "unconsciously" or "reflexively" to habitual thoughts and behaviors that may not always be the most adaptive to presenting demands.[76]

A systematic review of 311 studies examining the impact of mindfulness and meditation techniques commissioned by the U.S. National Center for Complementary and Alternative Medicine (NCCAM) and the U.S. Agency for Healthcare Research and Quality (AHRQ) titled "Meditation practices for health: State of the research,"[36] provides an analytic review of seven sub-types of mindfulness. The report concludes that, across types of mindfulness practice, there is a substantial amount of research to indicate that mindfulness practices may be effective in reducing heart rate as well as depression, anxiety, panic disorders, binge eating disorders and substance abuse.[36] Despite many seemingly positive bi-products to mindfulness practice, however, the authors caution unreserved reliance on findings due to methodological flaws found in many areas of mindfulness research.[36] A more conservative and recent meta-analysis of mindfulness[76] is more assertive in its claims about the benefits of mindfulness. Results of a meta-analysis focusing only on well-designed studies selected using strict cut-off criteria, concluded that mindfulness practice is effective for reducing anxiety and depression.[76]

In addition to the mood benefits of mindfulness, there is some indication that over time, mindfulness practice can help foster new patterns of thought as indicated by increased neuroplasticity and cognitive flexibility.[77] Finally, there is some indication that mindfulness practice can help strengthen attention control and working memory as well as increase

positive affect.[31] More studies are needed to conclusively determine these promising cognitive benefits of mindfulness practice.

The "relaxation response" is a term coined by Harvard cardiologist Herbert Benson[78] to refer to the body's natural state of relaxation, the opposite of the hyperactivity of the nervous system associated with the fight-or-flight response. Benson believed that *all* ancient meditation practices are capable of producing the "relaxation response" and promote a decrease in sympathetic nervous system activity.[79] He argued that the particular mindfulness technique used may not particularly matter when it comes to experiencing the positive benefits of practice.

In a recent study examining the potential "active ingredients" across mindfulness practice, Coffey, Hartman and Fredrickson,[74] helped elucidate what specific "mechanisms of action" might account for Benson's finding that multiple mindfulness practices appear capable of producing a beneficial response. Specifically, they[74] concluded that in contrast to attention regulation, the "acceptance" component of mindfulness practice is more strongly correlated with the ability to regulate negative affect (to include anxiety and depression) than is the attention regulation aspect of mindfulness.[74] The authors note that while all forms of mindfulness practice contain an attention-control practice component, not all forms of mindfulness contain an "acceptance" component, or instructions to accept and notice whatever internal experiences arise non-judgmentally.[36,74,80] The Coffey et al[74] study results are potentially important in that they indicate that mindfulness trainings that emphasize only attention control, but fail to teach trainees to notice and allow whatever sensations (particularly negative sensations and emotions) may arise during mindfulness practice may not, in fact, be effective for mood regulation.

Due to the fact that many mindfulness trainings and group practice sessions are fluid and interactive, mindfulness training and practice may be more influenced by qualities in the trainer than other integrative practices reviewed in this report (J. Kabat-Zinn, personal communication, September 4, 2010). As such, highly skilled communicators and skilled trainers who teach mindfulness skills may be more likely to elicit positive results than less skilled communicators or trainers. With this said, there have been more recent attempts to create more protocol-driven, or standardized, approaches to mindfulness so that the learning of mindfulness is less dependent on qualities of the instructor. More research is needed to determine whether it is possible to gain some of the same positive effects using such a protocol-driven training approach. As part of this effort, there are many approaches to mindfulness and more research is needed to identify active ingredients of tested practices as well as the variable impact of components of practice. While there are dozens of types of mindfulness practice, a review of some of the more promising mindfulness and meditation practices as well as their central components of training is described below.

Mindfulness-Based Stress Reduction (MBSR) Much of the empirical work in the area on mindfulness has focused on the program developed by Jon Kabat-Zinn, called Mindfulness-

Based Stress Reduction (MBSR). MBSR is a form of mental training that involves a series of exercises designed to help practitioners focus awareness on present experiences and return the attention focus to the target of attention repeatedly as the mind becomes distracted by other objects of attention, such as thoughts, memories or plans for the future. The mindfulness component of the program incorporates three different practices: a sitting meditation, Hatha yoga poses and a body scan/attention-regulation exercise, whereby participants are instructed to sequentially direct attention throughout the body.[81] The foundation for the practice of MBSR is the cultivation of acceptance, or non-judgment of sensations, emotions and thoughts occurring in the present moment.

The MBSR training program consists of an 8 week intervention with weekly classes that last 2-3 hours. While classes contain structured content, classes are also designed to allow room for dialogue between trainees and trainer so that practice questions and points of concern might be discussed and resolved. As such, MBSR is reliant upon skilled trainers who are well versed in issues that might arise during mindfulness practice. There is also typically a day-long intensive meditation session between the sixth and seventh sessions. Finally, participants complete 45-minute sessions at home, at least 6 days a week for 8 weeks.

Although MBSR is primarily designed to be a stress-reduction training, MBSR Mindfulness practice has been found to aid patients with anxiety disorders.[82] Additionally, MBSR has been shown to increase measures of positive emotion and well-being,[83,84] reduce depressive symptoms[85,86] and perceptions of stress and pain,[87] as well as improve immune function.[83]

Lastly, behavioral and neuroimaging studies indicate that MBSR mindfulness practitioners exhibit greater cognitive flexibility,[88] attention resources[89,90] and emotion regulation.[90-92] All of these skills are highly relevant to PTSD patients who often suffer self-regulatory deficits and feelings of lack of control.[93] Publications also suggest that MBSR practitioners are better able to direct their attention and concentration, compared to non-practicing controls.[83] In terms of possible mechanisms accounting for these findings, Davidson et al[83] found increases in right frontal brain activity following 8 weeks of MBSR training. More specifically, participants in the MBSR group showed greater increases in left-sided resting brain activity than did controls. Increases in left-sided activation are thought to be associated with more positive and adaptive emotional styles.[83]

Mindfulness Mind-Fitness Training (MMFT) Mindfulness Mind-Fitness Training is promoted as a stress reduction and mission enhancement technique that trains attention control and body awareness in a similar way we train body functioning at the gym. In contrast to MBSR, which focuses on stress reduction, MMFT is specifically designed to cultivate greater psychological resilience or "mental armor." The mindfulness component of the program incorporates four different practices:

1. Focusing attention exclusively on a single object

2. Enhancing awareness of sensations within the body
3. Grounding attention to the body's contact with the floor or chair in times of emotional distress
4. Learning to shift attention between inner experiences and outer awareness

When mindfulness skills have been mastered to deploy, sustain and re-direct attention, MMFT participants are then taught to focus attention to re-regulate physiological and psychological symptoms that develop from stressful experiences.

In addition to mindfulness practice that forms the basis of the intervention, service members that undergo MMFT are provided with education about the biology of stress and anxiety. Mindfulness skills are framed in terms of their potential for enhancing operational functioning (e.g., situational awareness and enhanced working memory) and mission success. Thus, a key difference between MBSR and MMFT is that while MBSR is primarily emphasized as a stress reduction technique, the explicit course goal of MMFT is to promote stress resilience and to enhance functioning (specifically working memory, attention awareness and environmental awareness) during times of high anxiety and stress. To accommodate often large numbers of trainees, rather than being interactive, MMFT is a more classroom - and "manualized" or protocol-driven method of training.

The MMFT course is taught to service members before they deploy for combat. Training requires 24 hours of classroom training over 8 weeks (average classroom time is 2 hours per session) and mandatory 30 minutes of daily practice exercises outside of class. There is also typically a day-long intensive meditation session in the 8th week.

Recent studies have shown a positive link between MMFT and improvements in mood and working memory in a high-stress U.S. military group preparing for deployment to Iraq.[31] In a study to assess the effectiveness of MMFT,[31] 31 male Marine reservists were provided the training pre-deployment and effects were compared to 17 Marines in a second group without training as a control. After the training period, both groups were evaluated in terms of working memory (through a task titled Operation Span Task that involves working memory function) and broad-based positive and negative affect (using the Positive and Negative Affect Schedule or PANAS). Study results found that working memory capacity degraded and negative mood increased over time in the control group. However, working memory significantly improved and negative mood decreased in those who underwent MMFT and spent extensive practice time over the 8-week period.[31] Further randomized control studies are needed to validate study findings.

Yoga Nidra Meditation (iRest) Although many forms of meditation and prayer targeting relaxation exist, for this paper, only Yoga Nidra (iRest) was reviewed. Integrative Restoration Yoga Nidra Meditation, or iRest®, was derived from an ancient yoga nidra practice. It was developed by psychologist Dr. Richard Miller over the last 28 years for clinical use. First tested by the Deployment Health Clinical Center at Walter Reed Army

Medical Center in 2006 for its feasibility as an adjunctive modality for service members experiencing PTSD, iRest® claims that it is now being successfully used in many VA and military health care facilities worldwide.

A typical iRest® class consists of: a brief check-in with students, a 30 to 45 minute guided meditation and a few minutes for questions at the end. Classes usually run between 60 and 75 minutes. Home practice recordings (CD or mp3) are used in all research and treatment settings.

The iRest® protocol consists of 10 sequential stages that include a thorough body scan; breathing awareness; systematic neutralization of negative emotions and beliefs; and development of the capacity to experience equanimity amidst the changing circumstances of life. Instructors are trained and certified to administer the iRest® protocol.

Participants report decreases in insomnia, depression, anxiety, hyper-vigilance, angry outbursts and pain and increases in energy level, perceived control in life, and, paradoxically, acceptance of circumstances beyond their control. iRest® may be particularly well-suited for military personnel and families because it:

- Is a non-pharmaceutical, cost-effective adjunctive program that complements any current treatments they are using for healing
- Develops mental focus on the present moment which helps people resist the urge to revisit traumatic life events or worry about possible future ones
- Emphasizes the practice of being aware of and non-judgmental acceptance of immediate as well as past experiences, and acceptance of life as it is without excessive tension
- Quickly establishes a feeling of success in learning and a means of self-regulation
- Is a self-administered program after just a few hours of in-person instruction
- Is a secular program suitable for all age groups and needs, families and caregivers

Although iRest® lists that research projects have been completed at The Walter Reed Army Institute of Research (Active Duty and PTSD); Brooke Army Medical Center (BAMC): (Compassion Fatigue & Health Care Workers); COTS (Homelessness: Anxiety, Well-being); Boise State University (Multiple Sclerosis); Brooklyn, New York (Chemical Dependency); and University of Missouri (College Students: Well-being), the results are unclear given that only the multiple sclerosis study was reported.

Guided Imagery Guided imagery, also called “visualization” and “mental rehearsal” can be defined as imagining an experience that resembles perceptual experience. Guided imagery techniques can be practiced alone or in a group with a therapist’s assistance, or it can be self-practiced using an audio or media recording. Guided imagery is used for a variety of

purposes ranging from stress relief, pain management, performance enhancement and treatment of a variety of psychological health conditions to include anxiety and PTSD.

There are many techniques used in the area of guided imagery. One common technique consists of focusing on an area of the body where pain or emotional distress occur and picturing pain or distress as an image (e.g., a shape or dial). By using this technique, the pain or distress can then be visually manipulated and reduced in size or intensity to elicit feelings of relief. Another common technique involves imagining a wise person, or inner-guide, who can help reduce feelings of loneliness or anxiety as well as help provide feelings of reassurance and healing. When used as a relaxation technique, guided imagery often involves imagining a scene that brings feelings of serenity or relaxation, such as lying on a sunny beach. A final common technique, used most commonly in meditation practices, is to have individuals meditate on images of inspiring objects or religious figures as a way to help inspire or uplift lift the mind as well as to move it away from negative thinking or distress.

Brain scans have indicated that imagery can stimulate the same areas of the brain and nervous systems as an equivalent experience can.[94-96] It has also been stipulated that the brain's visual cortex, which processes images, is connected to the autonomic nervous system.[97]

In terms of evidence supporting the use of guided imagery, a meta-analytic review of 46 studies suggest that guided imagery may be helpful for managing stress, anxiety, depression and pain management.[98] Many of the studies examined, however, combined imagery techniques with other interventions such as hypnosis, cognitive-behavioral therapy and relaxation techniques, making it difficult to definitively conclude that guided imagery was an active component in improvement.

Guided imagery has also been used in sports psychology to enhance performance. Feltz and Landers[99] conducted a meta-analytic review examining 60 studies in which mental practice was compared to control conditions. The review concluded that mental rehearsal (or mental practice using imagery) improved performance, though consistently less so than actual physical practice. As an illustration of findings, a randomized control study conducted by Roure[97] examined guided imagery and its impact on the autonomic nervous system, as well as on ball-passing performance among volleyball players. ANS functions to include temperature, heart rate and respiratory frequency were tested both during mental rehearsal sessions and actual practice. Study results indicate that mental imagery induces the same patterns of autonomic response that physical experiences can, but to a lesser degree of intensity. During an actual volleyball practice, players who had mentally rehearsed, displayed more balanced autonomic functioning (i.e., were calmer) during the game and rated significantly better on performance compared to the control group.

Recent research indicates that guided imagery may be promising as a treatment for PTSD. In a randomized controlled trial study through Duke University in partnership with the Durham

Veterans Affairs Medical Center, 52 women veterans with longstanding military sexual trauma experienced a significant drop in PTSD symptoms following 6 weeks of a guided imagery intervention specifically designed to treat individuals with PTSD.[100] The audio CD used in the intervention was created in partnership with Healthjourneys (www.healthjourneys.com), which is a company that partners with research centers and universities to develop and test guided imagery programs. Results of this study have recently been submitted to the Journal of the American Medical Association and are due to be published in the Summer of 2011 (J. Strauss, personal communication). Studies examining the effectiveness of guided imagery as a treatment for PTSD appear to hold promise but require more research to conclusively demonstrate effectiveness.

Mindfulness, Meditation and Guided Imagery Techniques: Conclusions and Future Areas of Research

In the last decade, increasing attention, both within and outside the military, has been paid to the potential focus and emotion-control benefits of mindfulness and meditation. Despite an increase in interest, there remain relatively few well-designed randomized control studies in this area. Though more recent meta-analytic studies indicate that mindfulness practice may be effective in reducing symptoms of anxiety and depression, there have been contradictory findings in regard to the effectiveness of some of the other health effects of mindfulness. A possible explanation to this is that mindfulness training may be dependent on trainer qualities as well as quality of training. In order to determine suitability for large-scale use, there is a need for more studies which examine protocol-driven and manualized approaches to training. Related to this, there is a need for more studies that isolate and examine the effective components of mindfulness practice. Lastly, few studies have been done to examine how much practice is needed for optimal results, and no studies were found that compare the relative benefits to more commonplace health practices or treatments (e.g., exercise, psychopharmacology or therapy). In the area of guided imagery, although studies examining its effectiveness appear promising on the whole, there appears to be a need for more specific research and attention to factors such as type of imagery, type of task and type of practice.

Table 3 provides a summary of advantages and disadvantages of mindfulness, meditation and guided imagery techniques reviewed, along with their differential features and mechanisms of action.

Table 3. Comparative Summary of Mindfulness, Meditation, and Guided Imagery Practices

Program or Model	Training Features	Proposed Mechanisms and Goals	Evidence Rating	Practice Features	Trainer Requirements	Practice Settings
MMFT	Small group format, 2 hrs. daily for 8 weeks (minimum of 24 hrs. total)	Attention control, increased cognitive flexibility and executive control. May enhance working memory.	II-1	30 mins. daily practice for 8 weeks is recommended.	Certification not yet offered.	MMFT is best practiced in CONUS settings, once mastered, it may be practiced anywhere.
MBSR	Small group format, 2-3 hrs. daily for 8 weeks.	Attention control, increased cognitive flexibility and executive control. Used to regulate stress, decrease anxiety and depression. Increases positive emotions and emotion control.	I	45 mins. daily practice is recommended.	Variable depending on trainer. Supervision is required.	MBSR is best practiced in CONUS settings, once mastered, it can be practiced anywhere.
Yoga Nidra (iRest),	Small group Instructor-led 10-day training for inpatients, 90 mins. per day over a span of 3 weeks. Day patients listen to CD set for 30-60 mins/day.	Postulated to activate the PNS, through conscious utilization of techniques that are meditative and visualization-based. Used to reduce depression, PTSD and anxiety. May increase energy.	II-1	30-60 mins. of daily practice is recommended. Can be done with a guided CD set.	Trainers can be certified to teach iRest after Level 3 training in these therapeutic facilities.	iRest is best practiced in CONUS settings. Once mastered, it can be practiced anywhere.
Guided Imagery	Group, individual or self-administered audio format for 25– 90 mins. daily.	Used to enhance performance, regulate stress and pain and decrease anxiety, PTSD and depression. Visualization stipulated to activate brain and ANS in same way real experiences can.	I	30 mins. of daily practice for 8 weeks.	N/A.	Anywhere.

Grade	Level Of Evidence Rating Descriptions
I	Evidence obtained from at least one properly randomized, controlled trial.
II-1	Evidence obtained from well-designed controlled trials without randomization.
II-2	Evidence obtained from well-designed cohort or case-control analytic studies, preferably from more than one center or research group.
II-3	Evidence obtained from multiple time series with and without the intervention. Dramatic results in uncontrolled experiments (such as the results of the introduction of penicillin treatment in the 1940s) could also be regarded as this type of evidence.
III	Opinions of respected authorities, based on clinical experience; descriptive studies and case reports; or reports of expert committees.

MIND-BODY PROGRAMS

It is likely that beneficial effects of integrative practices can be maximized and accelerated through combining techniques that are potentially effective for regulating the ANS. A scan of the evidence found a limited number of programs that have systematically studied outcomes. Two examples of effective integrative programs are the Center for Mind Body Medicine, founded by Dr. James Gordon and the Benson-Henry Institute for Mind Body Medicine at Massachusetts General Hospital, founded by Herbert Benson, MD.

Center for Mind-Body Medicine (CMBM)

Many organizations use multiple approaches to enhance fitness via ANS modulation. These include vocational and community-related wellness centers, gyms, coaching programs, schools, military training programs, medical systems and proprietary programs. The degree to which such programs attend to the state of scientific literature varies, as do the programs themselves.

The CMBM is an example of a proprietary program that includes training for professionals wishing to conduct a "mind-body medicine" program, as well as for those seeking to engage such a program for personal growth. Modalities employed in this program include: meditation, guided imagery and biofeedback (using bio-dots); self-expression in words, drawings and movement; and physical exercise, dance, yoga, and Tai chi. Domains of psychological fitness targeted are adaptability, readiness, competence, strength, self-awareness, self-assertion, self-care and appropriate behavior. Domains of physiological fitness measured include heart and respiratory rate, blood pressure and peripheral temperature. Exercises demonstrate how guided imagery and meditation affect bodily states and how movement, dance, yoga, active meditation and Tai chi affect mental states.

CMBM programs are designed to help induce a state of calm to improve decision making and work efficiency through mobilization of cognitive resources and enhanced intuition for better problem-solving. Programs are designed for professionals and laypersons. The CBMB has significant experience working in multinational war and disaster trauma settings and has generated literature with regard to the efficacy of its training programs and interventions.

CMBM has published numerous papers on the effects of its approach on trainees, health care professionals, medical students, children and adolescents.[34,101,102] Research has shown that the program produces highly significant improvements in mood, decreases in stress, a greater sense of professional satisfaction and enhanced feelings of optimism and hope.[34,101,102] It is not yet clear how much practice or participation is needed before results begin to become noticeable, but several CMBM studies indicate improvement after participating in a 12-hour course series (taught for 1 hour per day over 12 weeks in small group settings).

Learning CMBM skills takes place in small group settings through certified course instructors. Initial training in mind-body skills is a 5 day, 8 hour per day course. Participants interested in teaching course skills or in continuing with practice may participate in an advanced training program, also a 5 day course, 3 months after the initial course. Between programs, participants receive consultation to help them practice the skills they have learned on their own. For those interested in becoming certified teaching course skills, ongoing supervision begins after advanced training and is 2 hours per week in 10-week cycles (or for as long as the facilitator leads a small mind-body skills group).

Gordon and colleagues[34] conducted the first ever integrative intervention with a traumatized population in a study involving war traumatized adolescents following conflicts in Kosovo. In the study, 82 adolescents meeting criteria for PTSD according to the Harvard Trauma Questionnaire were randomly assigned to a 12-session mind-body group program or a wait-list control group. Following the program, the number of students exhibiting symptoms indicating PTSD was significantly reduced from 100 to 18 percent and reduction in symptoms was maintained at a 3 month follow-up.[34] Research indicates that similar beneficial effects can also be observed in adult health care professionals.[101] The CMBM is in the process of analyzing findings from a PTSD study conducted in Gaza. Data were gathered on 498 children who participated in mind-body skills groups taught by 38 Center-trained health professionals in Gaza in 2007.

The Benson-Henry Institute for Mind Body Medicine at Massachusetts General Hospital

Established in 1989, the Mind/Body Medical Institute (M/BMI) was founded by Herbert Benson, MD, as a non-profit scientific and educational organization dedicated to research, teaching and the clinical and public health application of integrative mind-body medicine programs with a focus on the importance of self-care through the use of vehicles designed to elicit the relaxation response (RR). In December 2006, M/BMI integrated with Massachusetts General Hospital (MGH) as a thematic center and became known as The Benson-Henry Institute for Mind Body Medicine (BHI). Its Director is Gregory Fricchione, MD and its Director Emeritus is Herbert Benson, MD.

The BHI enhances the clinical mission of MGH by making mind-body approaches available to those experiencing stress-related conditions. The BHI plays a key role in educating MGH caregivers to be better equipped to employ mind-body techniques in their practices. Education efforts in other settings such as schools, workplaces and in the military are also a large part of the work of the BHI. There has also been a role in public health through BHI-led efforts to promote health and well-being and to reduce the behavioral risk factors for physical and mental conditions. The BHI is working to improve understanding of stress-related diseases by forming partnerships with many hospital disciplines and subspecialties in unique research efforts to uncover the mysteries of mind-body effects and to find evidence-based therapeutic strategies.

At BHI, people are initially given a consultation with an integrative medicine internist who then refers the individual based on their profile of goals and needs to an 8 week program that meets once a week for 1 ½ hour group sessions. There are follow-up opportunities for booster sessions, to meet program alumni or to serve as peer group supporters. Individual integrative mind body sessions with a physician or nurse practitioner are also available. The program itself builds on a foundation of RR and includes mindfulness training to also include cognitive skills training; positive psychological approaches; social support and pro-social behavior; spiritual connectedness; and nutrition and exercise advice. Yoga is also offered as is Tai chi and qigong with acupuncture being planned.

The BHI group program as outlined above is called the Relaxation Response Resiliency Program (RRRP) and is designed to build skill in mind-body approaches, which reverse or buffer the effects of an activated stress system. Components include a variety of methods to elicit the RR, which reduces autonomic hyper-responsiveness, [103] has the potential to reduce oxidative stress,[104] activate the reward and motivation circuitries, restructure the brain's neural pathways toward adaptive networks,[105-106] alter gene expression profiles in peripheral blood mononuclear cells, and reduce activation of stress pathways.[107] In the RR, prefrontal neural pathways are engaged to build cognitive flexibility toward more adaptive beliefs and thoughts. Additionally, skill-building strategies in support of recuperative sleep, aerobic activity, anti-oxidizing compounds, nutrition and key ingredients of social support are also engaged to provide greater resilience.

Resilience is a function of the body's ability to mount an appropriate response sufficient to meet a physiologic or psychological demand and to terminate this response when no longer needed. Resilience is compromised by either sustained demands on the body's limited resources or by a lack of restorative behaviors. This relationship can be understood through a simple heuristic equation:[108]

$$\frac{\text{Resilience}}{\text{Stress}} = \text{Propensity to Health} + \text{Performance}$$

Mind-body approaches, such as the elicitation of the RR, not only bolster resilience but also limit stress to ensure a balance in favor of health, well-being and enhanced performance. The BHI stress reduction and resiliency enhancement approach has been shown to lead to better health outcomes.[109-110]

The BHI has been involved in educational programming since 1989. Its Educational Initiative (EI) has developed a Train-the-Trainers Program adaptable for use in educational settings from Head Start to Graduate Schools in high, middle and low-income settings. The EI model involves six to 12 hours of training plus in-class modeling exercises and direct student work. There have been several demonstration projects of mind-body approaches including RR/stress reduction, cognitive skills training, nutrition and exercise. The EI also provides a program geared to reduce test anxiety and improve test performance.

The BHI provides a five day clinical training in mind-body medicine three times per year. This training is open to clinicians, researchers and other interested individuals. Clinicians who want to incorporate the BHI approach into their practices are required to take extra training at BHI and to be trained by BHI group leaders.

Clinicians trained by BHI in this way are providing mind body interventions in the U.S. Army Bavaria Soldier Total Fitness Course (now called Soldier 360), as well as in the Boston Red Sox Home Base Program for Returning Veterans.

Biofeedback

Because the ANS regulates a number of biological processes, measuring biological functions regulated by the ANS can indicate arousal levels and feedback that might be used to regulate as well as monitor arousal. A sample of portable biofeedback tools listed below are available to measure and monitor the following ANS functions:

- Temperature: *Biodots (http://www.biodots.net/)*
- Heart Rate Variability: *Heartmath (http://www.heartmath.com)*
- Pulse: *StressEraser (http://stresseraser.com)*
- Respiration: (http://*www.t2health.org/)*

Researchers have begun to investigate ways in which biofeedback devices can monitor heart rate variability. Heart rate variability (HRV) reflects the healthy alternating balance of sympathetic and parasympathetic effects and increased HRV is associated with improved cognitive performance. Low rate variability signals an imbalance of these influences, with sympathetic tone generally predominating. Epidemiologically, low HRV has been associated with increased mortality.[111]

Individuals can be trained to increase the degree of HRV by breathing slowly, starting by approximating the rate that reflects respiratory sinus arrhythmia (RSA), about six breath cycles/minute. RSA variation is attributed to the natural heart rate increase during inspiration, when alveolar volume is maximized and increased blood circulation takes advantage of maximal ventilation (O_2/CO_2 exchange), while heart rate slows through expiration. It is theorized that a natural resonant frequency exists for each individual at which respiration/heart rate variations optimize autonomic self-regulation, and "If this model is correct, it identifies meditational pathways responsible for many "mind/body" and physical disorders."[2]

While individuals can purchase inexpensive HRV monitoring devices and train to increase their HRV, others may be introduced to them as part of treatment programs for various medical or psychiatric conditions (including military use with PTSD/TBI patients), or for performance enhancement. Treatment and enhancement programs integrate HRV training with other modalities designed to meet clients' primary objectives.

HeartMath is a company conducting HRV research, developing and providing HRV biofeedback training (25,000 people trained yearly) and marketing HRV pocket monitors, software and issue-focused training materials. Examples of specific programs include HRV training for stress and anger management, alleviation of depression, control of hypertension, improving sports performance, optimizing personal performance and losing weight.

A more comprehensive list of tools for monitoring autonomic activity can be found in the "Portable ANS Measurement Tools" table in Appendix D.

Summary and Conclusion

While traditional approaches to stress management have relied primarily on talk-based or task-based approaches to coping, this review focuses on integrative mind-body practices that have been speculated to more directly manipulate the ANS and associated biological processes to achieve greater control over stress, arousal and emotions.[5] Techniques that appear to help regulate the ANS are particularly promising for regulating stress, arousal and mood.

The ANS has two branches: the SNS and the PNS. These branches act like a driver choosing between pressing the accelerator (the sympathetic branch) and bearing down on the brakes (the parasympathetic branch). Both components are needed, but too much of one or the other can create a sudden change in the car's handling and speed. When the accelerator (SNS) is aroused beyond its optimal level, feelings of fear and distress predominate. When the accelerator (SNS) is not aroused enough, the car moves with less speed and agility. In more scientific terms, hyper-arousal of the SNS can lead to excessive stress and anxiety, which can impact cognitive functioning (i.e., attention, working memory and processing speed), as well as lead to more performance errors. On the other hand, not enough SNS activation can lead to sub-optimal levels of arousal, which can also negatively influence attention, performance and cognitive functioning.

The stress that occurs from an over-elevated SNS can ultimately be controlled by applying the brakes to bring harmony between speed and control. The brakes (the PNS) act as an inhibitor of stress, ultimately allowing for better control over arousal and emotions. The ability to tap into this involuntary brake mechanism or into the accelerator pedals was the primary basis of the discussion in this review. While most of the practices reviewed in this report aim to lower SNS arousal or activate the PNS, the paper also surveyed techniques that may prove promising for heightening arousal when it is too low.

Programs were surveyed across three domains of integrative wellness: breathing practices; manipulative body-based (tension release) exercises; and mindfulness, meditation and guided imagery practices. The results of the literature review suggest that a number of practices designed to enhance autonomic regulation appear promising on the basis of either their proven effectiveness, practice features, trainability to non-licensed health care professionals or potential operational settings for practice. A sample of 13 practices within these three domains was reviewed. Program features, in addition to comparative advantages and disadvantages of the 13 mind-body techniques surveyed, are summarized in Table 4.

Table 4. Comparative Summary of Mind-body Health Practices

Program or Model	Training features	Proposed Mechanisms and Goals	Evidence Rating	Practice Features	Trainer Requirements	Practice Settings
Slow-Paced Breathing	Group, individual or self-instruction with multi-media aid, 10-30 mins. daily.	Reverse fast-paced breathing associated with anxiety and hyper-arousal. Practice is thought to decrease stress and anxiety through increasing parasympathetic tone.	II-1	20 mins. for some effects, 20-30 mins. per day for 90 days is recommended.	No certification required.	Anywhere.
Fast-Paced Breathing	Group, individual or self-instruction, for 10-30 mins. daily.	Accelerate breathing as a way to increase autonomic arousal as well as energy and focus.	III	Unknown.	No certification required.	Anywhere.
Warrior Breath (SKY)	Small group format for 3-4 hrs. per day, 6-7 days per week.	Cyclical breaths strengthen parasympathetic (vagal) tone. Increases focus, lowers depression and possibly anxiety and PTSD symptoms.	II-2	30-60 mins. for some effects, 30 mins. daily for 60 days is recommended.	Completion of SKY 1 & 2 (2-3 full days each). Supervised SKY trainings.	SKY is best suited for in-CONUS operations. It has not been tested in theater.
Diaphragmatic / iBreathe - Breathe2Relax	Group, individual or multi-media format for 20 mins. daily.	Reverse shallow chest breathing associated with anxiety and hyper-arousal. Thought to induce greater feelings of calm and relaxation.	II-1	Unknown.	No certification required.	Anywhere.
TRM	Small group format, 3 full days; modified TRM being piloted for individual and group therapy.	Restore ANS balance by detecting and reversing physiological responses to trauma reminders. Thought to reduce reactivity to trauma reminders.	II-1	7-14 days for some effects, 15 mins. of daily practice while anxious is recommended.	Successful completion of TRM 1 & 2. Four supervised TRM trainings.	TRM is practiced in CONUS, O-CONUS and in theater.
TRE	Self-instruction through 50 minute videotape.	Discharging trapped stress by inducing tremors in muscle groups. Lowers PTSD symptoms.	III	Effects are reportedly immediate.	No certification required.	Anywhere.
Yoga (asana) postures	Small group format, 1-2 hour sessions.	Discharges trapped stress and reverses stress postures that maintain anxiety and stress.	I	Some immediate relief reported. No dosage studies.	Months to years depending on the trainer and type of yoga taught.	Anywhere.
MMFT	Small group format, 2 hrs. daily for 8 wks. Given pre-deployment.	Attention control, increased cognitive flexibility and executive control. Can enhance working memory function.	II-1	30 mins. of daily practice for 8 weeks is recommended.	Certification not yet offered.	Learned in-CONUS. Once mastered, it can be practiced anywhere.
MBSR	Small group format, 2-3 hrs. daily for 8 weeks.	Attention control, increased cognitive flexibility and executive control. Lowers stress and anxiety. Increases positive emotions.	I	45 mins. of daily practice is recommended.	Variable depending on trainer. Supervision required.	Best learned in-CONUS, once mastered, it can be practiced anywhere.
Yoga Nidra (iRest),	Small group format, 10-day inpatient training, 90 mins. per day for 3 weeks. Day patients listen to CD for 30-60 mins/day.	Postulated to activate the PNS through conscious use of techniques that are meditative and visualization-based. Claims to lower anxiety, anger and depression and increase energy.	II-1	30-60 mins. of daily practiced is recommended. Can be done with guided CD set.	Trainers can be certified to teach iREST after Level 3 training in these therapeutic facilities.	iRest is best practiced in CONUS settings. Once mastered, it can be practiced anywhere.
CMBM	Small group format, 5 day training. Training given after exposure to trauma.	Course teaches self-care psychoeducation and coping skills as well as meditation, guided imagery and biofeedback (using bio-dots), physical exercise, dance, yoga, and Tai chi. Goal is reduction in PTSD and trauma symptoms.	II-1	No predetermined practice recommendations.	Trainers can be certified after passing the basic and Advanced (5-day training) course.	CMBM can be practiced in CONUS, O-CONUS or in theater. Course is currently offered stateside and in disaster trauma settings.

Benson-Henry Institute at MGH: RR/Resiliency Program	Small group format, 2 hr. weekly sessions for 8 weeks (16 hrs. total).	Training in Relaxation Response (RR); cognitive skills; positive psychology (belief, optimism and meaning); spiritual connectedness; and exercise and nutrition in a setting with social support. Enhances resiliency while reducing stress/allostatic load thus improving health and performance.	I	10-30 mins. twice daily RR practice for 8 weeks and then daily thereafter. Booster session with trainer at 3-6 month intervals is recommended.	Manualized training with certificate of completion; Certification not yet offered.	Training sessions in CONUS settings. Once learned and personally integrated into daily routine, it may be practiced anywhere.
Guided Imagery	Group, individual or self-administered audio format. 25–90 mins. daily.	Enhances performance, decreases stress, pain, anxiety, PTSD and depression. Visualization activates brain and ANS.	I	30 mins. of daily practice for 8 weeks.	N/A.	Anywhere.

Although a number of promising integrative practices were identified, the results of the present literature review also suggest that practices designed to enhance autonomic regulation are infrequent topics of scientific study, especially in military populations. In the past 3 decades, experimental human studies began to identify biological substrates that mediate cognitive control mechanisms and autonomic mechanisms for stress regulation and executive functions. Nevertheless, the biological basis of cognitive-emotional resilience is poorly understood, and there are few well-designed randomized controlled studies examining integrative mind-body practices that may prove promising for enhancing autonomic control.

Research into integrative practices for regulating emotion and arousal is further confounded by the use of practices containing multiple potentially effective ingredients. More specifically, breathing practices often combine several breathing techniques (e.g., SKY practice combines slow, medium and fast-paced breathing and slow-paced breathing often incorporates diaphragmatic breathing practices). More studies are needed to isolate potentially effective breathing components so that their relative effectiveness can be evaluated. In the area of manipulative body-based practices (e.g., yoga or TRM), popular techniques often contain a breathing or meditation component to the practice. As with breathing techniques, these elements need to be isolated to determine if manipulative body-based techniques alone can produce beneficial results. Finally, most mindfulness as well as meditation and guided imagery techniques are partnered with other practices (e.g., yoga or relaxation techniques) as part of the training practice and these elements need to be isolated to determine if mindfulness alone is effective. The all-too-frequent bundling of techniques makes it difficult to definitively ascertain which core biological mechanisms of action might be at work, as well as what facets of practice account for program success. While combinations of techniques may work together to produce beneficial results in some, if not most, cases, the relative contribution of elements working to produce benefits is also an area meriting further investigation.

Finally, confusing and sometimes contradictory terminology within the field of integrative health and wellness makes unified or standardized research difficult. There is no standard

definition for the concept of “integrative” or “mind-body skills” in human studies, nor is there a standard definition of “mindfulness,” “yoga” or “breath.” Lack of consensus around basic terms would appear not only to further impede data interpretation across the current literature but also to hinder data sharing across disciplines.

The present paper concludes that, though evidence is limited across breathing practices, manipulative body-based techniques and mindfulness practices, a number of integrative practices may prove promising for regulating the autonomic nervous system. While some of these practices have been tested in civilian settings, their adaptation into real-world military settings remains largely untested. It should also be noted that various forms of controlled breathing, meditation, guided imagery and biofeedback are already being employed by various credentialed clinicians providing services within military settings. Although some of these techniques are being used in pre, post and during combat settings, to the best of our knowledge at the time that this report was completed, none of the techniques reviewed have been tested or compared across combat operation settings, such as while deployed, after deployment or during combat. Such research is likely to hold potential for identifying recommended uses and limits of use for integrative practices.

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Appendix A: Glossary of Terms

Term	Description
Autonomic Nervous System (ANS)	Part of the peripheral nervous system that acts as a control system, maintaining homeostasis in the body. These maintenance activities are primarily performed without conscious control or sensation. The ANS has far reaching effects, including: heart rate, digestion, respiration rate, salivation, perspiration, diameter of the pupils, micturition - (the discharge of urine), and erection. Whereas most of its actions are involuntary, some ANS functions work in tandem with the conscious mind, such as breathing. Its main components are its sensory system, motor system (comprised of the parasympathetic nervous system and sympathetic nervous system), and the enteric nervous system (16).
Sympathetic Nervous System (SNS)	A branch of the autonomic nervous system. It is always active at a basal level (called sympathetic tone) and becomes more active during times of stress or anxiety. Its actions during the stress response comprise the fight-or-flight response (16).
Parasympathetic Nervous System (PNS)	A branch of the autonomic nervous system. It is always active at a basal level (called parasympathetic tone) and becomes more active during times of relaxation. It can be seen in lowered heart rate and breathing, in warm, flushed skin, and lowered blood pressure (16).
Basal heart rate	An indicator of Autonomic Nervous System Activity. The number of times heart beats per minute while at complete rest. Higher heart rates indicate greater stress and anxiety and lower heart rates indicate feelings of calm and relaxation (16).
Heart Rate Variability	A measure of Autonomic Nervous System Activity. HRV reflects the healthy alternating balance of sympathetic and parasympathetic effects, and increased HRV is associated with improved cognitive performance. Low rate variability signals an imbalance of these influences, with sympathetic tone generally predominating (22).
Vagal Fibers (tone)	The vagal and sympathetic nervous system constantly interacts. The stimulation of the vagal afferent fibers leads to inhibition of sympathetic efferent activity. The opposite reflex events are mediated by stimulation of sympathetic afferent activity. Increased vagal tone is typically associated with greater feelings of relaxation and calm (47).
Pre-Frontal Cortex	Part of the cerebral cortex that is the center of judgment/ decision-making, and planning (16).
Cortical	Of or relating to the cerebral cortex, the outer portion of the cerebrum and the main part of the brain. It plays a key role in memory, attention, perceptual awareness, thought, language and consciousness (16).
Sub-Cortical	Relating to, involving, or being nerve centers below the cerebral cortex. Primarily non-conscious activities of a sensory and motor nature (16).
Limbic System	A system of functionally related neural structures in the brain that are involved in emotional behavior (16)
Respiratory Alkatosis	Respiratory alkalosis is a medical condition in which increased respiration (hyperventilation) elevates the blood pH (a condition generally called alkalosis). Alkalosis is caused by excessive elimination of carbon dioxide due to a respiratory abnormality, such as hyperventilation (16).
Integrative practice	An integrative practice implies a practice that offers multiple and diverse therapies—both conventional and complementary. The use of the word *integrative* grants specific allowance to a centralized mode of delivery. Thus, one practitioner with training in both conventional and complementary practices and principles is an *integrative practitioner.* His or her practice then becomes an *integrative practice* (2).
Emotions	Complex psycho-physiological experience of an individual's state of mind as interacting with biochemical and environmental influences (25).

Term	Description
Eastern medicine	A term that encompasses a whole system of medical practices performed in different countries in Asia, which include acupuncture, martial arts, herbal medicine, Feng Shui and massage (e.g., shiatsu). Of these therapies, acupuncture and Chinese herbology are the most popular in the United States. Some additional therapies include diet, nutrition and lifestyle counseling as well as Tai chi and qigong (physical exercise) and tui'na (manual therapies). Because many of the Asian medicines and therapies are rooted in the Chinese philosophy and the principles of Chinese medicine, the monograph focuses mainly on Chinese medicine (25).
Manipulative and body-based practices	Manipulative and body-based practices in complementary and alternative medicine are based on manipulation and/or movement of one or more parts of the body (25).
Cortisol	A vital hormone commonly known as the 'stress hormone,' as it is involved in our response to stress. Cortisol is typically high during periods of stress and low when relaxing (16).
Yoga	Used for health purposes, it typically combines physical postures, breathing techniques and meditation or relaxation. People use yoga as part of a general health regimen and also for a variety of health conditions (25).
Mindfulness	A conscious mental process using certain techniques—such as focusing attention or maintaining a specific posture—to suspend the stream of thoughts and relax the body and mind. It is used to increase calmness and relaxation, improve psychological balance, cope with illness, or enhance overall health and well-being. Techniques include specific postures, focused attention or an open attitude toward distractions (25).
Tai chi	Moving meditation (25).
Western medicine	A system in which medical doctors and other health care professionals (such as nurses, pharmacists and therapists) treat symptoms and diseases using drugs, radiation or surgery. Also called *allopathic medicine, biomedicine, conventional medicine, mainstream medicine* and *orthodox medicine* (25).
Mainstream medicine	The science and art (*ars medicina*) of healing. It encompasses a range of health care practices evolved to maintain and restore health by the prevention and treatment of illness (25).
Post-traumatic stress disorder	A severe anxiety disorder that can develop after exposure to any event that results in psychological trauma (25).

Appendix B: Additional Resources

Breath Techniques for ANS Regulation	
Paced-Breath	http://perfectbreathing.com/pace-breathing
SKY/Warrior Breath	http://www.artoflivingyoga.org/sudarshan-kriya.html
iBreathe/Breathe2Relax™	www.t2health.org/
Manipulative Body-Based and Tension-Release Techniques for ANS Regulation	
Yoga	http://www.yogaweb.com/yoga/essentials/history http://www.yogajournal.com/
Trauma Resiliency Model	http://www.traumaresourceinstitute.com/
Tension and Trauma Releasing Exercises	http://traumaprevention.com/
Mindfulness And Guided Imagery	
Mindfulness-Based Stress Reduction (MBSR)	http://www.mind-fitness-training.org/
Mindfulness Mind-Fitness Training (MMFT)	http://mind-fitness-training.org/tr_what.html
Yoga Nidra Meditation	http://www.irest.us/
Health Journeys Guided Imagery	http://healthjourneys.com
Mind Body Programs	
The Center for Mind Body Medicine	http://www.cmbm.org/
Benson-Henry Institute for Mind Body Medicine	http://www.mgh.harvard.edu/bhi/about/
Organizations/Research Centers	
Agency for Healthcare Research and Quality	http://www.ahrq.gov
Alternative Medicine Foundation	http://www.amfoundation.org/index.htm
Benson-Henry Institute for Mind Body Medicine	http://www.mgh.harvard.edu/bhi/about/
British Society of Integrated Medicine	http://www.bsim.org.uk
Consortium of Academic Health Centers for Integrative Medicine	http://www.imconsortium.org
International Society for Complementary Medicine Research (ISCMR)	http://www.iscmr.org
National Committee for Quality Assurance (NCQA)	http://www.ncqa.org
National Institutes of Health: National Center for Complementary and Alternative Medicine	http://nccam.nih.gov
Samueli Institute	http://siib.org

The Center for Integrative Medicine at the George Washington University Medical Center	http://integrativemedicinedc.com
U. Mass Medical School Center for Mindfulness	http://www.umassmed.edu/cfm/home/index.aspx
University of Maryland School of Medicine: The Center for Integrative Medicine (CIM)	http://www.compmed.umm.edu
Wholistic Healing Research	http://www.wholistichealingresearch.com

Appendix C: Interviewee List

Name	Organization	Title
Richard Davidson, PhD	Waisman Center for Brain Imaging and Behavior	Director, Waisman Center for Brain Imaging and Behavior University of Wisconsin, Madison
Jon Kabat-Zinn, PhD	Mindfulness in Medicine, Health Care, and Society	Director, Mindfulness in Medicine, Health Care, and Society: University of Massachusetts Medical School
John Killen, PhD	National Center for Complementary and Alternative Medicine (NCAMM)	Deputy Director, National Center for Complementary and Alternative Medicine (NCAMM)
James Gordon, MD	The Center for Mind-Body Medicine	Founder/Director, The Center for Mind-Body Medicine
Gregory L. Fricchione, MD	Benson-Henry Institute for Mind Body Medicine	Director, Benson-Henry Institute for Mind Body Medicine
Elaine Miller-Karas, LCSW	The Trauma Resource Institute	Co-Director and Co-Founder, The Trauma Resource Institute
Laurie Leitch, PhD	The Trauma Resource Institute	Co-Director and Co-Founder, The Trauma Resource Institute
Jennifer Alford, PhD	National Center for Telehealth and Technology	Functional Director, National Center for Telehealth and Technology
Matt Fritts, MPH	The Samueli Institute	Senior Research Associate at Samueli Institute
Elizabeth Stanley, PhD	Mindfulness Based Mind-Fitness Training	Founder/Director, Mindfulness Based Mind-Fitness Training Georgetown University
Emma Seppala, PhD	Waisman Center for Brain Imaging and Behavior	Research Associate, University of Wisconsin-Madison
Belleruth Naparstek	Heath Journeys: The Guided Imagery Resource Center	Founder/Director, Health Journeys
David Berceli, PhD	TRE: Tension and Trauma Release Exercises	Founder, Director , TRE
Jennifer L Strauss, PhD	Center for Excellence in Health Services Research	Assistant Professor, Center for Excellence in Health Services Research; Duke University

Appendix D: Portable ANS Measurement Tools

The table below presents a sample of portable and practical tools that can be used to measure ANS activity for the purpose of biofeedback as well as to gauge whether stress and anxiety levels are excessive or sub-optimal.

Measurement Tool: Particular device used to obtain measurement	**Examples of Tools**	**URL Link**	**Measurement Method:** Description of tool	**Neurophysiologic Process Examined:** Nervous System controlled target organ activity	**Usability:** Durability/ User-friendliness*	**Examples of Utilization** Ideal application of tool	**Evidence-Based Support** Research supporting tool reliability and validity**
Armband Pulse-meter	SenseWear Armband (BodyMedia, 2010)	http://sensewear.bodymedia.com/	Worn around the arm to monitor motion, physical activity levels, skin temperature, heat flux, galvanic skin response	• Galvanic Skin Response • Heart rate variability • Skin Temperature	• Portable • No skilled technician required • Durable • User-friendly operation	• Biofeedback • Immediately following stressor • Week following stressor • Health Baseline	3
	Polar Wearlink + Transmitter (Nike Inc, 2010)	http://store.nike.com/us/en_us/?sitesrc=uslp&l=shop,search,searchList-heart%2520rate%2520monitor#l=shop,pdp,ctr-inline/cid-1/pid-351634	Strapped around the arm to measure heart rate with verbal and visual feedback	• Heart rate	• Portable • No skilled technician required • Durable • User-friendly operation	• Biofeedback • Immediately following stressor • Week following stressor • Health Baseline	0
Automatic Sphygmomanometer	OMRON ® 7 Series™ Wrist (7 Series Wrist, 2010)	http://www.omronhealthcare.com/products/7-series-wrist/	Device worn on the wrist to detect blood pressure, heart rate and arrhythmia	• Blood pressure • Heart Rate	• Portable • No skilled technician required • Durable • User-friendly operation	• Biofeedback • Immediately following stressor • Week following stressor • Health Baseline	0
	OMRON ® 10 Series ™ (10 Series, 2010)	http://www.omronhealthcare.com/products/10-series/	Portable blood pressure cuff and monitor measure blood pressure	• Blood pressure	• Portable • No skilled technician required • Durable • User-friendly operation	• Biofeedback • Immediately following stressor • Week following stressor • Health Baseline	0
Intelligent Garment	Biodevices ® Vital Jacket (Biodevices Vital Jacket, 2010)	http://www.biodevices.pt/	EKG is monitored by wearing a light t-shirt and placing a small device in the user's pocket. Data can be collected on a storage device or sent real-time to a PDA	• Electrocardiography • Heart Rate	• Portable • No skilled technician required • Durable • User-friendly operation	• Biofeedback • Immediately following stressor • Week following stressor • Health Baseline	0
Peak Flow Meter	Assess ® Peak Flow	http://assesspeakflow.respironics.com/	Respiratory, inspiratory and	• Maximum speed of expiration (magnitude	• Portable • No skilled technician	• Biofeedback • Immediately following	2

Measurement Tool: Particular device used to obtain measurement	**Examples of Tools**	**URL Link**	**Measurement Method:** Description of tool	**Neurophysiologic Process Examined:** Nervous System controlled target organ activity	**Usability:** Durability/ User-friendliness*	**Examples of Utilization** Ideal application of tool	**Evidence-Based Support** Research supporting tool reliability and validity**
	Meter (Assess Peak Flow Meter, 2011)		expiratory volumes are measured by breathing in and out of mouth valve. Available in manual flow meters only	of airway obstruction in lungs)	required • Durable • User-friendly operation	stressor • Week following stressor • Health Baseline	
	Mini-Wright ® Peak Flow Meter (Mini Wright Peak Flow Meter, 2010)	http://miniwrightpeakflowmeter.com/	Respiratory inspiratory and expiratory volumes are measured by breathing in and out of mouth valve. Available in manual or digital flow meters	• Maximum speed of expiration (magnitude of airway obstruction in lungs)	• Portable • No skilled technician required • Durable • User-friendly operation	• Biofeedback • Immediately following stressor • Week following stressor • Health Baseline	3
Personal Digital Assistant (PDA) Monitoring System	Carepeutic ECG Heart Health Monitor (Active Forever, 2011)	http://www.activeforever.com/p-24807-carepeutic-ecg-fda-approved-heart-health-monitor.aspx?cm_mmc=froogle-_-na-_-na-_-nacarepeutic-ecg-fda-approved-heart-health-monitor	Monitors and analyzes the heart's condition, arrhythmias and heart rate. Display screen shows ECG waveform and heart rate	• Electrocardiography • Heart rate	• Portable • No skilled technician required • Durable • User-friendly operation	• Biofeedback • Immediately following stressor • Week following stressor • Health Baseline	0
	StressEraser® (StressEraser®, 2011)	http://stresseraser.com/	A personal hand-held biofeedback device that uses a finger sensor to convert pulse into heart rate variability wave	• Heart rate variability	• Portable • No skilled technician required • Durable • User-friendly operation	• Biofeedback • Immediately following stressor • Week following stressor • Health Baseline	1
Pocket Heart Rate Monitor	emWave Personal Stress Reliever® (Institute of HeartMath, 2008)	http://store.heartmath.org/store/emwave-handheld/emwave-handheld-silver	Hand-held device that measures heart rate variability to determine effects of different levels of stress	• Heart rate variability	• Portable • No skilled technician required • Durable • User-friendly operation	• Biofeedback • Immediately following stressor • Week following stressor • Health Baseline	1
	Markwort Pulse Pedometer (Markwort, 2011)	http://www.markwort.com/model_view.asp?model=9258	Measures heart rate (beats per minute), counts steps, miles and calories, and has an exercise timer	• Heart rate	• Portable • No skilled technician required • Durable • User-friendly operation	• • Biofeedback • Immediately following stressor • Health Baseline	0

Measurement Tool: Particular device used to obtain measurement	**Examples of Tools**	**URL Link**	**Measurement Method:** Description of tool	**Neurophysiologic Process Examined:** Nervous System controlled target organ activity	**Usability:** Durability/ User-friendliness*	**Examples of Utilization** Ideal application of tool	**Evidence-Based Support** Research supporting tool reliability and validity**
	Meta 1075 Heart Rate Monitor (Sport Line, 2007)	http://www.sportline.com/product.php?prod=70	ECG accurate continuous-read heart rate monitor, audible in-ear zone training indicator	• Heart rate	• Portable • No skilled technician required • Durable • User-friendly operation	• Biofeedback • Immediately following stressor • Health Baseline	0
Pupillometer	Colvard Pupillometer (OASIS Medical, 2004)	http://www.oasismedical.com/Products_Node_View.asp?id=58	Portable device that uses light amplification to measure pupil size in darkened space	• Pupillary dilation	• Portable • Skilled technician required • Durable • User-friendly operation	• Biofeedback • Immediately following stressor • Health Baseline	3
	NeurOptics VIP™-200 Pupillometer (Neuroptics Inc, 2011)	http://www.neuroptics.com/	An electronic, infrared device that measures the reactivity of the pupil to light. Used in preliminary examinations of patients who have sustained a significant head injury	• Pupillary dilation	• Portable • Skilled technician required • Durable • User-friendly operation	• Biofeedback • Immediately following stressor • Health Baseline	1
	Dynamic Binocular Infrared Pupillometer (Rosen, Gore, Taylor, Chitkara, & Howes, 2002)	http://www.procyon.co.uk/dynamic.php	Uses dynamic pupillometry to measure pupil motion in response to brief flashes. Device includes small laptop required to monitor results	• Pupillary dilation	• Portable • Skilled technician required • Durable • User-friendly operation	• Biofeedback • Immediately following stressor • Health Baseline	3
Thermometer (Oral)	ADTEMP I #412 THERMOMETER (ADTEMP I #412 Thermometer, 2010)	http://www.digitalthermometers.net/adtempiand153412thermometer.aspx	Detects body temperature orally, rectally and under the arm	• Temperature	• Portable • No skilled technician required • Durable • User-friendly operation	• Health Baseline	0
	Vicks Digital Thermometer 30 Second Reading (Vicks Digital Thermometer, 2010)	http://www.walgreens.com/store/c/vicks-digital-thermometer/ID=prod4986-product	Detects body temperature orally, rectally and under the arm	• Temperature	• Portable • No skilled technician required • Durable • User-friendly operation	Health Baseline	3

Measurement Tool: Particular device used to obtain measurement	**Examples of Tools**	**URL Link**	**Measurement Method:** Description of tool	**Neurophysiologic Process Examined:** Nervous System controlled target organ activity	**Usability:** Durability/ User-friendliness*	**Examples of Utilization** Ideal application of tool	**Evidence-Based Support** Research supporting tool reliability and validity**
Skin Thermometer	BestMed Digital Temple Thermometer Instant Read Non-Invasive (Digital Temple Thermometer Instant Read Non-Invasive-BestMed Health & Wellness Medicine Cabinet, 2009)	http://www.kmart.com/shc/s/p_10151_10104_038W595304110001P?vName=Health%20&%20Wellness&cName=MedicineCabinet&sName=Thermometers&sid=KDx20070926x00003a&ci_src=14110944&ci_sku=038W595304110001P	Detects skin temperature by sensing heat at the temple	• Temperature	• Portable • No skilled technician required • Durable • User-friendly operation	• Health Baseline	3
	Braun-Thermoscan Ear Thermometer (Braun-Thermoscan Ear Thermometer, 2011)	http://www.walmart.com/ip/Braun-Thermoscan-Ear-Thermometer/9863501	Detects body temperature through measuring infrared heat in the ear canal	• Temperature	• Portable • No skilled technician required • Durable • User-friendly operation	• Health Baseline	2
	Walgreens FHT5 Digital Temple Thermometer 8 Second (Walgreens FHT5 Digital Temple Thermometer 8 Second, 2010)	http://www.walgreens.com/store/catalog/Supplies/FHT5-Digital-Temple-Thermometer/ID=prod6000661-product?V=G&ec=frgl_&ci_src=14110944&ci_sku=sku6000299	Detects skin temperature by sensing heat at the temple	• Temperature	• Portable • No skilled technician required • Durable • User-friendly operation	• Health Baseline	3

User-friendly operation includes painless, non-invasive, non-stigmatizing operation

** Based on the following scale:

0 (No evidence)
1 (One to three articles support the tool's reliability)
2 (Four to 10 articles support the tool's reliability)
3 (More than 10 articles support the tool's reliability)

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