EFFECTS OF POSITIVE EMOTIONAL REFOCUSING ON EMOTIONAL INTELLIGENCE AND AUTONOMIC RECOVERY FROM STRESS IN HIGH SCHOOL STUDENTS

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Abstract

EFFECTS OF POSITIVE EMOTIONAL REFOCUSING ON EMOTIONAL INTELLIGENCE AND AUTONOMIC RECOVERY FROM STRESS IN HIGH SCHOOL STUDENTS

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Using 99 ninth grade students as participants, this study employed a between-group experimental design to investigate the impact of positive emotional refocusing—a method developed by the Institute of HeartMath (the Freeze Frame method)—on heart rate variability (HRV), emotional intelligence (EI), and trait anxiety in adolescent youth. A group of 62 students received training in positive emotional refocusing during a three-month course in social-emotional learning; 37 students were in the waiting group. Results were assessed using the intrapersonal, stress management, and adaptability subscales of the Bar-On Emotional Quotient Inventory for Youth and the State-Trait Anxiety Inventory (STAI). Impact on HRV was assessed by comparing coherence and HRV patterns in the very low frequency, low frequency, and high frequency bands during stress recovery. For exploratory analysis within the training group, students were also categorized as High Anxious (n = 23) or Low Anxious (n = 16), using combined scores on the STAI and the Negative Life Events and Positive Life Events scales of the Life Stressors and Social Resources Inventory for Youth.

Training group participants showed significant increased coherence ($p < .05$) during autonomic recovery from stress. No changes in EI or trait anxiety were detected in the training group. Within-group analysis indicated that significant increases in coherence during stress recovery ($p < .01$) were recorded for Low Anxious participants, as opposed to no change in the High Anxious group. Exploratory analysis on baseline data for all participants who completed both HRV and behavioral measures ($n = 72$) indicated significant positive correlations between EI and coherence in Low Anxious participants. Low Anxious youth showed a significant negative correlation between trait anxiety and stress management skills, while High Anxious youth appeared to benefit significantly from positive life events.

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Table of Contents

LIST OF TABLES

TABLE

LIST OF FIGURES

FIGURE

Chapter 1

INTRODUCTION

Nearly 20 years ago, in urging the development of a comprehensive system to assess stress in children, Chandler (1985) suggested that an effective system would: (1) address a large population of school-age children who may be showing evidence of emotional adjustment difficulties; (2) meet the needs of children who are coping with rapid change and disruption; (3) incorporate a taxonomy not bound by typical approaches to special education, in which only children classified with disorders receive assistance; (4) offer low-level, easily accessible interventions to larger numbers of children than are ordinarily served by psychological services; (5) incorporate a taxonomy of children's emotional disorders derived from empirical evidence and based on a theoretical model; and (6) make use of descriptive and quantitative assessments that are valid and clinically useful.

It is interesting to revisit these goals—still not met two decades later—given the present state of knowledge regarding stress and coping, emotions, and the disorders of childhood. In the 1970s and 1980s, stress researchers identified sources of stress for children that by contemporary standards now appear somewhat routine, including issues around personal goals, self-esteem, changing values, social standards, personal competence, birth of a sibling, starting school, changing schools, moving, school phobia, test anxiety, fear of success, and fear of failure (Humphrey, 1988; Sears & Milburn, 1990; Trad & Greenblatt, 1990). Concerns particular to adolescents included pubertal growth, heightened sexuality, changed relationships with parents, encounters with legal authorities, and cultural and societal expectations (Hendren, 1990).

It can be assumed that these factors are still important, but the overall list is now longer and freighted with more compelling concerns—an assumption shared by nearly all stress researchers (Hendren, 1990; Repetti, Taylor, & Seeman, 2002; Schroeder & Gordon, 2002). Even a cursory look at statistics supports this contention. For example, figures indicate that 40% of children experience divorce in their family, 22% live below the poverty level, 6% live with an alcoholic parent, and between 5% and 15% of children have parents with a serious medical condition. Using a formula for attributable risk—a measure of the strength and prevalence of a risk factor—each of these conditions shows strong effects for clinical levels of disturbance in children (Sandler, Wolchik, MacKinnon, Ayers, & Roosa, 1997).

Also, as the first decade of the 21st century unfolds, a new set of formidable stressors may be surfacing. Perhaps the most obvious candidate for an emerging stressor is violence as portrayed in electronic and digital media—a not-surprising hypothesis, given that by the end of fifth grade the average American child has watched 8000 murders and 100,000 assorted acts of violence such as rape, robbery, and assault via the media (Bushman & Huesmann, 2001). There is little firm evidence in this area, but preliminary research suggests a link between violent games and children's aggression, and surveys have documented an association between heavy television viewing and negative emotional consequences in the form of anxiety, posttraumatic stress disorder (PTSD), and depression (Calvert & Jordan, 2001; Cantor, 2001; Singer & Singer, 2001).

In addition, it appears that one of the few remaining sanctuaries for children—the classroom—contributes its own set of stressors. Although school-age stress has long been acknowledged (Humphrey, 1988; Sears & Milburn, 1990), in recent years standardized testing, performance anxieties, and college admissions have emerged as major stressors in children's lives, with some commentators speculating that rising school stress may be contributing to the general increase in childhood disorders (Edelstein, 2000). Although most of these concerns have not been verified, there are substantial journalistic accounts of self-reported academic stress from young people, along with widespread acknowledgment by professional educators that stress is increasing in academia (Edelstein, 2000).

Finally, the effects on children's hearts and minds from actual or potential levels of violence—in neighborhoods or entire nations—must be included in a contemporary discussion about stress and children. Throughout the world large-scale, institutionalized, life-threatening violence remains a fact of daily life for many children. Though children in the United States are generally shielded from the direct impact of these influences, possible violence on a world scale engenders stress. Although worries about hunger, poverty, and pollution have tended to remain stable from generation to generation in the last 25 years, the threat of nuclear violence resulted in a dramatic increase in anxiety for high school age students in the United States in the 1970s and 1980s (Christie & Toomey, 1990). With the growing focus on international terrorism and a world linked by a network that globalizes images of war and suffering, we may presume that comparable outcomes will be observed for the current generation of children.

Perhaps the chief conclusion that can be drawn from even a cursory examination of the topic of children and stress is that stress is omnipresent—much like an ocean is to a fish. And, the effects of pervasive stress on children appear ominous. Findings show that psychopathologies such as separation anxiety disorder and generalized anxiety disorder may occur in children when fear, anxiety, or worry become excessive and begin to seriously interfere with a child's functioning (Schroeder & Gordon, 2002). These anxiety disorders often are accompanied by comorbidities such as depression, impaired peer relations, poorer self-concepts, academic deficits, and attention deficit hyperactivity disorder (ADHD). Similarly, chronic stress in children can result in low self-esteem, depression, anxiety disorder, accident-proneness, decline in physical health, impaired dyadic interaction, and learned helplessness, while acute stressors may result in nightmares, flashbacks, hypervigilance, anxiety, irritability, guilt, detachment, sleeplessness, and depression, as well as repressive, passive-aggressive, impulsive, and dependent behaviors (Trad & Greenblatt, 1990). Other researchers point out the close association between symptoms identified with PTSD and stress (Putnam, 1997; Schroeder & Gordon, 2002; Turkel & Eth, 1990). Other documented reactions to stress include impaired adaptive, cognitive, affective, and behavioral functioning in children and indications that early childhood trauma may alter central nervous system (CNS) development (Clark & Miller, 1998).

The rise of social and emotional learning

Given the magnitude of stressful assaults and their impact on the emotional development of children, it is not surprising that prevention research reports in the last decade have detailed the decline in the mental health of children and lamented the absence of school-based programs that prevent problem behaviors, assess psychological functioning, and identify potential pathologies in children (Greenberg, Domitrovich, & Bumbarger, 1999; Resnick, Bearman, Blum, Bauman, Harris, et al., 1997; Substance Abuse and Mental Health Services Administration, Office of Applied Studies, 1999).

Interest in such prevention programs for adolescents and children was initially reflected in priorities and recommendations outlined by the National Advisory Mental Health Council Workshop on Mental Disorders Prevention Research, which estimated in 1990 that between 12% and 22% of America's youth under age 18 were in need of mental health services (Greenberg, Domitrovich, & Bumbarger, 1999).

Reports generally have addressed risk and protective factors related to four broad domains of adolescent health and well-being—emotional health, violence, substance abuse, and sexual behavior—as identified in the National Longitudinal Study on Adolescent Health conducted by Resnick et al. (1997). Results from this study showed "consistent evidence that perceived caring and connectedness to others is important in understanding the health of young people today" (p. 830). Accordingly, nearly all experts emphasize the need for school-based social and emotional learning (SEL) programs to promote social competencies, increase resilience, and reduce risk behaviors in youth. In addition, researchers now note strong correlations between SEL and improved academic outcomes, including findings that school success itself is a protective factor for diverse problem behaviors (Elias, Hunter, & Kress, 2001; Gewertz, 2003; Greenberg, Weissberg, O'Brien, Zins, Fredericks et al., 2003; Hanson & Austin, 2002, 2003; Henley & Long, 2003; Lewis, Schaps, & Watson, 1996; Pasi, 2001; Payton, Wardlaw, Graczyk, Bloodworth, Tompsett, & Weissberg, 2000; Weissberg & Greenberg, 1998).

Interestingly, recommendations made two decades ago for implementing stress management programs in schools mirror the language of SEL programs. SEL is currently a prominent label for an umbrella movement focused on placing topics such as health promotion, stress management, emotion-focused coping, communication skills, and character education alongside traditional academics in the classroom (Elias, Zins, Weissberg, Frey, Greenberg, et al., 1997; Kort & Reilly, 2000; Ross, Powell, & Elias, 2002). SEL has been referred to as "the explicit nurturing of skills and attributes whose level of development helps determine the strength of our emotional competence" (Pasi, 2001, p. xi) and has been associated with topics such as respect, responsibility, caring, candor, health, and the nurturing of the inner life (Pasi, 2001). SEL is often contrasted with academic learning, which emphasizes academic content and cognitive skills, and is cast as a preventive measure to arm young people with the basic and essential life lessons necessary to cope with an increasingly pressurized society (Ross, Powell, & Elias, 2002). SEL programs are also aimed at taking advantage of research linking enhanced cognitive functions and brain development with emotional development (Schwarz, 2002; Sylwester, 2003).

Key outcomes for school-based SEL programs have been variously identified as helping young people to recognize and manage emotions, cope with stress, avoid high-risk behaviors, appreciate the perspectives of others, establish positive goals, make responsible decisions, handle interpersonal decisions, and decrease violent or aggressive behavior (Collaborative for Academic, Social, and Emotional Learning, 2003; Schwartz, 1999; Pasi, 2001). Other educators (Elias, Hunter, & Kress, 2001; Ross, Powell, & Elias, 2002) recommend that SEL programs focus on building skills in four areas: (1) life skills and positive social competencies related to generic life, health, workplace, and citizenship skills; (2) health promotion and problem prevention/risk reduction skills related to specific adolescent needs for positive health behaviors and lifestyles; (3) conflict resolution and coping and social support for transitions and crises; and

(4) positive contributory service, such as tutoring, peer mediating, or community service. Specific skill-building exercises suggested to educators include problem solving, listening, emotional awareness, and cooperation (Payton et al., 2000).

The effectiveness of SEL programs is not yet clear. Generally, interventions associated with school- or community-based prevention programs can be divided into two categories: (1) programs that attempt to reduce the external risk factors linked to the development of a disorder, such as anger coping or social relations programs; and (2) programs that focus directly on internalizing behaviors and stress-related disorders (Greenberg, Domitrovich, & Bumbarger, 1999). Programs in the latter category include training in coping and social support for children suffering from stress, mood disorders, or disruptive disorders. Reviews of the effectiveness of these programs cite social support and problem-focused coping strategies as two protective factors that appear to modify risk factors for internalizing disorders (Greenberg, Domitrovich, & Bumbarger, 1999; Weissberg & Greenberg, 1998). However, despite the documented efficacy of SEL programs, researchers have concluded that prevention models for internalizing disorders are not well understood. They have also noted considerable gaps in research, including lack of studies on the impact of the quality of implementation on program effectiveness, poor understanding of the ecological considerations that affect variability in program effects on individuals, and insufficient knowledge of the measures necessary for assessing dimensions and outcomes (Weissberg & Greenberg, 1998).

Social-emotional learning and emotional intelligence

The range of outcomes associated with SEL makes it difficult to establish its precise theoretical underpinnings. Perhaps as a response to this empirical gap, SEL increasingly is identified with emotional intelligence (EI). EI began as a topic of study within academic psychology and grew out of research into intelligence testing from 1900 to 1969, followed by investigations into other areas such as the relationship between cognition and affect, nonverbal communication, social intelligence, and multiple intelligences (Mayer, 2001). Early proponents defined EI as "a type of emotional information processing that includes accurate appraisal of emotions in oneself and others, appropriate expression of emotion, and adaptive regulation of emotion in such a way as to enhance living" (Mayer, DiPaolo, & Salovey, 1990, p. 773). Popularized by Goleman (1995), EI has been variously equated with success in the workplace, organizational leadership skills, job security, satisfying marriages, increased intimacy, empathic accuracy, decreased risk of mental illness, self-actualization, wealth, flow theory and resiliency, giftedness, and the ability to improve individual learning performance (Barrios-Choplin, McCraty, & Cryer, 1998; Caruso & Wolfe, 2001; Cherniss, 1998; Ciarrochi, Forgas, & Mayer, 2001; Fitness, 2001; Flury & Ickes, 2001; Jordan, Ashkanasy, & Hartel, 2002; Lam & Kirby, 2002; Mayer, Perkins, Caruso, & Salovey, 2001; Parr, Montgomery, & DeBell, 1998; Salovey & Pizarro, 2003).

EI is strongly identified with the stress and coping literature—a development anticipated by researchers who have noted that stress primarily concerns negative person-environment relationships and emotional responses that fall under the larger rubric of emotion (Slaski, 2002). The varied definitions of stress usually point to this overlap between emotions and physiological responses to stress. Arnold (1990) defines stress as an extension into children's normal physical or psychosocial life experiences that acutely or chronically unbalances physiological or psychological equilibrium, threatens security or safety, or distorts physical or psychological growth or development, and the psycho-physiological consequences of such intrusion or distortion. Lovallo (1997) first defines stress as "a bodily or mental tension resulting from factors that tend to alter an existing equilibrium" (p. 28), but later defines it more broadly as "any challenge or threat to the normal processes or integrated functioning of a living thing" (p. 33).

EI thus spans popular psychology and empirical research efforts in a variety of domains, leading to chaotic definitions of the term as well as theoretical differences in conceptualizing EI (see Ciarrochi, Forgas, & Mayer, 2001). Competing views of EI now postulate EI either as a set of abilities or as a disposition (Mayer, 2001). Despite debate over appropriate definitions for EI, however, SEL programs are generally founded on the assumption that EI can be taught and learned, and that increasing EI will improve mental and emotional functioning and lead to improved academic functioning (Lewis, Schaps, & Watson, 1996). For example, Pasi (2001) introduces SEL by stating the need for developing the social and emotional intelligence of students. Bodine and Crawford (1999) use EI as the basis for behavior management and conflict resolution education.

Perhaps the most straightforward assertion of the importance of EI is the statement that "a primary principle of EI is that caring relationships form the foundation of all genuine and enduring learning" (Elias, Hunter, & Kress, 2001). This sentiment is echoed in a similar SEL guide for educators written by Elias et al. (1997), who refer to Goleman (1995):

> Social and emotional competence is the ability to understand, manage, and express the social and emotional aspects of one's life in ways that enable the successful management of life tasks such as learning, forming relationships, solving everyday problems, and adapting to the complex demands of growth and development. It includes self-awareness, control of impulsivity, working cooperatively, and caring about oneself and others. Social and emotional learning is the process through which children and adults develop the skills, attitudes, and values necessary to acquire social and emotional competence. In *Emotional Intelligence*, Daniel Goleman provides much evidence for social and emotional intelligence as the complex and multifaceted ability to be effective in all the critical domains of life, including school. But Goleman also does us the favor of stating the key point simply: "It's simply a different way of being smart." (p. 2).

A biopsychosocial wellness model for schools

Though laudatory and undoubtedly useful for children, at this time SEL is best seen as a collection of well-intentioned ideas rather than as a well-formulated approach to addressing the challenging issues of childhood stress and emotional health. The eventual success of SEL relies on resolving fundamental research questions of how EI fits with other aspects of intelligence and personality research, including key questions of whether EI is learned or inherited, and the extent to which EI is associated with personality traits (Sternberg, Lautrey, & Lubart, 2003). From these findings will flow answers to questions regarding the more practical aspects of SEL. How are emotional competencies taught to young people? What are the relationships between emotional competencies and the protective and adaptive aspects of stress and coping, particularly as related to adolescent and children's developmental issues? What diagnostic and intervention tools are most helpful in identifying and preventing emotional disorders in children? And, which methods are appropriate to use in a school environment?

How these questions might eventually be answered provide the context for the present study. The study was carried out in a school environment and focused on interventions and behavioral measures that could be incorporated into a comprehensive program integrating health prevention strategies, stress management skills, and the development of emotional competency into a broad-based wellness model for children and adolescents—a need expressed in diverse child development and health studies (Holahan, Valentiner, & Moos, 1995; Payton et al., 2000; Ross, Powell, & Elias, 2002; Saltzman & Holahan, 2002; Weissberg & Greenberg, 1998).

The theoretical foundation for the study is rooted in the emerging biopsychosocial model of disease and health—a model that recognizes the interaction between socio-cultural and mind-body processes that influence the stress response and overall health of individuals (Schwartz, 1979). As Pallson (personal communication, April 12, 2002) states, "[The biopsychosocial] model holds that clinical symptoms and health problems always result from interactions between physiological variables, psychological factors, and social influences." In part, this model is based on the finding that a well-defined set of psychological risk factors can be associated with physical complaints or that amplify physical disorders, demonstrating that disease and wellness are bidirectional (Wickramasekera, 1988). This assumption disputes the medical model of disease, in which the root cause of a disorder is assumed to be organic dysfunction, and in which the patient is generally seen as a passive recipient of medical services rather than as an active participant in treatment. The biopsychosocial model has become the preferred paradigm for understanding the etiology of a broad spectrum of common medical conditions that cannot be traced to a serious organic identifiable disease and that are often caused by stress. These conditions include chronic fatigue, chronic pain, headache, irritable bowel syndrome, tempromandibular jaw pain, primary insomnia, low back pain, and primary hypertension (Drossman, 1998; Wickramasekera, Davies, & Davies, 1996). For children, the list of physical ailments resulting from stress can include asthma, enuresis, anorexia, and gastrointenstinal ulceration (Chandler, 1985).

Confirmation of the model comes in part from a growing understanding of the physiological correlates of behavior problems in childhood, including autonomic nervous system (ANS) disruption (Bauer, Quas, & Boyce, 2002; Scaer, 2001b; Sudakov & Glashov, 2001). These studies show that alterations in both the sympathetic-adrenal-medullary and hypothalamic-pituitary-adrenal systems—the two major physiological stress response systems—are predictive of behavior problems in children and adolescents, with persistent low sympathetic activation linked to externalizing or aggressive behaviors and persistent high sympathetic activation associated with internalizing disorders such as depression and anxiety (Bauer, Quas, & Boyce, 2002). These findings have been verified by recent evidence indicating that family dysfunction not only leads to difficulties for children in psychosocial functioning and social competence, but also causes children to suffer from disruptions in stress-responsive biological regulatory mechanisms, thus accumulating risk for mental health disorders, chronic disease, and early mortality (Repetti, Taylor, & Seeman, 2002).

Research into the intricate physiological mechanisms of stress underscores this close relationship between the stress response and thoughts, feelings, behaviors, and lifestyle (see Theorell, 2001). Lovallo (1997) cites the causal elements of disease as including "complex behaviors such as the thoughts and emotions of the affected person and the socioculturally determined environment in which that person lives" (p. 12). Similarly, Rabin (1999), a psycho-neuroimmunologist, emphasizes in his work on stress and the immune system that, "one important factor, restated throughout the book, is that the response of individuals to stress will differ depending on factors experienced in utero, during the early formative years, adolescence, and adult life" (p. 6).

Included in the biopsychosocial model is the use of psychophysiological measures to assess the stress response or to provide physiological feedback through biofeedback training (Arena & Schwartz, 2003; Hamel, 1998). Interventions include relaxation therapies, stress management techniques, and various forms of biofeedback, including electroencephalographic and resonant frequency heart rate biofeedback, with training designed to modify physiology or improve performance (Gevirtz & Lehrer, 2003; Schreiber & Schreiber, 1995; Schwartz & Andrasik, 2003; Schwartz & Olson, 2003). These measures serve as potentially vital empirical indicators of health, stress, and mental disorder, thus creating a physiological profile of the manifestations of stress and stress reactivity in a patient's body and capturing psychological information that may yield clues as to the source and impact of stress (Pallson, personal communication, April 12, 2003). Such a profile can help uncover the effects of stress that occur beneath the conscious level and that can result in somatoform and psychophysiological disease. For example, Wickramasekera (1988) states that the purpose of a stress profile is to identify "the nature, the number, and the delay in recovery of physiological changes induced in the individual patient by a standardized psychological stressor" (p. 89), as well as to identify situational factors and psychological features such as coping skills or support systems that amplify, attenuate, or buffer physiological reactivity.

Because the biopsychosocial model embraces stress management, mental and physical health outcomes, and screening capability, it may provide a basis for schools to develop an adequate response to SEL issues while also addressing the significant challenge of identifying children at risk from stress or emotional disorders who are not marked by some public event such as divorce or illness, or whose disorders do not have clear beginnings (Roosa, Wolchik, & Sandler, 1997). School psychologists already recognize this issue and have attempted to move away from the current medical model paradigm commonly in place in schools (Ross, Powell, & Elias, 2002). This seems justified, since the increasingly diffuse nature of childhood disorders would seem to argue against less distinction between 'normal' and disordered children.

Exploring interventions: The heart-brain connection

A general review of studies on emotions and physiology supports the possibility that emotions can be induced through physical or psychological means and, similarly, that the consequences of emotions can be measured physically or psychologically (Maunder, 1995). The present study used heart rate variability (HRV)—a measure of the peak-to-peak variability in the heartbeat—to empirically link stress-induced behavior with physiological reactions and emotional state. Because of the connection between the heart and brain via the vagal nerve, which carries efferent and afferent nerve fibers associated with the parasympathetic system, HRV acts as an indicator of the functioning of the ANS (Friedman & Thayer, 1998; Kollai & Kollai, 1992; Porges, 1995a, 1995b). In healthy individuals, the sympathetic and parasympathetic nerves maintain a complex, finely tuned balance of activation and relaxation that can be measured through HRV spectral analysis, offering a powerful, noninvasive measure of neurocardiac function that reflects heart-brain interactions and ANS dynamics (Armour, 2003; McCraty, Atkinson,

& Tomasino, 2001). The finding that HRV is a sensitive indicator of vagal functioning makes it possible to derive new definitions of stress and stress vulnerability that are operationally defined by ANS functioning. In HRV terms, stress is a state of ANS compromise reflecting a disruption of homeostasis due to depressed parasympathetic tone (Porges, 1995a).

Generally, the HRV signal is analyzed by means of spectral analysis to quantify the amount of *variability* in heart rate. However, there is evidence that the analysis of heart rate *patterns* also may provide useful information (McCraty, 2002b). For example, power spectral analysis of HRV patterns can help quantify shifts in autonomic balance, vascular resonance, and coherence (the amount of entrainment between the waveforms generated by the sympathetic and parasympathetic nervous systems). Specifically, negative emotions show a more disordered spectral pattern, with studies associating disordered patterns with depression, anger, frustration, anxiety, and greater stress. In contrast, positive emotions such as appreciation, love, or compassion result in a more orderly or coherent spectral pattern that has been associated with less stress and fatigue and enhanced immunity and hormonal balance (McCraty, Atkinson, Tiller, Rein, & Watkins, 1995; Tiller, McCraty, & Atkinson, 1996). Thus, positive emotions have been associated with a shift in autonomic balance toward greater parasympathetic functioning, increased heart-brain synchronization as reflected by alpha rhythms and electrocardiogram activity, increased vascular resonance, and entrainment between diverse physiological oscillatory systems (Tiller, McCraty, & Atkinson, 1996).

These physiological indicators show that there may be a distinct mode of physiological functioning that can be associated with sustained positive emotion, a high degree of mental stability, integration of cognitive and emotional systems, and increased synchronization between the cognitive, emotional, and physiological systems (Childre & Martin, 1999; Song, Schwartz, & Russek, 1998; Tiller, McCraty, & Atkinson, 1996). As with many other undefined linkages between biological and psychological processes, the mechanism by which HRV patterns might be associated with emotions is not known. Four possible connections between the heart and brain have been identified by Song, Schwartz, and Russek (1998), who speculated that neurological transmissions through nerve impulses, biochemical responses via hormones and neurotransmitters, biophysical interactions via pressure waves, and energetic connections through electromagnetic fields may result in heart-brain interaction.

Of particular interest to SEL educators is the possible association of HRV patterns with cognitive performance and the emotional climate of schools. For example, altering one's emotional state may result in HRV patterns that enhance cognitive functioning in critical areas such as memory and attention (McCraty, 2002a; McCraty & Atkinson, 2003; Schwarz, 2002). Altered HRV patterns have also been associated with improved citizenship skills and a decrease in the negative effects of mental and emotional stress (McCraty, Atkinson, Tomasino, Goelitz, & Mayrovitz, 1999). In a further example, nonnoxious, friendly social interaction has been shown to induce a psychophysiological response pattern involving relaxation, increased vagal tone, and decreased sympathetic-adrenal activity (Uvnas-Moberg, 1997).

The potentially intimate relationship between stress, physiology, and the impact of positive emotions leads to a complementary focus on human behavior, in which our understanding of the relationship between humans and their environment improves our knowledge of both the weaknesses and strengths of human functioning. As captured by the current trend of focusing on the positive aspects of human psychology, there is now emerging a body of research literature aimed at acknowledging and assessing healthy processes that enable humans to function successfully despite the presence of stress. Already it is known that high levels of hope improve performance in academics and sports, and that the capacity for social connectedness has been linked to lower mortality rates, resistance to communicable diseases, lower prevalence of heart disease, and faster recovery from surgery (Lopez, Snyder, & Rasmussen, 2003). Other studies show the beneficial effects of gratitude (Emmons, McCullough, & Tsang, 2003). Added to this is an emerging body of literature that shows that brain function improves in a positive social environment, with some researchers positing that learning occurs most efficaciously in a social context defined by positive relationships and a sense of community (Land & Hannafin, 2000; National Research Council, 2000; Sylwester, 2003).

Such speculation leads to the argument that stress should be less associated with pathologies and disorders; instead, it may be appropriate to view stress as an ongoing, fundamental aspect of life. In this context, coping involves a proactive approach to self-imposed goals and challenges, and stress management becomes a core emotional skill in which all children should receive instruction and support (Schwarzer & Knoll, 2003). Thus, the present study is intimately concerned with two aspects of the lives of children: (1) How do we help children relieve the effects of stress, and (2) how do we measure and improve the aspects of their inner life that lead to optimal mental health, successful performance, and fulfilling relationships? The significance of this study is that it may contribute to programs in schools that accomplish these vital goals.

Purpose of the study

This quantitative study compared two groups of ninth grade students at the Marin School of Arts and Technology in Novato, California. Sixty-two students received training in positive emotional refocusing—a technique for stress reduction and emotional self-management (the Freeze Frame technique) developed by the Institute of HeartMath (IHM) in Boulder Creek, California. Thirty-seven students acted as a control group (the control group received identical training subsequent to final data collection). Pretest and posttest scores on measures for HRV during autonomic recovery from stress, trait anxiety, EI, and three EI subscales were collected for both groups. In addition, to assess the impact of training on various students, participants in the training group were identified as High Anxious or Low Anxious youth on the basis of their scores on measures of trait anxiety on the State-Trait Anxiety Inventory (STAI) as well as the presence or absence of environmental stressors as measured by the Negative Life Events or Positive Life Events scales of the Life Stressors and Social Resources Inventory for Youth (LISRES-Y). The High Anxious and Low Anxious groups were compared on the same measures as used to compare results for the control and training groups.

The students in the study represented the freshman class at the school. Data was collected on students in groups of 22, organized according to a 45-minute Advisory class period held twice a week. In addition to participating in the research, the students learned goal setting, active listening, and conflict resolution. All students, including the 37 in the control group, received the same training in these areas to avoid potential confounds between groups.

The purpose of the research was fourfold: (1) to assess the impact of training using a standardized protocol on autonomic recovery from stress, as measured by comparisons of coherent HRV patterns during recovery from stress; (2) to evaluate the impact of training on three aspects of EI—intrapersonal skills, adaptability, and stress management—as measured by subscales of the Bar-On Emotional Quotient Inventory: Youth Version (EQ-i:YV); (3) to assess the impact of training on overall EI, as measured by the EQ-i:YV; and (4) to assess the impact of training on trait anxiety, using the trait anxiety scale of the STAI.

Hypotheses

The study was designed to compare results between training and control groups using one dependent variable: positive emotional refocusing. The study was also designed to provide a within-group comparison of High Anxious and Low Anxious students in the training group, and to use the variables in the study to explore the characteristics of High Anxious and Low Anxious youth. There were five hypotheses for the study:

1) Training in positive emotional refocusing will improve autonomic recovery from stress, as compared to groups that receive no training;
2) Training in positive emotional refocusing will increase intrapersonal EI, stress management EI, and adaptability EI, as compared to groups that receive no training;
3) Training in positive emotional refocusing will increase overall EI, as compared to groups that receive no training;

4) Training in positive emotional refocusing will decrease trait anxiety, as compared to groups that receive no training; and
5) Training in positive emotional refocusing will result in greater gains for High Anxious students on overall EI, intrapersonal EI, stress management EI, adaptability EI, and autonomic recovery from stress than for Low Anxious students, and will result in lower trait anxiety in High Anxious students. This was treated as an exploratory hypothesis.

Chapter 2

REVIEW OF THE LITERATURE

In a recent work (1999), Richard Lazarus, among the most prominent of researchers in the field of stress, coping, and appraisal, criticized the separation of the fields of emotion research and stress research as "an absurdity...[that] reflects the highly fractionated nature of our discipline and social science in general" (p. 35). His comments underscore the fact that the overlapping fields of stress and physiological arousal, coping processes, personality and learning, and emotional development have not yet yielded an integrated model that describes the origins of emotional health in children, or that leads to obvious, effective interventions that reduce childhood risks for unhealthy behaviors or promote the development of emotional competence.

For both adults and children, the development of an integrated model of wellness and stress management begins with unifying psychological and physiological approaches to physical and emotional health—a task now under way in a variety of disciplines (see Damasio, 1994; Maunder; 1995; Parks, 1997; Wickramasekera, 1988, 1999). Several steps in pursuit of that goal have been completed. For example, the close relationship between emotional arousal and physiological changes is well established, particularly in the form of alterations in the sympathetic-adrenal-medullary and hypothalamic-pituitary-adrenal systems (Bauer, Quas, & Boyce, 2002). Also, the physiological response to emotion has generally been outlined, beginning with sensory inputs into the central nervous system (CNS) and the generation of emotion based on the appraisal process. Emotions appear to register in the body through a complex feedback system between the cortex and limbic systems, mediated and adjusted by autonomic and endocrine processes (Lovallo, 1997).

Further, a number of theoretical models have been proposed that seek to link physiological correlates with behavior problems. Bauer, Quas, and Boyce (2002) suggest that across two broad categories of behavior—externalizing behaviors such as physical and verbal aggression, and internalizing behaviors such as avoidance, sadness, or fear—there may be very different sympathetic responses. The authors cite research showing that low sympathetic activation arousal has been linked to externalizing and disruptive behaviors, while internalizing behaviors have been linked with high sympathetic and adrenocortical activation in children. The same authors also criticize older, unidimensional models of physiological dysregulation and behavior—which rely primarily on assertions that certain children have an inborn tendency toward overarousal of the central nervous system—by pointing out that such models do not account for comorbid behavior problems or take into account that environmental stressors may elevate or suppress sympathetic activity, and thus induce various kinds of behaviors. The authors strongly recommend that researchers collect data on both physiology and behavior as a means of investigating children's bio-behavioral responses to stress, including measuring individual differences in the stress response through measures of cardiac reactivity and heart rate variability (HRV)—a measure of the peak-to-peak variability in the heart beat (Jemerin & Boyce, 1990).

Results from recent studies seem to bear out this recommendation. In one study, using HRV as a measure, Wood, Klebba, and Miller (2000) posited that family relational patterns and bio-behavioral reactivity interact so as to influence the physical and psychological health of children—a study that provided evidence for family-related potentiation of vagal response. Other studies showed relationships between physiological reactivity and social contact (Uvnas-Moberg, 1997) and between physiological response and alexythymia (Stone & Nielson, 2001).

The issues around emotion-specific physiological activity—particularly in the autonomic nervous system (ANS)—have been described as "one of the most enduring research topics in psychology" (Christie & Friedman, 2003, p. 143). Studies designed to address the methodological and theoretical issues raised in the literature give indications that such specificity exists. For example, Brosschor and Thayer (2003) found that cardiovascular effects, as measured by heart rate, lasted longer for negative emotions than positive emotions, and that emotional valence was a significant predictor of prolonged heart rate activation. Similarly, in a very recent study Christie and Friedman (2003) used both self-report and ANS variables—including systolic, diastolic, and arterial blood pressure measures—to confirm the hypothesis that affective states and emotional valence are associated with specific ANS patterns.

One area still to be explored in detail is the relationship between physiology and positive emotions—a not-surprising omission in the literature, considering that traditional approaches to the study of emotions have tended to overlook or ignore positive emotions (Tugade & Frederickson, 2002). Yet studies show that positive emotions—including a sense of humor, forgiveness, gratitude, and empathy—are clearly adaptive in that they appear to broaden an individual's thought-action repertoire, enlarge cognitive contexts, and help build enduring personal resources (Lopez & Snyder, 2003; Tugade & Frederickson, 2002). Also, positive emotions appear to influence health and well-being, based on studies showing strong relationships between emotional health and work outcomes (Robitschek, 2003), subjective well-being (Keyes & Magyar-Moe, 2003), and quality of life (Power, 2003).

The mechanisms by which positive emotions are generated—and how those mechanisms influence emotional development or expression—are still a topic of speculation. One focus of investigation, highlighted in the present study, is the role of the heart in generating positive emotions. For example, McCraty (2002b) relates HRV dynamics to emotional states, with positive emotions—particularly love, appreciation, and gratitude—resulting in a highly ordered, or coherent, pattern of heart rhythms that reflects greater synchronization between the sympathetic and parasympathetic nervous systems. Such coherent patterns have been linked to entrainment phenomena occurring between HRV frequency patterns, respiration rates, and very low frequency electroencephalogram recordings, suggesting relationships between relaxed self-attention and the diverse oscillating systems of the body, and implying that heart-focused methods enhance connectivity between the heart and brain (Song, Schwartz, & Russek, 1998).

Similarly, Pearce (2002) suggests that coherent ANS functioning influenced by feelings of appreciation, love, or gratitude results in a shift in the electromagnetic field of the heart, thereby communicating positive feelings to other parts of the body. Scaer and Schneider (2002) dispute this view, arguing that ascribing intrinsic brain functions to the heart is at present a metaphorical example rather than a scientific conclusion. However, the authors (Scaer & Schneider, 2002) concur with studies of nurturing and social bonding that clearly implicate the limbic system of the brain in the development of positive emotions. Adding to this debate (and illustrating the range of theoretical models under discussion), Seward (2000) describes stress as unresolved issues of anger and fear that disrupt the coherence of the electromagnetic fields of the body, and speculates that a model of wellness will emerge that links physiological coherence and subtle body energies to overcome and manage spiritual stressors such as lack of relationships, values, or a meaningful purpose in life.

Stress and child development

The importance of developing integrated models to support health and wellness in children cannot be overstated. Empirical support for the effects of stress on children is clearly evident in a recent meta-analysis of the impact of family stressors on the mental and physical health of children (Repetti, Taylor, & Seeman, 2002), with the research literature consistently pointing to the adverse developmental effects of the two general characteristics of an at-risk family social environment: (1) conflict and aggression; and (2) a cold, unsupportive, or neglectful home. These stressors can lead to disruptions in physiological functioning and to acquisition of inappropriate emotional and behavioral self-regulatory skills. The authors cite studies showing that the bulk of damage to physical health comes from the initiation of biologically dysregulated responses to stress, including dysregulation of the parasympathetic nervous system and sympathetic-adrenomedullary system and hyper-reactivity in the hypothalamic-pituitary-adrenocortical system. Repeated exposure to stress and repeated social challenge appear to result in cascading effects that disrupt basic homeostatic processes central to the maintenance of health. These stressors point to potentially irreversible interactions between genetic predispositions and environmental factors, and eventually lead to large individual differences in susceptibility to stress, biological markers of the cumulative effects of stress (including chronic disease), and stress-related mental and physical disorders.

The mental effects of stress on children are associated with the experience, control, and expression of emotion, particularly in emotionally arousing situations, with the data showing effects such as high emotional reactivity, deficits in emotional understanding, and a reliance on unsophisticated coping responses to stressful situations (Repetti, Taylor, & Seeman, 2002). In turn, emotion processing affects social competence, leading to poor social skills, more hostile and aggressive behaviors, and a shift in the basic cognitive structures that guide social behavior and relationships in childhood and adulthood (Repetti, Taylor, & Seeman, 2002). These findings have far-reaching consequences, given that it is generally accepted that exposure to stress and trauma is increasing in society and that the trauma necessary to place individuals at risk may be more subtle than previously believed, as indicated by evidence that family dysfunction during childhood correlates with several of the leading causes of death in adults (Scaer, 2001b). Further, there is strong evidence that environmental insults to the brain during critical periods of childhood can affect corticolimbic development and functioning, leading to neuropsychiatric disorders or psychopathologies (Benes, 1995).

Although it appears that more children are exposed to greater stress at an earlier age than in previous eras, the research on how children cope with stress has not kept pace with the pressures on children (Sandler et al., 1997). Research on resiliency—generally defined as the accomplishment of positive developmental outcomes in the face of adversity—has yielded information on the characteristics of the child, relationships with primary caretakers, and support from extrafamilial community resources. However, studies have been criticized for lacking a broad stress and coping framework that identifies the family of variables that concerns adaptation to stress events (Sandler et al., 1997). For example, Sandler et al. contend that a more broad-based transactional model, composed of three interrelated components, is more useful for understanding how children cope with stress. The components of the transactional model are: (1) environmental stressors, (2) appraisal and coping strategies, and (3) social resources for help. Coping, in turn, is broken down into three aspects: (1) coping resources, which are relatively stable characteristics of the individual; (2) coping styles, which are habitual preferences; and (3) coping efforts, such as asking for help or seeking out an adult. It is also important to note that the same authors emphasize that links between the theoretical and intervention research are not strong, although there is consistent evidence showing that problem solving and positive cognition about a stressful situation lead to fewer mental health problems and less substance abuse in children (Sandler et al., 1997). Successful coping and positive psychological adjustment have also been associated with parental support (Holahan, Valentiner, & Moos, 1995) and social support (Saltzman & Holahan, 2002).

Trad and Greenblatt (1990) note that vital questions remain unanswered about stress, coping responses, and the impact of stress on children's maturation. For example, they cite three unresolved issues relating to stress and the normal trajectory for a child's psychological development: (1) What is the impact of stressors on children's psychological health? (2) Can stress have a serious impact on the progression of development? (3) Does stress deflect or enhance the developmental achievements of children? To answer these questions, Trad and Greenblatt examined a variety of factors that interact with the developmental process in children, including age, temperament, attachment figures, cognitive skills, locus of control, and skills at seeking social support. For example, helpful temperament characteristics include emotional flexibility, a positive emotional outlook, and ego resiliency. Attachment and family support are identified as critical factors. In addition, perception of control emerges as a central, recurring theme in stress and coping responses of children. For example, if the locus of control orientation is internal in children, with a body of mastery experiences to reinforce belief in their own abilities, children can cope more successfully. Similarly, the link between stress and psychiatric disorders is much stronger when the stressful event is seen as uncontrollable by children. Trad and Greenblatt state that "children's ability to control their environment, and their faith in that ability, is one of the strongest protective factors for stress" (p. 39).

Aldwin (1994) confirms that less is known about coping in adolescents than in younger children, who generally use emotional regulation and emotion-focused coping strategies under stress. As children move beyond middle childhood into adolescence, problem-focused coping becomes more sophisticated and decreases in egocentrism improve interpersonal negotiation skills. However, in adolescence maladaptive behaviors and gender differences in depression also appear, making it likely that adolescence constitutes a critical stage in the development of coping skills (Aldwin, 1994). It is during this critical stage of adolescence where it appears that some individuals do not master more internal techniques for coping, but instead continue to rely on behavioral emotion-focused strategies or turn to licit or illicit substances to modify internal states. Aldwin

(1994) suggests that research findings indicate that programs designed to improve cognitive emotion-focused coping strategies in preteens and adolescents may be the most effective intervention at those ages.

Lazarus (1999) underscores the lack of research on adolescent coping, citing the study by Seiffge-Krenke (1995) as the most comprehensive study of adolescent development and coping skills, in which Seiffge-Krenke draws on extensive data on European youth to conclude that age 15 is a turning point in the use of coping strategies and social resources. For example, early adolescents may be unable to differentiate between sources of support, while late adolescents can select support to address the problem at hand.

Adding further complexity to the question of stress vulnerability is the relationship between child development, personality, and stress or anxiety. It has been found, for instance, that trait anxiety and conduct problems tend to be positively correlated, while callousness and unemotional traits tend to be negatively correlated (Frick, Lilienfedl, Ellis, Loney, & Silverthorn, 1999). Further, personality is associated with dissociative tendencies that may heighten the effects of stress or the physiological reaction to stress (Scaer, 2001a). With a long history in psychology, dissociation is generally viewed as a function of the multiplicity of the self, whether stated as modularities or multiple states of mind (Erdelyi, 1994; Kihlstrom, 1994; Krippner, 1997; Nemiah, 1998). In addition to the relationship between dissociation and trauma, dissociation has also been associated with hypnotic ability and constructs such as openness to experience and imaginative involvement (Bowers, 1994; van der Kolk & McFarlane, 1996).

Dissociation is of interest because of its relationship to psychophysiological disorders. First, there are indications that dissociation is a natural physical response to chronic physical and psychological pain (Carlson, 1994; Spiegel & Vermutten, 1994). Carlson (1994), for example, associates dissociation with seizure disorders, premenstrual syndrome, eating disorders, and physical and sexual abuse. Second, dissociation is closely related to hypnotic ability and cognitive styles such as absorption, a construct describing one's tendency to absorb self-altering experiences from the environment and to become fully involved in a perceptual or ideational experience (Spiegel & Vermutten, 1994; Tellegen & Atkinson, 1974). Similarly, a close relationship has been established between dissociation, hypnosis, and somatic function, including hypnotic effects on skin disorders, burns, allergies, blood flow, gastrointestinal functioning, and neurological and respiratory symptoms (Spiegel & Vermutten, 1994).

Stress and physiology

The foundation for the modern concept of stress has been traced to disagreements in the 19th century between the school of physiologists led by Claude Bernard, who argued in favor of mechanical determinism, and the vitalists, who asserted that living things were subject to more than physicochemical laws and that attempts to study life by reducing it to subcomponents disrupted the vital force (Lovallo, 1997). Effectively countering the arguments of the vitalists, Bernard showed that simple, one-celled organisms were not capable of maintaining themselves independently of external factors such as moisture, temperature, oxygenation, and nutrients. He held that the functions of complex living organisms were determined by the internal and external environment, and demonstrated that external challenges to the organism provoked responses to counteract those threats.

Early in the 20th century, Cannon (1929, 1935) coined the term *homeostasis* to describe the body's process of detecting nonoptimal internal states as the result of physical or psychological challenges and using autonomic or endocrine processes to reestablish optimal conditions. Cannon recognized that the struggle to adapt and survive can impair the homeostatic steady state and that bodily resources mobilized to avoid danger or attack a foe resulted in a "fight-or-flight" reaction associated with anger or fear. In turn, Selye (1957)—invoking the concept of stress as a systematic means of understanding responses by the organism to environmental stressors—identified a range of physiological responses to stress that could be considered either adaptive or disease-producing, depending on the severity of the stressor and the capacity of the organism. Selye described a general adaptation syndrome—a set of orchestrated neurochemical defenses—that enabled the body to defend against physical or unwanted stressors. The syndrome begins through the action of the pituitary gland, which is closely linked to the hypothalamus and secretes adrenocorticotrophic hormone (ACTH)—a principal hormone that stimulates the adrenal glands to release glucocorticoid hormones, including cortisol—to activate energy metabolism, body defenses, blood flow to the skeletal muscles, and a sharpening of the senses (Habib, Gold, & Chrousos, 2001). This hypothalamus-pituitary-adrenocortical axis represents one of the body's main stress-responsive systems and, as currently understood, is seen as a complex antagonistic system that involves a variety of neurohumoral responses to stress, including endorphin activity and the release of growth hormone and prolactin (Bourne & Yaroush, 2003; Habib, Gold, & Chrousos, 2001; Lazarus, 1999).

The second biological system that is highly reactive to stress is the nervous system, primarily through the two divisions of the ANS—the sympathetic nervous system (SNS) and the parasympathetic nervous system (PNS). Sympathetic nerves arouse the body, initiating a largely catabolic response that uses up bodily resources for energy and emergency effort, partially through stimulating the release of adrenaline and noradrenaline. These catecholamine hormones, secreted by the medulla in the adrenal glands, are responsible for peripheral responses associated with stress, including increases in heart rate, blood pressure, respiratory rate and perspiration, and the inhibition of digestive and social functions (Cacioppo, 1994). Furthermore, the SNS acts to decrease gastrointestinal motility, reduce saliva and mucus, induce sphincter contraction, and cause bronchodilation. Parasympathetic responses dampen this arousal and facilitate anabolic processes that restore, reconstruct, and relax the body by increasing gastrointestinal motility, decreasing sphincter tone, and contracting pupils (Aldwin, 1994; Lazarus, 1999). The two systems interact in ways that are reciprocal, additive, or subtractive, with overall activation of the ANS occurring primarily via the spinal cord, hypothalamus, and brain stem. Down regulation of the ANS is also possible through cerebral activity (Gevirtz & Lehrer, 2003).

The schematics of the stress response, as sketched out in the above sentences, have turned out to be far more complicated than can be described by a simple causal model. Stress research is now rooted in transactional models that take into account the complex relationships between emotions, physiological response, psychological state, individual differences, and person-environment interactions (Aldwin, 1994; Lazarus, 1999). In the transactional model, sociocultural, psychological, and biological factors influence each other, both within and across levels. Lazarus (1999), for example, presents arguments for a cognitive-mediational-relational approach to stress and the emotions that imply that the most important task in stress research is to specify what is "psychologically noxious—that is, to identify the rules that make a psychological event stressful, thereby producing a stress reaction" (p. 48). Aldwin (1994) argues for an even broader viewpoint, stating that the study of stress reveals an intimate relationship between the mind, physiology, neuroendocrine system, and immune system, making human adaptation within a transactionist framework "one of most important constructs in the clinical and social sciences today" (p. 20).

Regardless of the exact parameters of the model, a brief description of how stressors may be perceived and processed by the brain illustrates the complexity of deciphering the stress response. For example, Lovallo (1997) states that sensory information is relayed through the thalamus, which directs information to the prefrontal cortex, where raw sensory information mixes with stored information and meaning or significance is attached to the information. After evaluation and interpretation in the frontal lobes, plus the generation of the appropriate coping strategy, the limbic system is engaged. Here the amygdala, as a center of memory and emotion, helps us decide if we face a genuine threat and begins the activation of autonomic and neuroendocrine responses through the hypothalamus or structures in the brainstem such as the pontine reticular formation, nucleus of the solitary tract, nucleus paragigantocellurais, and brainstem aminergic nuclei. Depending on commands from the amygdala and hypothalamus, a complex set of endocrine responses then occur, including secretion of corticotropin releasing factor (CRF)—which controls beta endorphin and ACTH release and the ultimate secretion of cortisol by the adrenal cortex. At the same time, CRF acts as a neuropeptide that appears to coordinate emotion, behavior, and autonomic and hormonal response in the hypothalamus, brainstem, prefrontal cortexes, and hippocampus (Lovallo, 1997).

In addition to targeted physiological responses in the body, stress also affects the immune system. A comprehensive review of contemporary research on stress and immune function, such as offered by Rabin (1999), is beyond the scope of this study. But evidence indicates that psychological and physical stressors alter humoral and cellular immune function—changes linked to increases in cancer, allergies, and autoimmune and immuno-deficiency diseases (Aldwin, 1994; Rabin, 1999). The question of how stress affects the immune system is tied to understanding the complex system of hormonal pathways employed by the brain to regulate normal homeostatic processes, a system that has yet to be fully deciphered. Rabin (1999), for example, reviews research findings—nearly all of which are preliminary—on the effects of 10 prominent stress-related hormones and neuropeptides on immune function. Most prominently, this list includes the catecholamines, which have a known effect on the bone marrow production of lymphocytes, and the glucocorticoids, which affect adrenal function, steroid production, and lymphocyte levels in the blood. In addition, a variety of secondary substances associated with a stress response either depress the production of hormones by immune cells or attenuate the suppression of the immune response. These substances include somatostatin (a peptide released from sensory nerve terminals), growth hormone and prolactin from the pituitary gland, melatonin from the pineal gland, enkephalins and endorphins (naturally occurring proteins in the brain), and serotonin (produced by neurons).

Stress and autonomic dysfunction.

A discussion of the confluence of psychological stress and physiological response often centers on the ANS. A number of specific stress-related disorders, such as chronic fatigue or irritable bowel syndrome, have been linked to dysregulation of the ANS. ANS dysregulation as a response to acute stress has also been identified as a potential source of somatic disorders and dissociative responses in persons suffering from posttraumatic stress disorder (PTSD) (Scaer, 2001a). Dysregulated emotional states may also be related to ANS dysfunction. For example, less parasympathetic activity—or lower cardiac vagal tone —may support a predisposition toward anger, depression, or anxiety, while elevated sympathetic activity may support tendencies toward panic attacks or impulsive aggression (Kollai & Kollai, 1992; Porges, 1995a; Watkins, Grossman, Krishnan, & Blumenthal, 1999). This dysregulation may also be exacerbated by behavioral predispositions (Beauchaine, 2001).

Further, as the sympathetic and parasympathetic systems oscillate in response to chronic stressors, there is a perpetuated and excessive cyclical dysfunction of autonomic regulation leading to alternating symptom categories of arousal and avoidance. Thus, the normal oscillations of the sympathetic and parasympathetic nerves move from a homeostatic mode to extremes of physiological tolerance. Scaer (2001a, 2001b) hypothesizes that these extremes may be associated with dissociative disorders, cognitive impairments, and diverse chronic diseases—all of which may result from a single substrate of autonomic dysfunction. Labeling chronic disorders as the "diseases of trauma" that result from prolonged or excessive exposure to stress and repeated elevation of the SNS, Scaer directly links stress to the growing number of disorders found in both children and adults. Scaer places importance on the role of the PNS as well, noting evidence from infant studies that a negative maternal response can elicit a state of shame or withdrawal in the infant that is characterized by a shift from sympathetic ergotrophic arousal to parasympathetic trophotrophic arousal. The parasympathetic response is accompanied by decreased muscle tone, withdrawal from social interaction, vasodilation, and loss of facial expression (Scaer, 2001a).

The relationship between the long-term effects of trauma and disease is less well documented than the effects of stress on the body (Scaer, 2001b). However, as with stress, trauma has been shown to have physiologic effects. Rather than impact the cortical-based processes in the body, as does acute stress, it is reasonable to hypothesize that the effects of trauma may more directly impact autonomic regulatory mechanisms and parasympathetic and sympathetic balance. The predicted effects of trauma would include vagal and vasomotor symptoms as well as cardiac, pulmonary, bowel, and exocrine gland dysfunction. The list of current chronic disorders that might be associated with such dysfunction includes irritable bowel syndrome, Crohn's disease, bronchial asthma, fibromyalgia, and chronic fatigue. A number of studies also suggest that trauma may contribute to autoimmune diseases (Scaer, 2001a).

Cardiac vagal tone.

An important and intriguing aspect of the emerging model of stress, emotions, and autonomic dysfunction is the vital role played by autonomic processes in controlling the pacing of the heart rhythm—creating a constant variation in the rhythm that can be linked to healthy, or homeostatically balanced, states (Gevirtz & Lehrer, 2003). The heart connects with the brain via the vagal nerve—the 10th cranial nerve—which has efferent fibers that originate in different areas of the brainstem. The dorsal vagus complex originates in the dorsal motor nucleus of the brainstem, while the ventral vagus complex originates in the nucleus ambiguous. The vagal pathways from both nuclei terminate on the sinoatrial nodes of the heart, and both are responsible for regulating heart rate—creating parasympathetic connections between heart and brain that coordinate or compete with sympathetic activation.

The theoretical underpinning for assessing the dynamic functions of the vagal nerve stems from research indicating that in mammals the dorsal and ventral complexes represent two vagal systems—a vegetative "reptilian" system controlled by the dorsal complex and a neo-mammalian system that is myelinated and controlled by the nucleus ambiguous (Porges, Doussard-Roosevelt, Portales, & Greenspan, 1996). The two systems have different response strategies, with the mammalian system providing a rapid adjustment of metabolic output through vagal withdrawal and heart rate acceleration, while the dorsal system has little impact on cardiac output under most conditions. However, in threatening conditions, including low oxygen availability, the reptilian system supports resource conservation by stimulating bradycardia and apnea—a physiological response that appears to be adaptive for reptiles but potentially lethal for mammals, since it can lead to cardiac arrest and sudden death (Porges et al., 1996). Similarly, a persistent state of sympathetic activation is dangerous to mammals, and may result in states of immobility and life-threatening arrhythmias during extreme, prolonged activation (Scaer, 2001a, 2001b).

In humans, psychological processes related to vigilance, attention, and the "fight-or-flight" syndrome are also associated with vagal response and the balance between the dorsal and ventral complexes (Porges, 1995b). It has been hypothesized that extreme vagal withdrawal may contribute to the generation of severe emotions, especially "those of terror and helplessness," which, as noted earlier, are often associated with dissociation (Scaer, 2001a, p. 81). Sympathetic activation results in a heightened or even constant state of vigilance associated with the fight-or-flight response, an associated shift in vagal tone and cardiac reactivity, and altered brain function and physiology reflected by changes in brain wave patterns and levels of endorphins or other chemicals in the brain. These changes, if not balanced by the PNS, presumably lead to cognitive impairment, affect dysregulation, somatization, and a psychological state of dissociation. The implication of this hypothesis is that prolonged or repeated activation affects health and disease in the body, and that the root cause of chronic disorders may be traceable to traumatic events through the mechanism of vagal influence.

Thus, it is appears that vagal tone has two roles. First, during states of low environmental demand, the vagal system fosters homeostasis to promote growth and restoration. Second, during states characterized by environmental demand, the vagus acts as a "brake" to rapidly regulate cardiac output, functionally keeping the heart rate slow by increasing vagal output to the heart and actively inhibiting sympathetic influences.

Release of the vagal brake reduces vagal inhibition of the pacemaker on the sinoatrial node, thus increasing heart rate. In general, cardiac vagal tone increases to support homeostatic functions and decreases to support cardiac output and specific motor behaviors in response to environmental challenge (Porges et al., 1996). The key assumption is that environmental interactions require that metabolic output be rapidly regulated to support psychological and behavioral processes required to engage and disengage with the environment. The nervous system receives continuous sensory feedback from interoceptors within the body and exteroceptors outside the body, creating a complex feedback system that requires the organism to continually adjust, either to challenges from outside the body or to a need for growth and restoration. Cardiac vagal tone, as a central mechanism in this feedback loop, can be seen as a measure of the organism's ability to mediate these responses.

Studied extensively for the last decade as a marker of emotional regulation and psychological adjustment, cardiac vagal tone has been linked to emotional expression, temperamental reactivity, attachment status, empathic responding, social competence, and attentional capacity (Beauchaine, 2001). Porges (1995a) has been a leading proponent of a polyvagal theory of emotion and behavior, in which vagal tone regulation is seen as a key psychophysiological process that links autonomic function and primary emotions such as orienting, attention, and the fight-or-flight response. This conclusion has been consistently supported by studies of vagal tone that link anxiety and autonomic dysregulation (Friedman & Thayer, 1998). Adults diagnosed with Panic Disorder often demonstrate low vagal tone, as opposed to non-anxious controls; similarly, developmental research on children has linked low cardiac vagal tone with unresponsivity, distractibility, and emotional dysregulation. Using a vulnerability-stress model of psychopathology, it has been proposed that reduced vagal tone may be the outcome of complex interactions of genetic, physiologic, and environmental factors, in which low vagal tone is viewed as a predisposing risk for panic disorder.

Cardiac vagal tone can be assessed through spectral analysis by measuring the phasic relationship between respiration and vagal control of the sinoatrial node of the heart—a measure known as the respiratory sinus arrhythmia. Because of this phasic relationship, the quantification of the amplitude of this measure has been proposed to be an accurate indicator of the balance between sympathetic and parasympathetic influence and the magnitude of cardiac response—thus serving as an index of vagal functioning and regulation (Fracasso, Porges, Lamb, & Rosenberg, 1994).

Heart rate variability.

Heart rate represents the net effect of the PNS, with beat-to-beat changes in heart rate reflecting shifts in autonomic outflow to the heart from the vagus nerve, which slows the heart, and the sympathetic nerves, which accelerate the heart. At rest, both sympathetic and parasympathetic nerves are active, with vagal influence dominant. Sudden changes in heart rate are parasympathetically mediated, since the response time of the sinus node to vagal stimulation is a very short one to two heartbeats; response to sympathetic activation is relatively slow, with a delay of up to five seconds before the stimulation results in an increased rate (Hainsworth, 1995).

Pacing of the heart rhythms by the sympathetic and parasympathetic nerves can be distinguished through measurements of the peak-to-peak variability (HRV) in the heart rate, usually measured as the standard deviation of the interbeat interval. HRV data can be collected though an electrocardiogram or a pulse plethysmograph—both of which produce closely parallel frequency calculations (Giardino, Lehrer, & Edelberg, 2002). HRV is indicative of the autonomic control of the heart, and the data can be directly translated into power spectral density to discriminate and quantify sympathetic and parasympathetic activity by reducing the HRV signal to frequency components and quantifying the relative power of each component (McCraty, Atkinson, Tiller, Rein, & Watkins, 1995). The very low frequency range of .0033 to .04 H_z represents slower changes in heart rate and is an index of sympathetic activity. The high frequency range of .15 to .4 H_z indexes parasympathetic activity. The low frequency band of .1 H_z is more complex and reflects a mixture of sympathetic and parasympathetic activity and is thus the most useful of the components as an indicator of overall autonomic activity. Total power value reflects the power in all bands during the recording session and is associated with higher risk of cardiac death and all-cause mortality in post-infarction patients (Saul, Arai, Berger, Lilly, Colucci, & Cohen, 1988). Healthy individuals vary considerably in autonomic activity, and HRV is affected by factors such as posture, movement, talking, emotional state, and sleeping—requiring that measurement protocols be carefully followed. Higher resting HRV has also been associated with better cardiac health (Tiller, McCraty, & Atkinson, 1996) and improved performance on tasks involving executive functions (Hansen, Johnsen, & Thayer, 2003).

The finding that the ANS is continuously servicing the viscera in an attempt to maintain homeostasis and promote physiological stability under stress, and the fact that HRV has emerged as a sensitive psychophysiological indicator of ANS functioning, makes it possible to derive new definitions of stress and stress vulnerability that are operationally defined by physiological functioning. In HRV terms, stress is a state of ANS compromise reflecting a disruption of homeostasis due to depressed parasympathetic tone and elevated sympathetic activity. Thus, spectral analysis of HRV provides an important physiological measure of traumatic or stress-induced reactions and potential somatoform diseases, emphasizing the neurophysiological mechanisms mediating the stress response and the uniqueness of the individual's response to stress (Porges, 1995a).

While HRV measures are still inexact in that normal variation in HRV appears to be driven by non-linear dynamics and does not have constant statistical properties, the physiological significance of HRV is that heart dynamics appear to be an emergent property of a complex physiology designed to prevent the heart from becoming locked into any one dominant frequency that might prevail under particular patterns of a person's behavior (Solê & Goodwin, 2000). The sum of the influences on the heart—including the ANS, hormonal signals, and behavior patterns—thus result in a dynamic coherence reflecting the health of a single unified system. An important extrapolation of this observation is that HRV allows practitioners to measure the health of one part of the system—that is, HRV—to assess the overall health of the body.

Decreased HRV has been linked to increased risk of sudden death and mortality from both coronary and non-coronary causes (Kleiger & Miller, 1978; Wolf, 1995). Recent research also indicates that low HRV may be associated with depression, schizophrenia, anxiety disorders, and PTSD (Cohen, Mata, Kaplan, & Kotler, 1999; Watkins, Grossman, Krishnan, et al., 1996). Studies of HRV and personality traits have shown strong correlations between sympathovagal tone and personality variables. For example, high sympathetic tone has been associated with greater inhibition, greater excitability, more anxiety, and greater emotional lability (Schweiger, Wittling, Genzel, & Block, 1998). However, other studies have indicated that vagal response is sensitive to persistent emotional distress but is independent of disposition toward experiencing anxiety (Dishman, Nakamura, Garcia, Thompson, Dunn, & Blair, 2000). Similar results were obtained in studies comparing high-trait, socially anxious individuals versus low-trait, socially anxious individuals (Mauss, Wilhelm, & Gross, 2003). And, though it has been shown that sympathetic activity increases in healthy males under the stress of a mental arithmetic task, similar results were not found for females, indicating potential gender differences in reactions to stressful situations (Sharpley, Kamen, Galatsis, Heppel, Veivers, & Claus, 2000).

Further, dynamic changes in HRV may be related to emotional regulation and social behavior, with negative emotions such as anger, frustration, or anxiety resulting in disordered or more erratic heart rhythms, and positive emotions such as appreciation, love, or compassion resulting in more highly ordered or coherent patterns that reflect greater synchronization between the two branches of the ANS (Calkins, 1997; McCraty, Atkinson, Tiller, Rein, & Watkins, 1995; Tiller, McCraty, & Atkinson, 1996). It has also been shown that emotions such as frustration, worry, or anger result in an increase in sympathetic predominance and a decrease in parasympathetic activity (Pagani, Mazzuero, Ferrari, Liberati, Tavazzi, Vaitl, & Malliani, 1991). This has led some researchers to identify HRV patterns with a distinct mode of physiological functioning associated with the experience of sustained positive emotion—a mode termed physiological coherence that is denoted by increased sympathetic and parasympathetic synchronization, increased synchronization between heart rhythms and 8-12 H_z (alpha) rhythms in the brain, increased vascular resonance, and entrainment between diverse physiological oscillatory systems such as respiratory, craniosacral, and blood pressure rhythms (McCraty & Atkinson, 2003; Tiller, McCraty, & Atkinson, 1996). Psychologically, this mode has been linked to improved cognitive performance, increased emotional stability, enhanced psychosocial functioning, and reduced anxiety and depression (McCraty & Atkinson, 2003).

Cardiac studies of infants have confirmed the reliability and stability of individual differences in HRV, indicating that cardiac vagal tone and interbeat interval are stable indicators of autonomic functioning over time (Fracasso, Porges, Lamb, & Rosenberg, 1994). There are also indications that infant regulation predicts child behavior problems and that it may contribute to a psychobiological model of social behavior (Porges, Doussard-Roosevelt, Portales, & Greenspan, 1996). Further, low sympathetic activation has been linked to externalizing, aggressive, or disruptive behaviors in children, while high sympathetic activation has been associated with internalizing behaviors such as avoidance, social withdrawal, worrying, feelings of inferiority, sadness, and fear (Bauer, Quas, & Boyce, 2002). The same study also concluded that vagal tone is reduced acutely in infants subjected to physical and emotional stressors, and that this decrease may be predictive of future stress-related reactions, cognitive development, mother-infant attachment, vigorous behavioral reactions to stimuli, and health outcomes in childhood (Bauer, Quas, & Boyce, 2002). As a result of these findings, the authors of the study recommended that physiological and behavioral measures be used to assess children's responsivity to stress, and that information gleaned from multidisciplinary studies be used to "make the health care system and the community of providers more responsive to the needs of vulnerable children" (Bauer, Quas, & Boyce, 2002, p. 147).

Coping, appraisal, and temperament

The integrative approach to understanding stress, coping, and development as articulated by authors such as Aldwin (1994) has led to a substantial literature describing the transactional relationship between stress in the environment and the organism—a multifaceted task that involves understanding the response of the nervous, endocrine, and immune systems as well as identifying appraisal systems, personality variables, coping styles, and other factors that govern or influence the stress response.

In nearly all studies, the brain takes center stage. Representative of this approach, for example, are remarks by Lovallo (1997) stating that "the brain is how we make contact with the external environment" (p. 85) and explaining that transactions between the person and the environment take place through a regulatory hierarchy of systems linking the ANS, endocrine messengers, brainstem and hypothalamus, and the higher brain centers above the hypothalamus that integrate emotion, memory, and awareness. In a similar vein, Arnold (1990), an expert in childhood stress, declares that "the brain is the basis of cognition, emotion, and behavior" (p. 6).

Theories of cognitive appraisal and anxiety use a schematic view to explain how the brain and CNS employ a variety of hierarchical controls to regulate stress, anxiety, and affect. For example, Lazarus and Folkman (1984), formulators of perhaps the best known model of cognitive appraisal, describe a process of primary appraisal of the threat value of an event and a secondary appraisal of the effectiveness of available coping options. In this system, events are judged to be benign or irrelevant or to be threats or challenges. Under threats—such as events that violate our beliefs about the world or preclude us from carrying out our commitments—the brain triggers an alarm system that motivates physiological and psychological consequences. At the same time, the brain evaluates the variety and effectiveness of potential coping responses. Coping responses may be problem-focused strategies that attack the problem itself or emotion-focused strategies that limit emotional disruption.

The appraisal approach to stress management has been recommended for use with young people. For example, in the same discussion suggesting a systematic approach to stress, Chandler (1985) primarily cites cognitive appraisal as the basis for developing coping strategies for youth. Quoting from the work of Moos and Billings (1982), Chandler (1985, p. 128) classifies coping responses into three categories: (1) logical analysis, in which the cause of the problem is identified and possible actions are rehearsed; (2) information or advice seeking, such as asking for help or guidance; and (3) affective regulation, in which attention is postponed by suppression, keeping a "stiff upper lip," or trying not to be bothered by conflicting feelings.

Similarly, Eysenck (1997) endorses the proposition that emotional experiences depend on the cognitive appraisal of the situation. However, he also cites two crucial arguments against appraisal theory. He notes that appraisal theory fails to take sufficient account of how emotions themselves can influence the cognitive appraisal process, and he acknowledges that empirical evidence for appraisal theory is suspect, primarily because it is difficult to assess a person's emotions if they are not accessible to consciousness. Using anxiety as his example, Eysenck also notes that "the greatest weakness of Lazarus' appraisal theory is that it does not provide an explanation of the lack of concordance typically found across self-report, physiological, and behavioural measures" (1997, p. 37).

These statements reveal some of the difficulties in cognitive theories of stress and anxiety. Partly, these difficulties stem from conflicting views on the relationship between physiological activity and emotional arousal, which make it challenging to integrate emotions into cognitive theories (Eysenck, 1997). Early theories of emotion and physiology, such as the James-Lange theory of emotion (James, 1898), put forth the hypothesis that emotions follow physiology—that is, we feel sorry because we cry, rather than cry because we are sorry. Later theorists (Schacter, 1964; Schacter & Singer, 1962) suggested that emotional experience depends on three factors: (1) the situation must be interpreted as an emotional one; (2) there must be a state of physiological arousal; and (3) the emotional situation must be perceived to be the cause of the physiological arousal.

The approach of cognitive psychologists in integrating emotions into general theories of anxiety is evident in Parkinson's (1994, 1995) work and Eysenck's (1997) four-factor theory of anxiety. The key theoretical assumption by Eysenck is that the emotional experience of anxiety—perhaps of other emotions as well—is based on input from four sources of information: (1) cognitive appraisal, which he identified as the most important determinant of anxiety; (2) physiological activity, which is filtered through two cognitive processes—selective attention and interpretation; (3) information stored in long-term memory; and (4) the experience of anxiety based on the individual's own tendencies (high- or low-trait anxiety). According to Eysenck, individuals high in trait anxiety possess a range of cognitive biases that are applied to ambiguous or threat-related stimuli, including selective attentional bias, interpretive bias, or memory bias—all of which are greater when individuals are stressed or high in state anxiety. As a final note on Eysenck's theory, the figure drawn to depict the various information routes to the brain shows a broken line connecting emotional experience back to cognitive appraisal. This line is broken because, as Eysenck confirms, the evidence remains inconsistent on the issue of whether emotional experience generally affects cognitive appraisal (Eysenck, 1997).

A number of authors (Lemerise & Arsenio, 2000; Saarni, 2000; Saarni, Mumme, & Campos, 1999) have argued strongly that developmental psychologists need to take a broader view of children's social and cognitive development by considering, both empirically and theoretically, how emotional and cognitive processes can be integrated into models of social competence. For example, Lemerise and Arsenio (2000) argue that the domain of emotion includes emotion processes that vary in duration from briefly experienced feelings resulting from appraisal to more enduring affective styles, and that a broader definition of cognition should incorporate recent neurophysiological evidence (see LeDoux, 1996; Damasio, 1994) that emotion processes and cognitive processes influence one another. Saarni (1999) specifically relates coping skills with emotional regulation and the development of emotional competence, stating that emotional regulation allows one to regulate one's emotional arousal and facilitate one's coping with an environmental stressor or conflict. A review by Saarni (1999) of several research studies shows that both high intensity of feeling and high frequency of negative feelings are aspects of emotional regulation that interfere with coping efficacy, especially in the social arena. Saarni also points out that the internal dimensions of emotional regulation become more salient in older children as they develop the facility to confront aversive emotional experiences with metacognitive strategies such as distraction, thinking optimistically, or shifting perspectives. Temperament, family, gender, and social maturity affect this facility. Saarni cautions that the influences of temperament are subject to definitional and measurement issues and must be seen broadly—that is, temperament should be applied to how a person responds emotionally to stress under particular social and cultural conditions rather than regarded solely as an inherent response to stressful circumstances.

Personality and stress.

Questions about stress—including how an individual's ability to cope with stress is dependent on levels of personal anxiety or on social and cultural mileus—are closely tied to fundamental issues surrounding personality research, including ongoing attempts to reconcile processing dynamics and behavioral dispositions (Mischel & Shoda, 1998). These issues directly influence competing conceptual models that have been developed to explain the processes by which personality interacts with stress and anxiety. Mischel and Shoda (1998) call for a theoretical reconciliation of these competing models, citing important gaps in the research on coping as a consequence of divided research approaches. The authors point out that to capture individual differences in flexible use of coping styles requires a perspective that focuses on stable individual differences in coping that is situationally contextualized and process-connected. Among other evidence, Mischel and Shoda (1998) cite child development studies that show high levels of stability and continuity in personality coherence and, at the same time, show shifts in cognitive-attentional processes that support the construct of social-emotional intelligence.

The history of temperament and trait models in personality research is the story of psychologists' continued attempts to categorize and verify the basic elements of personality—a daunting task, as pointed out by Wiggins (1997), who demonstrates that traits are obvious in everyday language but that a scientific account of traits is not easily achieved. Currently, a five-factor model of personality is popular (Wiggins & Trapnell, 1997). Known as the "Big 5," they are: (1) surgency/extraversion, (2) agreeableness, (3) conscientiousness, (4) neuroticism, and (5) openness to experience/intellect. These traits represent a distillation of five decades of trait research, beginning in the 1930s when Gordon Allport identified an exhaustive lexicon (nearly 4500) of potential trait-names. These were categorized and progressively refined by succeeding researchers such as Cattell, Tupes, and Norman from 1940 through 1960. By the 1960s the five-factor model of personality was sufficiently persuasive to be advocated by many trait theorists (Wiggins, 1997).

Empirical data shows that traits of the above types are enduring dispositions that seem to be stable over time and may even be present in non-English-speaking and Eastern cultures (Costa & McCrae, 1995). In addition, tests such as the Hogan Personality Inventory show that the five-factor model is useful as a basis for evaluating organizational and occupational effectiveness (Wiggins, 1997). The five factors, as they are derived from lexical research, align with patterns of behavior as described in language (Wiggins, 1997). In addition, heritability of personality traits is suggested by behavior genetics studies (Geen, 1997), and a biological basis for personality traits—rooted in various brain structures—has been strongly argued by leading researchers (Eysenck, 1967).

The close relationship between stress and theories of personality are evident in the work of Wiebe and Smith (1997), who discuss four models of personality and health that focus on different aspects of personality research: (1) the stress-moderation model, which assumes that stress causes illness and that dispositional factors influence one's vulnerability to stress; (2) the health behavior model, in which personality affects one's choice of health practices; (3) the constitutional predisposition model, which focuses on genetic predispositions toward health or illness; and (4) the illness behavior model, in which people's actions when they perceive themselves to be ill affect health as much as an organic disease or objectively measured pathophysiological process.

A key research question in personality underlies each model: Which personality constructs—including those such as Type A behavior, hardiness, optimism, or neuroticism—are valid and sufficiently stable to be used as a basis for assessing their impact on health-related behavior (Wiebe & Smith, 1997)? Of these, Wiebe and Smith suggest that neuroticism is the most useful construct, emphasizing the reliability of the five-factor model and the significant correlation between neuroticism and various measures of illness. This suggestion is buttressed by research showing a close association between negative affect—a construct closely aligned with neuroticism—and somatoform disorders that result from stress and immune suppression (Wickramasekera, 1998). However, the authors caution that neuroticism is a broad personality construct often associated with self-reported, subjective measures of health. Thus, the authors argue the need for additional research that distinguishes psychological causes of illness from physiological causes. They also point out that significant group differences may reflect somatopsychic processes rather than psychosomatic effects. That is, personality differences may be the result, rather than the cause, of physical illness.

Bolger and Zuckerman (1995) link neuroticism, interpersonal conflicts, coping, and daily distress into a theoretical framework for studying personality and stress. They begin with a model that distinguishes personality and stress exposure from personality and reactivity processes, which highlight coping choice and effectiveness. Using neuroticism as their construct, they conclude that high neuroticism is associated with greater exposure to stress and greater reactivity. They also conclude that high versus low neuroticism trait individuals differ in their choice of coping efforts and effectiveness.

In another study, Paulhus, Fridlander, and Hayes (1997) reviewed the contemporary literature on psychological defenses and health. Early work on psychological defense includes: (1) psychoanalytic theories of repression and denial; (2) trait and type approaches in which individuals were measured on a single trait and studied intensively; (3) Haan's (1965) work on coping and defense as independent, parallel modes of ego expression; and (4) Vaillant's (1992) studies of defensive maturity. This work has culminated in current studies on how individuals make active, conscious efforts to manage stress, and it emphasizes process rather than trait measurement as well as variability across situations. It has resulted in theories suggesting that stressful person-environment relations are mediated in stages in which individuals appraise the situation and determine their response. Coping becomes a constantly changing cognitive and behavioral effort to manage demands that are perceived to exceed the person's resources.

Norem and Illingsworth (1993) have attempted to use other constructs that may prove to be more precisely associated with coping. They propose that individuals use two strategies to reflect on themselves and their tasks in life: optimism or defensive pessimism. Defensive pessimism, which the authors hypothesize allows individuals to perform better and feel better in life, is defined as setting low expectations and thinking through possible outcomes as one anticipates upcoming events. This strategy is opposed to chronic optimism, in which individuals either ignore or distort negative information.

Both of these strategies are considered to be theoretical units of personality that refer to coherent patterns of appraisal, planning, effort, attribution, and retrospection that characterize an individual working toward a goal. They fall between more global dispositions or motives, and molecular behavioral sequences. Thus, individuals who are similar at a dispositional level of analysis may develop different domain-specific strategies. The two studies reviewed by the authors provide convergent evidence for this view, suggesting that reflecting on one's own feelings and goals had quite different effects for different individuals. However, neither study was able to identify the exact processes involved in pessimistic or optimistic strategizing, nor was there direct evidence that defensive pessimism is a constructive problem-solving process.

In another approach to personality and stress, Garmezy (1993) provides an overview of current research on vulnerability and resilience. The author frames the discussion by stating that vulnerability represents a heightened probability for maldevelopment because of the presence of one or more risk factors. Resilience is defined by the presence of any or many of these risk factors, but is also affected by positive elements within the individual or the external environment that serve a protective function. Risk factors for vulnerability include genetic disorders, presumed environmental variables, and links to affective disorders. There is also correlational data linking vulnerability to the chronic adversities that accompany poverty. For resilience, research suggests that three core protective factors operate for individuals in stressful situations: (1) temperament and personality, (2) warmth and cohesion in families, and (3) availability of social support. According to the author, personality attributes that may enhance resilience and further define the resiliency construct have been advanced by studies on ego-resilience and its relatedness to mobility, cognitive controls, competence, and coping strategies.

Personality and coping have also been linked to Rotter's (1966) work on internal-external locus of control, in which internal locus of control is associated with coping strategies and external locus of control is associated with defense mechanisms (Paulhus, Fridlander, & Hayes, 1997). Although locus of control is not considered a single factor in personality nor a stable personality dimension but a cognitive style based on several factors (Buss, 1997; Fournier & Jeanrie, 2003), it has been identified as an important aspect of personality that influences a person's transactions with the environment (Rotter, 1966). It is also now agreed that locus of control can vary with the situation and does not refer to a fixed, innate trait (Fournier & Jeanrie, 2003). Nonetheless, it is often included as an essential element in stress moderation models that assume that dispositional factors make an individual more or less vulnerable to the pathogenic effects of stress—an assumption born out by research (Wiebe & Smith, 1997). For example, children judged to have an internal locus of control were found to be more resilient in the face of alcoholic parents (Chassin, Barrera, & Montgomery, 1997), while youth with divorcing parents experienced less locus of control and poorer outcomes (Grych & Fincham, 1997). The assumption of researchers is also that a greater sense of control—the sense that one's own actions can influence events—correlates with higher self-esteem and ego strength and results in greater coping skills (Turkel & Eth, 1997). Locus of control is an intellectual function and develops at different rates in children relative to cognitive development in other spheres. This is an important consideration, given findings that a child's cognitive view of personal influence on events is intimately related to individual responses to stress (Skinner, Chapman, & Baltes, 1988).

The concepts of state and trait anxiety were introduced in the 1960s by Spielberger (1972) to study personality styles and traits in relation to stress. Spielberger distinguishes state and trait anxiety, regarding personality states and emotional reactions as temporal cross-sections in the stream-of-life of a person. Anxiety states are characterized by subjective feelings such as tension, nervousness, or worry of tension. In contrast, personality traits can be conceptualized as relatively enduring differences among people in "specifiable tendencies to perceive the world in a certain way and with dispositions to react or behave in a specified manner with predictable regularity" (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983, p. 5). Trait anxiety refers to relatively stable individual differences between people in the tendency to perceive stressful situations as dangerous or threatening, with corresponding elevations in state anxiety. There have not been consistent findings on the relationship between trait anxiety and psychophysiological measures—an inconsistency attributable to the fact that individual differences in trait anxiety may surface only to the extent that they interact with situational conditions to produce state anxiety (Geen, 1997). However, a recent study showed a relationship between trait anxiety and increase in arousal and impairment of steadiness under stress (Noteboom, Barnholt, & Enoka, 2001).

It is clear from the above review that while environmental factors influencing resilience and vulnerability can be well described, the exact mechanisms of emotion and cognition, as modulated by personality, remain unknown and result in continuing attempts to reconcile personality dispositions with processing dynamics driven by social interaction (Mischel & Shoda, 1998). Thus, linking physiology to theories of personality and cognition is difficult. Geen (1997) also points out that there are no impressive or consistent results correlating neuroticism with physiological processes in the body. However, recent advances in cognitive neuroscience that link mental processes to mental functioning research may yield additional information on the relationship between psychobiology and the structure of temperament (Rothbart & Bates, 2000). Rothbart and Bates (2000) also have noted advances in personality research using psychophysiological methods. For example, using measures of HRV and cardiac vagal tone, studies have found that high HRV predicts attachment security in infants, indicating potential links between temperament and physiological responses.

Stress and emotions: Toward an integrated model

Based on the conviction that emotions were epiphenomenal or could not be measured with specificity, the role of emotions in studies of stress and coping was generally not emphasized prior to the 1980s. The trend changed with the emergence of a functionalist approach to emotions that showed how emotions profoundly affect cognitive, perceptual, social, and self-regulatory processes and demonstrated how closely emotions are tied to temperamental dispositions, attachment, and parent-child interactions (Saarni, Mumme, & Campos, 2000). Increasingly, leading stress theorists now incorporate emotions into stress and coping theories. Lazarus (1999, p. 37), for example, states, "the three concepts, stress, emotion, and coping, belong together and form a conceptual unit, with emotions being the superordinate concept because it includes stress and coping." A similar view is expressed by Aldwin (1994, p. 47), who states, "one of the thorniest issues in stress research remains the interrelations between stress, personality, and health." Arguing that emotionality affects the subjective experience of stress, Aldwin (1994) disputes unidirectional causality models of stress and proposes a multidirectional view in which appraisal is seen as a function of both the person and the environment, and in which stress is seen as either causing or reflecting mental health problems.

Such a position is consistent with a functionalist view of emotions, in which emotions are seen as guiding or activating the self's behavior within a situational context, or in which the self appraises a situation for its meaning or relevance and thus experiences emotion (Saarni, 1999). Saarni (1999), for example, describes a set of skills necessary to be self-efficacious or emotionally competent, particularly in emotion-eliciting social transactions. These skills include: (1) awareness of one's emotional state; (2) ability to discern other's emotions; (3) ability to use the vocabulary of emotions; (4) capacity for empathetic and sympathetic involvement; (5) ability to realize that inner and outer states need not correspond to emotional expression; (6) capacity for adaptive coping; (7) awareness that the structure of relationships is in part defined by emotions generated by the relationship; and (8) the capacity for emotional self-efficacy (to feel how one wants to feel).

The above social-constructivist model of emotion views emotional experience as embedded in the conditions that justify it—that is, emotions do not take place in a vacuum, nor can they be deciphered purely by introspection, but are "contingent on specific context, unique social history, and current cognitive developmental functioning" (Saarni, 1999, p. 13). Interestingly, this view is closely related to Aldwin's (1994) review of coping strategies in adolescents, in which adolescents display increased problem-focused coping skills with the onset of formal operations, better interpersonal negotiation skills with the decline in egocentrism, and more ability to reach out for social support to siblings or peers. Aldwin also cites two formidable issues regarding the assessment of coping, in which it is critical to understand the role of emotions: (1) the question of whether to assess coping styles, which are thought to be stable personality characteristics, or coping processes, which are fluctuating strategies that change in response to environmental demands; and (2) the question of whether people use defense mechanisms in coping with stress, which means that coping strategies may be partially unconscious and inaccessible to self-report measures.

In Saarni's (1999) view, emotional regulation—the ability to modulate the degree of emotional arousal—facilitates coping with an environmental stressor or conflict by allowing one to adjust the intensity of one's feelings and respond more adaptively to the stressor or conflict. Citing Brenner and Salovey (1997) as evidence that many investigators now use the term "coping" and "emotional regulation" interchangeably, Saarni (1999, p. 220) states, "effective coping is inseparable from effective emotional regulation and vice versa." In Saarni's view, emotional regulation and self-regulation—often identified with coping strategies—are similar concepts, with emotional regulation enabling a person "to manage one's subjective experience of emotion…and manage strategically one's expression of emotion in communicative contexts" (1999, p. 220).

Since emotional arousal, even in infants, necessitates modulation, the question of how emotional regulation develops can be studied across the age spectrum. Saarni (1999) points out that temperament and emotional regulation appear to be closely entwined in infancy and well into childhood, while regulatory efforts in older children, youth, and adults are often directed at the antecedents of the anticipated emotional reaction—that is, the situation can be reappraised or reframed to alter the meaning attributed to it. As children mature, a combination of growing cognitive sophistication, exposure to varied social models, and breadth of social-emotional experience contribute to the ability to solve problems or generate coping strategies. Optimal emotional regulation development occurs when individuals have acquired a flexible repertoire of coping strategies that combines active problem solving and recruitment of social support with the capacity to tolerate intense aversive emotions to the degree that appraisal processes can take place (Saarni, 1999).

Saarni, Mumme, and Campos (2000) cite key aspects of emotional regulation that appear to interfere with efficacy of coping, especially in a social context, including: (1) temperamental reactivity, (2) deployment of attention, (3) the components of emotion (including physiological, expressive, and subjective elements), and (4) approach-avoidance tendencies. Temperament, for example, may be used in a fairly global fashion and characterized as "a collection of dispositions that characterize the individual's style in responding to environmental change" (Saarni, Mumme, & Campos, 2000, p. 287). Thus, individuals may be seen as modulating their emotional reactions according to these dispositions, with individual differences influencing coping efficacy. Beyond temperament, Saarni, Mummer, and Campos (2000) also cite research indicating that coping efficacy is influenced by differences in family conflict and dysfunction, parenting styles, gender, levels of depression or hopelessness, and social maturity.

Emotional intelligence.

Along with coping and emotional regulation, Saarni, Mumme, and Campos (2000) list a number of other core issues related to future research on emotion, including: (1) understanding how emotions are generated in human development, (2) learning how social referencing takes place through social signals, (3) deciphering the language of emotion, (4) knowing the source of vicarious emotional responsiveness, (5) and understanding differences between dissembled or genuine displays of emotion. To this list can be added current efforts to: (1) understand the neurological basis of emotion (Damasio, 1994; LeDoux, 1996); (2) define the relationship between emotion and cognition (Schwarz, 2002); (3) highlight positive aspects of emotions, as expressed through the positive psychology movement (Lucas, Diener, & Larsen, 2003; Tugade & Frederickson, 2002); and (4) develop models and measures for emotions, as captured by the emerging field of emotional intelligence (EI) (Barrett & Salovey, 2002; Mayer, Ciarrochi, & Forgas, 2001).

The uncertainty of the field of EI is most evident in the fact that two different conceptions of EI—the *ability* model and the *mixed* model—have emerged, each with its own scale of measurement and set of component abilities and skills (Mayer, 2001). The ability model is defined as follows by Mayer and Salovey (1997, p.10):

> Emotional intelligence involves the ability to perceive accurately, appraise, and express emotion; the ability to access and/or generate feelings when they facilitate thought; the ability to understand emotion and emotional knowledge; and the ability to regulate emotions to promote emotional and intellectual growth.

The ability model posits EI as the "ability to recognize the meanings of emotions and problem-solve on the basis of them" (Mayer, 2001, p. 9). Ability theories divide EI into abilities related to emotional perception and expression, use of emotions to facilitate thought, understanding and analyzing emotions, and managing emotions. Measures of ability-focused EI are closely related to traditional intelligence testing, in that they rely on performance measures with responses that can be evaluated against objective, predetermined scoring criteria (Ciarrochi, Chan, Caputi, & Roberts, 2001).

Nearly in direct contrast is the mixed model. For example, Bar-On (2001, p. 87) refers to EI as "a multifactorial array of interrelated emotional, personal, and social abilities that help us cope with daily demands." This model blends EI with other qualities such as well-being, motivation, and capacities to engage in relationships (Mayer, 2001). In this sense, the mixed model links more strongly to efforts to understand emotions from a broader perspective, while the ability model relies more on cognitive appraisals of emotion, giving it a narrower scope but improved psychometrics (Ciarrochi, Chan, Caputi, & Roberts, 2001).

Critics have referred to ability models as a "new folk theory of emotion for the high tech information age," asserting that ability-focused EI definitions lack sufficient references to empathy, interpersonal focus, and moral character, and give less weight to emotions in social contexts or to self-efficacy (Saarni, 1999, p. 59). Defenders of the mixed model assert that it may be more useful for promoting self-actualization as well as more useful for developmental psychologists who find it difficult to separate out the ability from the dispositional aspects of childhood growth and change (Arsenio, 2003; Bar-On, 2001). In response, it has been argued that mixed model research—since it incorporates traditional personality constructs such as positive mood, optimism, self-regard, and extroversion—is merely an extension of individual differences research. This criticism is supported by strong negative correlations between EI and trait anxiety on mixed model EI measures, which in addition are highly related to each of the Big Five personality dimensions: neuroticism, extroversion, openness, agreeableness, and conscientiousness (McCrae, 2000). Thus, there is dispute over whether self-report measures of EI using the mixed model assess EI, or whether they assess emotionally intelligent behavior and emotional competence. Bar-On, a leading proponent of the mixed model, acknowledges this problem by referring to the BarOn EQ-I, a mixed model measure of EI for adults, as a "self-report measure of emotional and social competence, which provides an estimate of emotional and social intelligence" (2001, p. 89).

The mixed-model of EI is important because it holds promise as a measure of behaviors related to stress management and adaptation to stress, since mixed models generally assess specific abilities such as coping ability under stress and adaptability to stress (Taylor, 2001). In addition, the mixed model refers to enduring differences between people in affective style and incorporates prior work on personality testing in areas such as self-esteem, social desirability, and trait anxiety (Forgas, 2001). Further, it serves to link recent studies showing that affect and cognition are not separate, independent faculties of the mind but interdependent influences on the way we retrieve memories, notice and learn information, and respond to social situations (Forgas, 2001).

Finally, on a practical note, the measures for ability-based models have not been developed for children under the age of 18.

Advocates of EI agree that the unique contribution of EI is to help focus attention on how "thought and emotion are adaptively and intelligently intertwined" (Mayer, Ciarrochi, & Forgas, 2001, p. xiii). They argue that EI provides an organizing framework that enables the field to synthesize research on affective phenomena and to reach beyond traditional views of intelligence by incorporating the emotional system, thus providing a theory of individual differences in emotional competencies (Salovey & Pizarro, 2003). Bar-On (2001), for example, argues that the mixed model incorporates work from the field of social intelligence and that the constructs of emotional and social intelligence may be virtually identical. As evidence for this view, Forgas (2001) cites recent empirical evidence on emotion suggesting that affect is an essential component of an adaptive response to a social situation, and that affect can either facilitate or impair effective thinking and responses depending on circumstances by influencing memory, judgment, and thinking styles.

However, such claims immediately entwine EI in the complexities of the fields of intelligence and personality research—fields in which the ideological lenses have "many colors" (Sternberg, Lautrey, & Lubart, 2003, p. 3). Nevertheless, EI has begun to be used as a theoretical framework for understanding the relationship between emotion and cognition (Forgas, 2001), personality (Mischel & Shoda, 1998; Stankov, 1999), and individual differences and intelligence (Schlinger, 2003). Primarily, this may be because cognitive research has yielded mixed results in the area of individual differences in intelligence. For example, despite the stability of individual IQ scores and interindividual differences in intelligence, there is no theoretical explanation as to why marked changes occur in patterns of cognitive ability over the lifespan (Weinert & Hany, 2003), nor are correlations between biological measures and intelligence impressive (Stankov, 1999).

It is clear that research on EI has helped overcome the increasingly discarded notion that affect and cognition are separate—a trend that is supported by neuro-anatomical studies of the brain showing the intricate relationship between emotion and reason (Damasio, 1994). For example, Schwarz (2002) describes research in situated cognition showing that cognitive processes are tuned to meet situational requirements. Such theoretical work supports a broad range of trends in instruction in schools, including more collaborative student interaction, increased focus on multiple intelligences and different learning styles, and constructivist approaches to problem solving. Since mixed models of EI focus on actual behaviors that are labeled intelligent, critics of conventional assessments of intelligence—which are largely based on g factor or genetic information that cannot be changed as a result of life experience—see EI as a welcome expansion of the concept of intelligence (Schlinger, 2003). This view receives some support in the literature. For example, higher levels of EI—using mixed model measures—have been found to correspond with dominant functions of intuition on Myers-Briggs type indicator assessments (Higgs, 2001). In another study, EI measured through ability tests has been used as a basis for exploring the relationship between EI and giftedness, with some indications that giftedness contributes to high EI (Mayer, Perkins, Caruso, & Salovey, 2001). Similarly, Lam and Kirby (2002) concluded that overall EI, as measured through ability tests with 304 undergraduates, uniquely explained individual cognitive-based performance over and above the level attributable to general intelligence.

The murky relationship of EI, cognitive measures of intelligence, and personality is evident in discussions of the EI construct by personality theorists—arguments anticipated two decades ago by cognitive psychologists such as Revelle (1987), who noted personality issues as sources of inefficiency in cognitive performance. For example, although in agreement that the g factor has been overemphasized through an overly reductionist approach to intelligence research, Stankov (1999) notes the ambiguity of EI measures and concludes that most measures of EI do not assess intelligence but instead simply invoke known personality traits such as extraversion or neuroticism. Mathews (1999) supports this view, pointing out that traits are related to performance impairment in evaluative contexts. For example, in academic environments neuroticism is positively related to degree of achievement and therefore drives motivation, causing the relationship between anxiety and motivation to vary with the situation and coping resources, while anxiety conditions themselves may be underpinned by a variety of negative self-beliefs (Mathews, 1999). In a similar vein, Kanfer and Heggestad (1999) suggest that emotion control is important early in learning, when cognitive demands are high, and late in learning, when additional effort can lead to improvement on task performance. Stankov (1999) attempts to reconcile views on EI and traditional personality theory by suggesting that EI may be a measure of a self-confidence trait, since self-confidence is related to self-efficacy but is not entirely personality-like or entirely cognitive in origin. While Stankov (1999) concludes that the limitations of EI measures make EI theoretically useless at this time, Alexander and Murphy (1999) believe that EI—since it highlights distributed, shared, or social processes—may reflect the mix between multidimensional aspects of individual differences and the complexities of formal learning in a classroom community. Similar to this view, Ackerman (1999) suggests that openness correlates with many knowledge scales and that some combination of process, trait, and content measures is necessary to understand learning and individual differences. Mischel and Shoda (1998) have pursued this line of inquiry by first pointing out that the division between trait theorists and social psychologists has resulted in gaps in understanding how individual differences are expressed in particular contexts. This split is exemplified in stress and coping research, which has focused on either dispositional coping styles or a coping processes approach. Mischel and Shoda (1998) suggest a theoretical reconciliation in the form of a cognitive-affective personality system that integrates the conceptual and methodological barriers separating the two approaches. This suggestion is underscored by the authors' comments that current research supports both long-term personality coherence as well as the influence of context and situational cues on the expression of traits, and that these findings support the construct of social-emotional intelligence.

Support for EI has been sufficient to encourage the use of EI in other areas of psychological research, including as a construct for linking psychoanalytic techniques and current research on the brain (Taylor, 2001). The authors consider EI to show considerable overlap with Freud's concept of signal affects, the concept of psychological mindedness, and reflective functioning. They also cite findings that confirm a strong, inverse relationship between EI and alexythymia. Furthermore, drawing from the work of LeDoux (1996), they suggest that low EI may be associated with an interhemispheric transfer deficit and underactivity of that part of the anterior cingulate cortex involved with selective attention and working memory.

In quite recent discussions of EI and childhood development (Arsenio, 2003; Mathews, Roberts, & Zeidner, 2003; Zeidner, Mathews, Roberts, & MacCann, 2003), it has been proposed that the multifaceted ambiguities in measuring EI may be resolved by distinguishing multiple levels of emotion regulation processes that include temperament, rule-based skill acquisition, and self-aware emotion regulation. Calling interest in EI "part of the current *zeitgeist* of modern Western society," Zeidner et al. (p. 70) note that both the mixed and ability models of EI contain a number of untested assumptions that need to be resolved. These include: (1) relying on declarative knowledge (and instruments) when reporting on EI aptitudes, rather than on assessing unconscious procedural skills; (2) seeing the causal status of EI as an outcome of social interaction that excludes biological influences (not proven); (3) lack of clear criteria for emotionally intelligent behavior (for example, should superior emotional functioning be assessed in terms of positive functioning or as absence of negative indices); and (4) the view that EI may reflect a "goodness of fit" between person and environment (that is, knowledge of cultural norms for expressing and managing emotions) rather than an intrapersonal quality. Describing a multi-investment model of investigating the development of EI, Zeidner et al. suggest that at least three levels of emotional function may control individual differences in emotional competence and that these need to be investigated separately. These levels are: (1) the biological bases for emotionality, in which heritable temperamental factors influence basic processes such as perception and primitive control strategies early in life; (2) the learned rule-based skills for emotion regulation, in which behaviors have a more social character; and (3) self-aware emotion regulation, including mindful self-regulation, awareness of specific cognitive processes, use of reflective problem solving, and development of "mental models" of how thinking takes place.

Interestingly, Zeidner et al. specifically link the development of self-aware emotion regulation to Saarni's (2000) [previously cited] work on emotional competence. The authors state that the primary difference between EI and emotional competence is in the inclusiveness of emotional competence, which they call a mixed model of EI that explicitly emphasizes the influences of social relationships as well as disposition, motivation, and one's developmental history. The authors conclude that this explicitly ecological conceptualization of emotional competence situates emotional development in concentric circles with social-environmental influences such as family, peer group, educational environment, and wider culture, transmitted in part by the media.

Zeidner et al. support Saarni's (2000) conceptualization, but they suggest that it is necessary to assess the component skills of emotional competence and place them in a psychometrically acceptable dimensional model. Their multi-investment model points the way toward a number of remaining issues that represent a current summary of the research agenda for EI. These issues include: (1) development of psychometric models that can adequately assess rule-based skills acquisition and self-aware emotion regulation, (2) more knowledge of continuity and developmental shifts in EI from childhood to adulthood, (3) increased focus on the adaptive significance of EI, (4) an emphasis on understanding the relationship between EI and culture, (5) more knowledge about the biological bases and heritability of EI, and (6) increased research on the relationship between the development of EI through learning and training in educational contexts.

Measuring the stress response

To measure the stress response, stressors are often classified into two categories: (1) "systemic" stressors that present direct physiological threats to an organism, such as infections or temperature extremes; and (2) "neurogenic" or "processive" stressors that do not represent a direct threat, but are perceived as a potential threat (Bourne & Yarish, 2003). The most common processive stressors fall into categories such as traumatic life events, performance anxiety, psychosocial pressures from interpersonal relationships, and environmental pressures.

Since stressors generally activate the SNS, the stress response can be determined through use of neurophysiological measures that can correlate the effects of real-life or laboratory stressors by quantifying the activity of the ANS through measuring heart rate, skin conductance, blood pressure, respiratory rate, skin temperature, electromyography, and blood-volume pulse. These physiological measures yield useful information on the condition of the physiological system at rest, how much the system deviates from baseline under stress, and recovery periods after exposure to a stressor (O. S. Pallson, personal communication, April 12, 2002). However, while the sympathetic system shows a great deal of response specificity, the parasympathetic response is less discrete than once believed. For this reason, there is currently no empirically validated method for exact quantification of ANS activity (Pallson, Boregowda, & Downing, 1998). In addition, since the stress response is mediated by the neuro-endocrine system, ANS measures do not provide a complete picture of stress activity in the body. Thus, other physiological markers of stress include levels of salivary cortisol, testosterone, and immune system cytokine products (Bourne & Yarish, 2003).

The effects of stress can also be measured through self-report measures that describe how people feel and performance measures that describe how people behave under stress. Research into cognition and stress, for example, has shown that the subjective stress state can be characterized by three themes—commitment to task, cognitive overload, and self-evaluation—that represent three principal adaptive challenges in stressful performance environments, each of which is accessible to self-report (Mathews, 1996). Other researchers use task performance measures that evaluate changes in behavioral performance efficiency, often as a method to determine the response to stress in emergency environments or under difficult work conditions. Studies of human performance focus on multiple cognitive processes that are affected by stress, including arousal and activation (stress intensity is directly related to arousal and alertness levels), resource allocation (stress controls the distribution of attentional resources), and plans or strategies (Bourne & Yarish, 2003). Research has established broad parameters for various levels of arousal, showing that task performance is facilitated by mid-level or optimal levels of arousal but degraded or impeded by high levels of arousal that can lead to controlled rather than automatic actions ("choking") or to primitive, instinctive, panic behavior aimed at survival (Bourne & Yarish, 2003).

The usefulness of different measures of stress often depends on the objective of the study and the conditions for the investigation, with some researchers contending that self-report measures of stress are more sensitive and reliable than physiological measures of heart rate and blood pressure (Shostak & Peterson, 1990). Physiological measures, however, help independently determine the effects of stress by correlating physiological and cognitive variables and enabling the investigation of potential mediating relationships between physiological states and behavior under stress. In addition, physiological measures for stress have become an important factor in epidemiological studies that attempt to quantify the extent to which stress affects the general population. This is partly because measuring shifts in physiological parameters tends to be inexpensive, ethically acceptable, and practically feasible, and also because physiological parameters fluctuate slowly, allowing longitudinal assessment of long-lasting, everyday adverse psychosocial conditions that elicit a stress response. This is an important advance for two reasons. First, stress, like virtually all other health outcomes, follows a socioeconomic gradient, in that stress is more prevalent among lower-income populations (Gunnar, Bruce, & Hickman, 2001; Kelly & Hertzman, 2001). Early detection and intervention in particular subpopulations may be helpful in addressing stress management. Second, the extent to which stress is connected to other health issues, such as infectious diseases, heart disease, or cancer, can be investigated to determine the relationships between disease and stressful socioeconomic conditions early in life.

The best markers for large-scale epidemiological surveys are still being researched. Kelly and Hertzman (2001), in a review of a Canadian national health survey aimed at identifying physical measures of stress, investigated and catalogued more than 30 potential measures for stress, including blood assays and waist-hip ratios. They concluded that a glycosylated protein found in the blood and consistently associated with stress, combined with a well-known population distribution, was the most promising marker for large-scale epidemiological studies. Other researchers have contended that cortisol levels in saliva show promise as a marker (Gunnar, Bruce, & Hickman, 2001). As noted earlier, cortisol is a hormonal end-product of the stress response. Normal levels are associated with the fluctuations in daily stress influences, while higher levels are associated with responses to challenges. Noninvasive saliva collection devices can be left with subjects to allow for repeat samples of cortisol. Cortisol levels have also been used to measure stress levels in infants, with results showing that sensitive and responsive care very early in life may buffer stress by reducing cortisol elevation early in development (Gunnar, Bruce, & Hickman, 2001).

Other studies note that cardiac reactivity, as measured by heart rate, is typically associated with stress and has been implicated as a physiological marker for stress in healthy children (Murphy, Alpert, Willey, & Somes, 1988). For example, a recent study of European children used a polyparametric system for measuring stress that included HRV, heart rate, and the measurement of cortisol levels, showing that 50% of 400 children assessed for stress showed no signs of chronic disorders but did show an impaired relationship between these different homeostatic functional systems (Sudakov & Glasachev, 2001). As Theorell (2001) notes, the increased knowledge of the physiological processes accompanying stress has led to more sophisticated use of biological markers for screening and identifying stress disorders. This is an important advance in stress management, since persons under stress may deny or fail to report stress influences for psychological or social reasons, or due to lack of bodily sensitivity and awareness of the effects of stress.

Aldwin (1994) cites several design and measurement considerations related to stress and health outcomes studies. These include the timing of the stressor and the probable etiology of the particular health outcome under study, knowing that the stress measures are appropriate culturally and developmentally, and attempting to understand whether the effects of stress are additive or multiplicative. The last point has yet to be resolved, as the dose-response curve between stress and various health outcomes is poorly understood and the duration of stress effects is still a matter of debate. The question also remains of the causal directionality between stress, personality, and health outcomes—a problem that has resulted in an ongoing debate over whether the subjective appraisals of stress and the meaning of a stressful event are more effective in predicting health outcomes, or whether the perception of stress is more rooted in prior personality and mental health and is thus confounded by personality characteristics (Aldwin, 1994).

The above review indicates the importance of using a broad range of measures in stress management studies. Ideally, studies should collect data on both physiological and emotional responses to stress, identify environmental stressors and buffers, help reveal the successful coping mechanisms used to manage the effects of stress, contribute to further knowledge about the relationship between personality and health, and reveal aspects of stress management that can be learned and taught to young people. This requires an integrated approach to research that blends the extensive literature on stress and the emerging focus on emotional competence into a holistic vision of health and well-being.

Chapter 3

METHOD

Design

The study used a between-group and within-group control group design, with a pretest and posttest (Campbell & Stanley, 1963). Other than agreeing to participate, there were no criteria for selection of students. Participants were drawn from a convenience sample of 110 ninth grade students from the Marin School of Arts and Technology in Novato, California. Students were 13 to 15 years old (average age = 14.6) and represented a cross-section of students in Marin County—a middle– to high-income community with approximately 25% nonwhite residents. Prior to the ninth grade, approximately 20% of the students had been designated as special need students. Approximately 65% of the students were boys. Ninety-nine consent forms (m = 72, f = 27) were signed by students and parents of students and gathered prior to data collection. The training group consisted of 62 students who were enrolled in three Advisory periods during the school day; the control group consisted of 37 students in two Advisory periods. All Advisory groups were under the direction of credentialed teachers.

For within-group comparisons, behavioral measures were used to identify 19 students in the training group as High Anxious youth and 16 students as Low Anxious youth.

The independent variable in the study was a method of positive emotional refocusing (the Freeze Frame method) developed by Institute of HeartMath (Childre, 1998). This technique enables individuals to intervene in the moment that they experience stress or an emotional reaction by shifting attention to the physical location of the heart, generating a sincere positive feeling in place of a negative reaction and breathing "through the heart" to focus attention. It is differentiated from other stress management techniques that attempt to elicit an emotional response through mental visualization or emotional recall. Further, although the method uses breathing as part of the technique, it does not rely upon breathing as the primary intervention and is differentiated from instructions to "take a deep breath" to relax.

Four dependent variables were addressed in the study as the result of the training: (1) autonomic recovery from stress, as measured by the coherence of heart rhythm patterns before and after training, during baseline, stressor, and recovery conditions; (2) emotional intelligence (EI), as measured by scores on a standardized measure of EI; (3) stress management behavior, as measured by the intrapersonal, stress management, and adaptability subscales of a standardized measure of EI; and (3) trait anxiety. Both between-group and within-group scores were compared on all four variables before and after training. The study was conducted over a period of three months.

Measures

Bar-On Emotional Quotient Inventory for Youth.

In the Bar-On model, EI is defined "as an array of emotional, personal, and interpersonal abilities that influence one's overall ability to cope with environmental demands and pressures" (Bar-On, 1997). The Bar-On Emotional Quotient Inventory for Youth (EQ-i:YV), which was specifically designed to measure EI in school-aged youths, consists of five subscales: (1) intrapersonal EI, a measure of self-regard and emotional awareness; (2) interpersonal EI, a measure of empathy and social responsibility; (3) stress management EI, a measure of stress tolerance and impulse control; (4) adaptability EI, a measure of flexibility and problem-solving ability; and (5) general mood EI, a measure of optimism and happiness. The EQ-i:YV can be used in schools to prepare children to cope with environmental demands and increase their potential for success, and also in clinical settings to assess an individual's general degree of EI, potential for emotional health, and present psychological well-being (Bar-On, 2001; Ciarrochi, Chan, Caputi, & Roberts, 2001). The measure does not correlate with traditional measures of cognitive intelligence, but attempts to assess EI as a construct that incorporates a broad array of emotionally intelligent behaviors in a social context (Bar-On, 2000).

The EQ-i:YV consists of 133 brief items and uses a five-point Likert scale. Responses to the 133 items generate a total score and five composite scale scores. The EQ-i:YV also contains two validity indicators. First, the Positive Impression Scale measures the extent to which an individual is trying to present him or herself in a positive light. Second, the Inconsistency Index detects individuals who are responding haphazardly or in an inconsistent way to the measures. Additionally, a General Mood subscale indicates the overall mood level of the respondent—an important indicator since general mood and EI are strongly related (Bar-On, 1997).

Results of the EQ-i:YV yield both raw and standard scores that can be compared to norms established for males and females in age ranges of 7- to 9-year-olds, 10- to 12-year-olds, 13- to 15-year-olds, and 16- to 18-year-olds. Age and gender effects have been investigated and noted for total EI scores as well as for each of the subscales. Females have been found to score significantly higher than males on the total EI scale, and younger children have been found to under-report negative qualities (Bar-On, 1997). In addition, general mood is known to influence scores. Standard scores on the EQ-i:YV have a mean of 100 and a standard deviation of 15. Scores below 80 are believed to indicate an underdeveloped capacity for emotionally intelligent behavior, while scores above 109 indicate a high or well-developed emotional and social capacity (Bar-On, 1997). The technical manual urges caution in interpreting results of total EI scores, suggesting that the pattern of scale scores be examined carefully and that additional measures be employed, such as academic records, interviews, and behavioral observations (Bar-On, 1997).

Individual and independent administration of the EQ-i:YV is preferred, but the measure can administered to groups (Bar-On, 1997). When administered in groups, respondents must be cautioned to reserve questions until the end, when the administrator can answer without biasing other respondents. In the present study, the measure was administered to groups of up to 22 students each and proctored by the Advisory teacher.

State-Trait Anxiety Inventory.

The State-Trait Anxiety Inventory (STAI) is a 40-item instrument measuring state anxiety and trait anxiety. Used extensively in research and clinical practice, the STAI is comprised of 20 statements that evaluate how respondents feel at the moment, and 20 statements that evaluate how respondents feel in general. Scales can be scored separately. The measure is designed for use with high school students and adults but has also been useful with junior high students (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). The STAI is designed to be self-administering and may be given either individually or in groups (Spielberger et al., 1983). In the present study, the STAI was administered to each

Advisory group. No time limits are established for the measure, which normally requires about ten minutes for completion of both scales. The test developers state that it is important that the examiners establish rapport with the respondents prior to the test, that results be kept confidential, and that the STAI be referred to as a self-evaluation questionnaire rather than a measure of anxiety (Spielberger et al., 1983).

In addition to clinical usefulness, the STAI is considered to be an excellent research tool for studying stress and anxiety, and for differentiating between anxiety-proneness as a transitory emotional state and individual differences in trait anxiety-proneness (Spielberger et al., 1983). Early use of the STAI focused on the effects of stress and anxiety on learning and performance, but it increasingly has been used to investigate stress-related psychiatric and medical disorders and as an outcome measure for research on biofeedback and other forms of treatment (Spielberger, 1983).

Each item is given a weighted score of 1 to 4, with a rating of 4 indicating the presence of a high level of trait or state anxiety. Weighted scores are added and can be compared to norms established for a wide range of groups, including working adults, college students, high school students, and military recruits. Raw scores are easily converted to standard scores in the technical manual.

Life Stressors and Social Resources Inventory-Youth Form.

The LISRES-Y (Moos & Moos, 1994) uses 209 questions and 16 scales—9 that measure life stressors, including health issues, and 7 that measure social resources—to provide an integrated picture of a youth's current life context and to assess stable life stressors and social resources. The nine stressor domains are physical health, home and money, parents, siblings, extended family, school, friends, boyfriend/girlfriend, and negative life events. Resource domains are parents, siblings, extended family, school, friends, boyfriend/girlfriend, and positive life events.

The LISRES-Y can be administered in a self-report format or as a structured interview. It can be used with healthy youth, psychiatric or medical patients, or youths with behavioral or conduct disorders, either wholly or in part (Holahan, Valentiner, & Moos, 1995; Saltzman & Holahan, 2002). Seven of the nine stressor indices and five of the seven resource indices have been shown to discriminate significantly among youth with conduct disorders, youth with rheumatic disease, and healthy controls. Self-report and interview formats show no significant differences in means or variations. Raw scores on the measure can be converted to standard scores for either Life Stressors or Social Resources, allowing students to be grouped by categories using T-scores.

The LISRES-Y was developed using a five-stage process of item pool development and field-testing and revisions (Moos & Moos, 1994). Measures of five aspects of youth temperament related to inherited personality traits—distress, fear, anger, activity, and sociability—were included in initial items and field tests, and intercorrelations were established among stressors, among resources, and between stressors and resources (Moos & Moos, 1994). The measure has an average predictive value of $r = .39$ for predicting youth functioning in areas of depression, anxiety, alcohol and drug use, behavior problems, and self-confidence. The LISRES-Y can be used to examine issues in stress and coping theory, the relationship between life events and life context for youth, and how life stressors and social resources may determine coping responses (Moos & Moos, 1994).

In a group setting, the LISRES-Y can be administered in 45 minutes or less. In the present study, the LISRES-Y was administered to groups of 22 students each in a 45-minute period, proctored by a credentialed teacher. Students who requested extra time to complete the form were allowed to do so.

Heart Rate Variability.

Heart rate variability (HRV) is a noninvasive measure of neurocardiac function that reflects heart-brain interaction and autonomic system dynamics. HRV data can be collected via an electrocardiogram or a pulse plethysmograph placed on the index finger. Interpretation of HRV data using short-term measures is done using time domain frequency analysis and frequency domain analysis. Frequency domain analysis decomposes the HRV waveform into its individual frequency components and uses power spectral density analysis to quantify the components in terms of their relative intensity. Using Fast Fourier transformation, spectral analysis of HRV reveals peaks at several frequency ranges, defined as high frequency (HF) (0.15 to < 0.4 H_z), low frequency (LF) (0.04 to < 0.15 H_z), and very low frequency (VLF) (0.0033 to < 0.04 H_z) regions of the power spectrum. The HF component is widely accepted as a measure of parasympathetic or vagal activity (Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, 1996). The LF band, modulated by both the parasympathetic and sympathetic systems, is related to blood pressure control and resonance and baroreceptor activity (Malliani, 1995). VLF measures are less well-defined, with indications that VLF rhythms are associated with sympathetic activity and thermoregulation (Task Force of the European Society of Cardiology and the

North American Society of Pacing and Electrophysiology, 1996). Each participant receives an assessment report showing the R-R interval (beat-to-beat variability), plus measures of variability in HF, LF, and VLF. Measures of total power and the ratio between LF and HF results are also provided. In addition, measures of coherence are obtained using spectral data showing narrow-band, high-amplitude peaks in the sympathetic and parasympathetic waves in the LF range, at a frequency of about 0.1 H_z.

Procedures

At the beginning of the school year and prior to the study, freshman students were assigned randomly to five Advisory groups of approximately 22 students each, with each Advisory under the supervision of a credentialed classroom teacher. The Advisories met for two 45-minute periods each week throughout the school year. General activities in the Advisories consisted of discussing school activities, developing personalized learning plans, community building, goal setting, and communication skills training. All groups met separately, eliminating any potential crossover effects.

The investigator met initially with each of the five groups of students and their teachers to explain the goals of the study, to answer questions, and to describe the physiology of the stress response, including research on HRV. The Advisory teachers were encouraged to lead discussions with students regarding the impact of stress and the importance of stress management skills. The investigator also reviewed the intent and procedures of the study with parents at parent meetings prior to the study.

The teachers administered baseline measures and the investigator collected information on all students to determine scores on two psychological measures—the STAI and the EQ-i:YV. Students also completed the LISRES-Y.

After collection of baseline data, students in both the control and training groups participated in listening, communication, and conflict resolution activities led by their Advisory teachers, who used a specific curriculum developed by the investigator (see Appendix A). In addition, as part of the curriculum the training group received instruction from the investigator in the positive emotional refocusing method. The instruction included preliminary methods for identifying and generating positive feelings and direct implementation of the method (see Appendix B). The training for positive emotional refocusing was administered in a series of steps, with students first practicing by brainstorming positive emotions and memories, and then learning to focus their awareness on their heart area as they generated a positive emotion. Discussions and practice helped students learn when and how to use the technique in their daily lives. Students in the training group were expected to complete at least eight practice sessions over a period of six weeks. Practice sessions were monitored by the investigator and verified by the Advisory teacher, using attendance sheets and teacher notations.

In addition, during the course of the study each student in the training group participated in one 30-minute computer session with the investigator, in which small groups of students received individual instruction and practiced positive emotional refocusing while using the biofeedback capability of software developed by the Institute of HeartMath. In these practice sessions students were given the option of playing one of three games on the software or simply using positive emotional refocusing to improve their score on the bar columns that measure stress response. The two Advisory groups acting as controls received similar training after the collection of posttest information.

HRV data was collected on all students in small group sessions using seven desktop personal computers with Windows operating systems. First, resting baseline figures for HRV were obtained during an initial seven-minute period using software developed by the Institute of HeartMath and pulse plethysmographs attached to the left index finger of each participant. HRV reactivity then was measured during a five-minute interval by administering the Stroop Color-Word Test (Golden & Freshwater, 2002), a cognitive stressor. During this period students were instructed to read the Stroop Color-Word Test silently and press the appropriate key on the keyboard that corresponded to the red, green, or blue color of the word (i.e., R, G, or B). A background noise of acoustic interference (white noise) was played through a tape recorder at 90 decibels—a sound at the upper level of noise tolerance designed to elicit a further stress response (Choi et al., 2003; Mathews, Gump, Block, & Allen, 1997; Sembulingam, Sembulingam, & Namasivayam, 1996). During a final five-minute period—to measure autonomic recovery from stress—the noise and the Stroop test were discontinued, and students were instructed to relax through any means that they normally used.

After the three month training period, all students again completed the EQ-i:YV, STAI, and the HRV protocol. Results were compared between the training and control groups, and between the High Anxious and Low Anxious participants in the training group.

Scores on the psychological measures were recorded on forms included in the assessment instrument. HRV data was recorded on password-protected files on the seven desktop computers. Results were held in individual files on the laptop computers and then transferred to diskettes.

Definition of terms

For within-group comparisons, High Anxious and Low Anxious categories of participants were created to identify students who had experienced a high or low degree of environmental stress, felt more or less anxious, and who differed in social resources available to buffer stress. High Anxious students and Low Anxious students were defined by a combination of standard scores on the STAI and the Negative Life Events and Positive Life events subscales of the LISRES-Y. Participants with a trait anxiety score on the STAI above the sample mean of 51.1 and a score on the Negative Life Events scale that exceeded the sample mean of 52.96 were placed in the High Anxious category. Students in the High Anxious category who also scored above the sample mean of 50.9 for Positive Life Events were eliminated from the category. Similarly, participants with a trait anxiety score below the mean on the STAI and below the mean for Negative Life Events were placed in the Low Anxious category. Students in the Low Anxious category who also scored above the mean for Negative Life Events were eliminated from the Low Anxious category.

Data analysis

Data analysis was conducted using statistical software (SPSS®, version 11.0) to test the five hypotheses with the control and training groups, and to explore data gathered for High Anxious and Low Anxious participants, Summary data in the form of means was collected for all measures. Results for each of the behavioral measures were summarized in tables, which included means, range of scores, and correlations of significance or interest. Between-group comparisons were calculated using two-sample *t*-tests for means comparisons. Gain scores for the training and control groups were computed and transformed to standard scores for comparison and analysis of distribution. Frequency distributions for all scores were graphed.

Coded HRV data was transmitted electronically to the Research Director of the Institute of HeartMath (who was blind to the coding), where mean scores for baseline HRV, HRV reactivity under stress, and resting HRV during recovery from stress were analyzed using the Institute's spectral equipment. HRV data was recorded for mean interbeat interval and mean heart rate. Log scores were computed for the following variables: coherence, HF, LF, VLF, total power, interbeat interval, and parasympathetic/sympathetic ratio during baseline, stress, and recovery conditions.

Autonomic recovery from stress was compared by measuring changes in coherence, sympathetic/parasympathetic ratios, and responses in the LF, HF, and VLF bands before and after training during the baseline, stressor, and recovery periods. Paired-sample *t* tests were used to compare results between the training and control groups, and to determine if training had affected autonomic recovery from stress. Changes in EI were measured by comparing gain scores on the EQ-i:YV for training and waiting groups for overall EI, as well as scores on the intrapersonal, adaptability, and stress management scales of the EQ-i:YV. Similarly, scores were computed for the training and control groups for trait anxiety using pre- and post-STAI scores to determine if trait anxiety had decreased as a result of training. Using the same methods and measures, within-group comparisons of High Anxious and Low Anxious participants were completed

Beyond the specific data analysis methods designed to address the hypotheses in the study, a number of exploratory analyses were conducted, including comparisons between baseline HRV levels and initial EI scores, baseline HRV levels and initial trait anxiety scores, and changes in EI scores in the training and control groups related to HRV indicators of coherence, LF, VLF, and HF responses before and after training.

For between-group and within-group analysis, correlation and regression analysis data was collected to identify the relationships between physiological and behavioral variables and behavioral variables.

Chapter 4

RESULTS

Prior to participating in the study, 99 students returned permission slips signed by the students and their parents. At the beginning of the study, 89 students completed HRV data recording sessions, and 87 students completed the BarOn Emotional Quotient Inventory: Youth Version (EQ-i:YV) and the State-Trait Anxiety Inventory (STAI). In addition, early in the study 81 students completed the Life Stressors and Social Resources Inventory-Youth Form (LISRES-Y), which was used in conjunction with the STAI to distinguish High Anxious and Low Anxious participants in the training group.

Students participated in the study over a period of three months. They met twice a week in Advisory classes, except when school holidays and occasional changes in the school schedule resulted in cancellation of the class. The control and training groups followed an identical social-emotional learning (SEL) curriculum in the Advisories (see Appendix A for an outline of the SEL curriculum). In addition, students in the training group learned and practiced the positive emotional refocusing method (see Appendix B for a description of instructions to participants in the training group).

After finishing the curriculum and training, the students then completed the EQ-i:YV, STAI, and HRV data recording sessions for a second time. The number of students completing both the pretest and posttest measures varied slightly with each measure due to discarded or incomplete tests, absences, or errors in saving data in computer files. A total of 62 students (E = 39, C = 23) completed pretest and posttest EQ-i:YV and STAI measures, with 66 students (E = 41, C = 25) completing pretest and posttest HRV measures. A total of 52 students (E = 33, C = 19; m = 38, f = 14) completed all of the measures in the study. Analysis of measures was done using pair-wise deletions to adjust for missing data. The control and training groups were matched demographically, with a slightly larger ratio of males to females in the control group (see Tables 1 – 3).

Table 1

Gender and average age of participant

Group	n	male	female	age
All participants	99	72	27	14.6 years
Control	37	30	7	14.7 years
Training	62	42	20	14.6 years

Table 2

Mean values for primary HRV variables for participants prior to training

Group	n	IBI	COH	VLF	LF	HF	LF/HF
Control	25	786.80	1.49	5.98	6.32	6.12	12.37
Training	41	805.26	1.46	6.08	6.37	6.08	12.71

Note. IBI = the interbeat interval or heart rate. COH = coherence. VLF = very low frequency. LF = low frequency. HF = high frequency. LF/HF = low frequency/high frequency ratio. All numbers are expressed in log forms. Values taken during 7-minute baseline period prior to stressor. For correlations among HRV variables, see Appendix D.

Table 3

Mean values for EI, EI subscales, and trait anxiety for participants prior to training

Group	n	EI	EIA	EIC	EID	T
Control	23	94.3	98.0	100.3	92.9	52.9
Training	39	97.9	100.7	99.5	94.8	50.0

Note. EI = overall emotional intelligence. EIA = intrapersonal EI subscale. EIC = stress management EI subscale. EID = adaptability EI subscale. T = trait anxiety.

Mean scores for baseline emotional intelligence (EI) differed for males and females (m = 95.21, f = 100), as did scores for trait anxiety (m = 50.7, f = 52.04). EI and trait anxiety were normally distributed for females but less evenly distributed for males, as compared to the overall population (see Appendix C for population characteristics and distributions). Females conformed to norms established for 13-to 15-year-olds for EI (Bar-On & Parker, 2000). Males scored slightly below the mean EI norm (M = 100) for their age group (Bar-On & Parker, 2000). Of the 87 students who completed the EQ-i:YV, 17 students (20%) scored above 109, considered to be a superior score, and 11 students (13%) scored below 80, considered to represent an underdeveloped capacity for socially and emotionally intelligent behavior (Bar-On & Parker, 2000).

Mean scores on trait anxiety for both males and females, as well as for the control and training groups, were significantly above norms established by Spielberger, Gorsuch, Lushene, and Vagg, (1983) for 10th grade students (for males, M = 40.17, SD = 10.53; for females, M = 40.97, SD = 10.63). Distributions on primary HRV variables at baseline did not differ significantly between males and females.

Consistent with the broader goal of the study—to investigate and collect normative HRV and EI data on high school students and establish associations among HRV and behavioral variables—Pearson correlations were run to review baseline characteristics of the population. No significant correlations were established for the population between behavioral and HRV measures. As expected, since the EI score is a function of scores on the EI subscales, all subscales were significantly correlated with EI. Further, EI and trait anxiety were negatively correlated—a result consistent with predictions in the literature. However, it is noteworthy that the negative correlation was highest (r = -.584, $p < .01$) for trait anxiety and EIC, the EI subscale that measures stress management behaviors (see Table 4).

Table 4

Intercorrelations among EI, EI subscales, and trait anxiety for all participants prior to training

Variable	EI	EIA	EIC	EID	T
EI	--	.681**	.689**	.750**	-.470**
EIA	.681**	--	.299**	.350**	-.203**
EIC	.689**	.299**	--	.455**	-.584**
EID	.750**	.350**	.455**	--	-.381**
T	-.470**	-.203**	-.584**	-.381**	--

Note. EI = overall emotional intelligence. EIA = intrapersonal EI subscale. EIC = stress management EI subscale. EID = adaptability EI subscale. T = trait anxiety.
** = $p < .01$.

The study design called for students in the training group to practice the positive emotional refocusing technique at least eight times in the classroom and to participate in one 30-minute session in the computer lab, where the investigator instructed students in the technique and students practiced on software games designed for HRV biofeedback. However, interviews with the three Advisory teachers in charge of the training groups indicated that students practiced only four times in class, significantly reducing the time spent on, and the presumably the effects of, training. Analysis of results by Advisory class showed no significant differences between groups.

Hypothesis 1 was supported, with significant differences observed between the control and training groups in increased coherence during recovery from stress. However, Hypotheses 2 – 4 were not supported. This may be the result of an insufficient amount of training, the lack of impact or minimal impact of physiological interventions on behavioral changes, or characteristics of the population itself, such as the fact that trait anxiety was above the norm for the age group. However, within-group comparisons showed significant differences in outcomes between High Anxious and Low Anxious participants across behavioral and HRV variables. These results—noted under Hypothesis 5 in this chapter and discussed in detail in Chapter 5—indicate that High Anxious and Low Anxious participants may have quite different characteristics and may react differently to training and interventions.

Hypothesis 1

Hypothesis 1, designed to test the impact of positive emotional refocusing on HRV measures of autonomic recovery from stress, was supported, with a one-tailed test of significance showing significant increases ($t = 1.979$, $p < .05$, $df = 40$) in coherence during the recovery period after training, as compared to nonsignificant changes in the control group ($t = .382$, $df = 24$). In addition, the effect size for the change in coherence for the training group was .44, as compared to an effect size of .07 for the control group, indicating a stronger association between training and increased coherence in the training group than in the control group. Other pre- and posttest measures of HRV changes included mean differences between low frequency (LF), high frequency (HF), and low frequency/high frequency (LF/HF) scores during stress recovery. Significant increases ($p < .05$) in low frequency were observed in the control group. Training results for HRV variables for males and females did not differ significantly.

The control and training groups both showed significant differences in coherence between the stressor and recovery periods, indicating that coherence improved between stress and recovery periods (as expected after stress is removed). However, the training group showed larger and more significant increases (t = 3.088, df = 43, p < .004) in coherence than the control group (t = 2.216, df = 27, p < .05). Table 5 contains a summary of HRV results. Additional tables are provided in Appendix D.

Table 5

Group differences for HRV variables after training

Group	Variable	Mean Differences	Standard Deviation	*t*	*df*	Sig.
Control	COH3	.0643	.8416	.382	24	.353
(n = 25)	LF	.2988	.8045	1.857	24	.038*
	HF	-.1430	.8958	-.798	24	.217
	LF/HF	.1558	1.3125	.593	28	.276
Training	COH3	.3295	1.0659	1.979	40	.027*
(n = 41)	LF	-.0458	.8655	-.339	40	.369
	HF	-.0411	.6668	-.395	40	.348
	LF/HF	-.0869	1.1157	-.499	48	.310

Note. COH3 = mean difference between coherence during recovery, pre- and posttraining. LF = low frequency. HF = high frequency. LF/HF = low/high frequency ratio. Sig. = one-tailed test of significance. All differences recorded during recovery period, pre- and posttraining.
* = p < .05

Differences between mean scores for baseline coherence after training and prior to the stressor (control group, t = -.935; training group, t = -.473) suggest that training may have prepared participants for the posttest stressor. The effects of repetition were investigated using analysis of variance (ANOVA) with posttest baseline coherence scores as the covariate. A chi-square analysis using a Wilcoxon Signed Ranks Test did not indicate significant differences between positive and negative rankings of the control and training groups.

Hypothesis 2

Hypothesis 2 was not supported. Scores on the subscales for intrapersonal EI, stress management EI, and adaptability EI decreased for both the control and training groups. Notable was a significant decline ($p < .05$) in stress management EI that was recorded for the control group. Scores for the training group also declined, indicating that students reported less ability to manage stress at the end of the training period than at the beginning of training (see Table 6). With the exception of stress management EI scores for the control group, results indicated that the limited amount of training in positive emotional refocusing had no impact on EI scores.

Hypothesis 3

Similar to the previous findings, Hypothesis 3—that EI will increase as a result of training—was not supported. As shown in Table 6, mean scores on overall EI declined for both the control and training groups. Declines in scores were not significant, however. The decline in the mean EI score for the control group was slightly larger than that of the training group—a decline attributable to the significant decrease recorded for the control group on the stress management EI subscale.

Hypothesis 4

Hypothesis 4—that trait anxiety will decrease as a result of training—was not supported. The results contained in Table 6 reveal a slight increase in trait anxiety for both the control and training groups after the training. These results would be expected given the inverse relationship established between EI and trait anxiety, both in this study and the literature, and given the outcomes reported for Hypothesis 2 and Hypothesis 3.

The increase was smaller for the training group, but the differences between groups were not significant. Note again that prior to training both the control and training groups scored above the norms established for their age group for trait anxiety. (See Table 6. Also, see Table 7 for within-group comparisons between High Anxious and Low Anxious students.)

Table 6

Group differences for EI, EI subscales, and trait anxiety variables after training

Group	EI	EIA	EIC	EID	T
Control	-2.83	-2.35	-4.00*	1.48	2.08
Training	-1.16	1.05	-2.46	3.05	1.49

Note. EI = overall emotional intelligence. EIA = intrapersonal EI subscale. EIC = stress management EI subscale. EID = adaptability EI subscale. T = trait anxiety.

* = $p < .05$.

Hypothesis 5

For the within-group study, High Anxious and Low Anxious participants were categorized by combining trait anxiety scores with scores on the Positive and Negative Life Events scales on the LISRES-Y. Out of the 81 students who completed both the STAI and LISRES-Y, 64 were identified as High Anxious or Low Anxious youth (High Anxious, n = 32; Low Anxious, n = 32). The remaining 18 students were not included in the within-group study. Of the 64 students categorized as High Anxious or Low Anxious, 39 (High Anxious, n = 23; Low Anxious, n = 16) participated in the training group and completed the pre- and posttest EQ-i:YV and STAI measures; 35 (High Anxious, n = 19; Low Anxious, n = 16) completed the pre- and posttest HRV measures.

Comparisons between High Anxious and Low Anxious participants provided data for Hypothesis 5, an exploratory hypothesis predicting that High Anxious participants will show greater changes in HRV, EI, and trait anxiety than Low Anxious participants as a result of training in positive emotional refocusing. For EI, EI subscales, and trait anxiety measures, this hypothesis was not supported. There was no significant change in either group, as shown in Table 7.

Table 7

Within-group comparison of mean scores on behavioral variables before and after training

Group		EI	EIA	EIB	EIC	EID	EIE	T
High Anxious (n = 23)	Before training	93.6	98.9	92.7	97.0	90.0	95.6	54.7
	After training	93.5	99.8	94.3	95.3	85.2	94.3	54.9
Low Anxious (n = 16)	Before training	103.3	102.4	96.6	107.8	99.0	98.1	42.6
	After training	103.3	103.1	92.1	108.2	97.8	97.3	44.6

Note. EI = overall emotional intelligence. EIA = intrapersonal EI subscale. EIB = interpersonal EI subscale. EIC = stress management EI subscale. EID = adaptability EI subscale. EIE = general mood EI subscale. T = trait anxiety.

Low Anxious students showed a significant increase in coherence during autonomic recovery from stress ($t = 2.55$, $p < .05$, $df = 14$). High Anxious students did not show significant increases. Effect size for the training was .63. As reported earlier under Hypothesis 1, in the control and training groups coherence increased during recovery from stress in both the pretest and posttest. In contrast, coherence during recovery decreased for High Anxious participants (t = -1.18) during the posttest, while Low Anxious participants showed a significant increase in coherence (t = 2.580, $p < .01$, df = 14) during recovery (see Table 8).

Table 8

Within-group mean differences for HRV variables after training

Group	Variable	Mean Differences	Standard Deviation	t	df	Sig.
High Anxious	COH1	.14	.97	.594	15	.281
(n = 19)	COH2	.02	.79	.099	13	.461
	COH3	-.22	.71	-1.177	13	.130
	LF	-.13	.82	-.584	13	.363
	HF	-.25	.59	-1.547	15	.073
	LF/HF	-.38	.95	-1.472	13	.083
Low Anxious	COH1	.01	.93	.061	18	.476
(n = 16)	COH2	.13	.56	.921	14	.187
	COH3	.69	1.17	2.549	14	.012*
	LF	-.02	.86	-.096	14	.462
	HF	.023	.87	.105	14	.459
	LF/HF	.00	1.35	-.006	14	.498

Note. COH1 = mean difference between baseline coherence, pre- and posttraining. COH2 = mean difference between coherence during stressor, pre- and posttraining. COH3 = mean difference between coherence during recovery, pre- and posttraining. LF = low frequency during recovery. HF = high frequency during recovery. LF/HF = low/high frequency ratio during recovery. Sig. = one-tailed test of significance.

* = $p < .01$

To further explore differences between High Anxious and Low Anxious youth, analysis of baseline scores prior to training was conducted for all High Anxious and Low Anxious participants in the study (n = 64), both in the control and training groups. Since

High Anxious and Low Anxious participants were identified partially on the basis of trait anxiety scores (as well as LISRES-Y scores on Positive and Negative Life Events), mean scores differed significantly for trait anxiety (High Anxious, $M = 56.9$, SD = 5.9; Low Anxious, $M = 43.3$, SD = 4.1), as would be expected. However, correlation analysis also indicated significant differences between High Anxious and Low Anxious participants on other baseline behavioral variables, including differences in overall EI, stress management EI, adaptability EI, and general mood EI. (Note: The general mood EI subscale was not used for study results; however, it is considered a facilitator of the other subscales. See Table 9.)

Table 9

Mean baseline scores for EI and EI subscales for High and Low Anxious participants

Group	n	EI	EIA	EIB	EIC	EID	EIE
High Anxious	32	91.9	97.8	90.9	96.2	89.4	83.3
Low Anxious	32	105.2	103.2	94.5	108.8	102.9	98.5

Note. EI = overall emotional intelligence. EIA = intrapersonal EI subscale. EIB = interpersonal EI subscale. EIC = stress management EI subscale. EID = adaptability EI subscale. EIE = general mood EI subscale. Differences in EI, EIC, EID, and EIE mean scores are all significant at $p < .000$.

As Tables 10 and 11 indicate, correlations showed differences in the relationship between EI, the EI subscales, and trait anxiety for the two groups, indicating that EI for High Anxious students may be affected by low general mood scores that are negatively correlated with higher trait anxiety ($r = -.387$, $p < .05$). EI for Low Anxious students is affected by higher stress management scores ($r = .672$, $p < .01$) and lower trait anxiety ($r = -.458$, $p < .01$).

Table 10

Baseline correlations among EI, EI subscales, and trait anxiety for High Anxious students

Variable	EI	EIA	EIB	EIC	EID	EIE	T
EI	--	.684**	.755**	.398*	.688*	-.387*	-.107
EIA	.684**	--	.514*	-.006	.349	.488*	-.171
EIB	.755**	.514*	--	.088	.318	.413*	-.154
EIC	.398*	-.006	.088	--	.135	-.057	.090
EID	.688*	.349	.318	.135	--	.305	-.094
EIE	-.387*	.488*	.413*	-.057	.305	--	-.387*
T	-.107	-.171	-.154	.090	.094	-.387*	--

Note. n = 32. EI = overall emotional intelligence. EIA = intrapersonal EI subscale. EIB = interpersonal EI subscale. EIC = stress management EI subscale. EID = adaptability EI subscale. EIE = general mood EI subscale. T = trait anxiety.

* = p < .05. ** = p < .01.

Table 11

Baseline correlations among EI, EI subscales, and trait anxiety for Low Anxious students

Variable	EI	EIA	EIB	EIC	EID	EIE	T
EI	--	.887**	.741*	.672**	.661**	.622*	-.458**
EIA	.887**	--	.624*	.477**	.438*	.552*	-.375*
EIB	.741*	.624*	--	.260	.335	.673*	-.110
EIC	.672**	.438*	.260	--	.324	.220	.-.576**
EID	.661**	.438*	.335	.324	--	.343	-.301
EIE	.622*	.552*	.673*	.220	.343.	--	.673*
T	-.458**	-.373*	-.110	-.576**	-.301	-.274	--

Note. n = 32. EI = overall emotional intelligence. EIA = intrapersonal EI subscale. EIB = interpersonal EI subscale. EIC = stress management EI subscale. EID = adaptability EI subscale. EIE = general mood EI subscale. T = trait anxiety.

* = p < .05. ** = p < .01.

Factors affecting EI in High Anxious and Low Anxious students were explored through analysis of the relationship between EI, trait anxiety, and positive and negative life events. Results showed that High Anxious youth had experienced more negative life events (M = 58.8, SD = 14.2) than had Low Anxious youth (M = 46.3, SD = 10.3). Both groups reported nearly identical scores for positive life events (see Appendix D).

Regression analysis, as shown in Table 12, indicated that trait anxiety was a significant predictor variable for EI and EI subscale scores in the entire population of students, with lower trait anxiety contributing to higher EI scores. However, the relationship of trait anxiety to EI subscales differed for both High Anxious and Low Anxious students. Trait anxiety was a significant source of variance for general mood in High Anxious participants but not for other subscales. Similarly, lower trait anxiety appeared to be a significant source of variance in improved EI stress management. In addition, Table 12 shows that positive and negative life events differed as predictor variables for EI and EI subscales. Note that positive life events were a significant (β = .405, $p < .05$) source of variance in adaptability EI in High Anxious youth. For additional regression analysis results, see Appendix D.

Table 12

Regression coefficient summary for variables predicting EI and EI subscales

		EI	EIC	EID	EIE
Group	Variable	β	β	β	β
All Participants					
(n = 72)	T	-.413***	-.551***	-.307**	-.519***
	NLE	-.220	-.128	-.283*	-.175
	PLE	.212	.009	.276*	.244
High Anxious					
(n = 32)					
	T	-.077	.070	-.043	-.373*
	NLE	-.158	-.194	-.154	-.294
	PLE	-.265	-.174	.405*	.212
Low Anxious					
(n = 32)					
	T	-.468**	-.587**	-.325	-.270
	NLE	-.132	-.096	-.322	.016
	PLE	.046	-.103	.089	.153

Note. EI = overall emotional intelligence. EIC = stress management EI subscale. EID = adaptability EI subscale. EIE = general mood EI subscale. T = trait anxiety. NLE = negative life events. PLE = positive life events.
* = p < .05. ** = p < .01. *** = p = .000.

Exploratory analysis was also conducted to detect relationships between behavioral and physiological variables among all High Anxious and Low Anxious students in the study (n = 64). In Low Anxious participants (n = 32), higher EI (r = .394, $p < .05$) correlated with higher coherence during the pretest baseline period, while no significant correlation was found between EI and coherence in all participants or in the High Anxious group (n = 32). Figures 1 and 2 illustrate these findings. Note that increased coherence, as measured in log form, is recorded as a negative number.

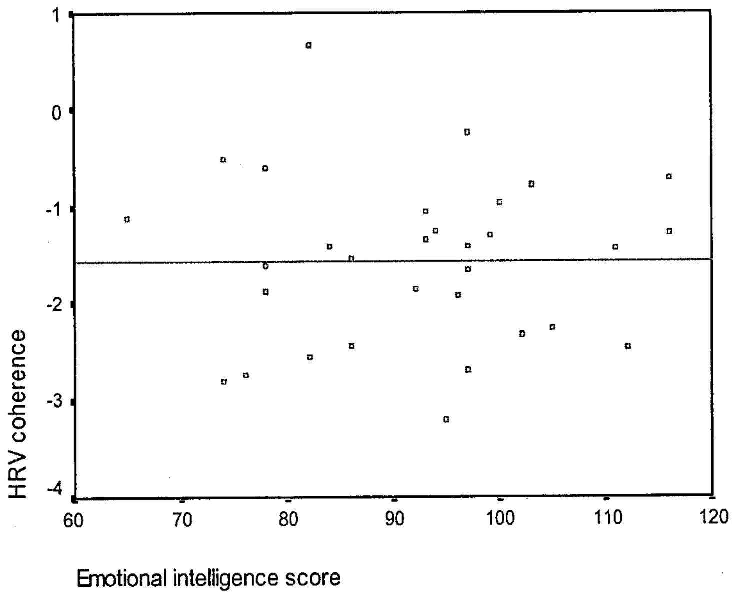

Figure 1. Relationship of EI and coherence in High Anxious participants (n = 32)

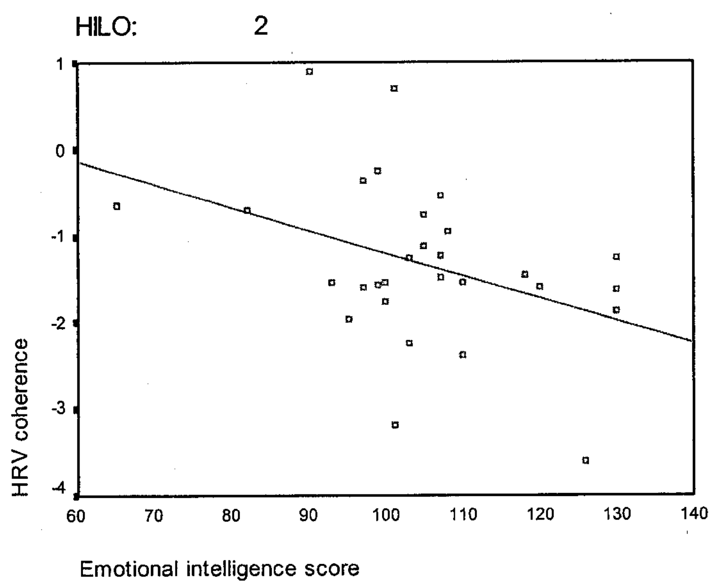

Figure 2. Relationship of EI and coherence in Low Anxious participants (n = 32)

Regression analysis conducted to explore HRV as a source of variance in behavioral variables showed that lower heart rate and higher parasympathetic activity were significantly associated with EI scores of Low Anxious participants but were not associated with EI scores of High Anxious participants. VLF activity was a significant source of variance in trait anxiety in the Low Anxious group (see Table 13). Prior to training, no significant differences in HRV variables were observed between High Anxious and Low Anxious students who participated in the training group.

Table 13

Regression coefficient summary for HRV variables predicting EI, EI subscales, and trait anxiety

		EI	EIC	T
Group	Variable	β	β	β
High Anxious (n = 32)				
	IBI	.035	.232	.372
	COH	-.013	.105	-.240
	LF	-.209	.131	.106
	VLF	.011	-.151	-.129
	HF	.094	-.434	-.270
Low Anxious (n = 32)				
	IBI	-.486*	-.321	.123
	COH	-.375	-.259	-.183
	LF	-.166	.102	.348
	VLF	.083	.110	-.696*
	HF	.607**	.298	-.174

Note. EI = overall emotional intelligence. EIC = stress management EI subscale. T = trait anxiety. IBI = baseline interbeat interval. COH = baseline coherence. LF = baseline low frequency. VLF = baseline very low frequency. HF = baseline high frequency.

* = $p < .05$. ** = $p < .01$.

Chapter 5

DISCUSSION

The intent of this study was threefold: (1) to determine the impact of positive emotional refocusing on emotional intelligence (EI) and autonomic recovery from stress in adolescents; (2) to compare findings from the study with the current research literature on stress, coping, and emotional development; and (3) to fit the findings into the broader context of developing effective, accessible, school-based programs for stress management and social-emotional development. Particularly, the study was designed to provide data on behavioral and psychophysiological measures that could be incorporated into a biopsychosocial approach to wellness in schools.

The study findings showed that training in positive emotional refocusing had a positive impact on heart rate variability (HRV), with significant ($p < .05$) mean increases in coherence during autonomic recovery from stress in the training group, as compared to no observed differences in coherence in the control group. The increases in coherence were recorded despite the training group's limited practice in positive emotional refocusing, suggesting that additional practice would result in greater shifts in coherence and that positive emotional refocusing is an effective method for improving HRV.

Further, significant increases in coherence during autonomic recovery from stress were recorded for Low Anxious students in the training group, while no significant changes were observed in High Anxious students. This indicates that Low Anxious students may be more receptive to training than High Anxious students. Additionally, at the outset of the study Low Anxious and High Anxious students differed significantly across behavioral variables, with significant correlations between increased coherence and higher EI observed in Low Anxious youth. This implies that the relationship between emotions, physiology, and social buffers may differ among young people and thus influence stress vulnerability and coping styles.

Based on the findings, it appears likely that preventive health promotion strategies cannot be applied equally to all children and that it may be useful to include a prescreening measure to assess appropriate levels of support and assistance for individual children. While not all findings were significant, the use of three measures—designed to provide information on disposition, emotional behavior, and physiology—provided a triangulated picture of students' stress levels, emotional management capabilities, and ANS functioning that may contribute to or contrast with the many theoretical models of stress and coping detailed in the literature.

The study also underscored the challenge of developing school-based programs for social-emotional learning (SEL), particularly when using interventions such as positive emotional refocusing or other psychophysiological methods that may be unfamiliar to teachers and students. As anticipated, the study confirmed that the culture and conditions in schools do not lend themselves easily to comprehensive social-emotional interventions. Limited time, an agenda crowded by academic and school business, variable teacher interest and capability, and a complex mix of cultural and demographic characteristics in the student population combine to make the implementation of programs focused on health and emotional well-being a challenging task. These factors impacted the results of the study by limiting the amount of practice in positive emotional refocusing provided to the training group and reducing compliance rates among students.

In general, study findings contribute to the important task of supporting the healthy emotional development of youth. Recent reviews of resiliency studies indicate that 70% to 75% of at-risk youth, including those from highly stressed families or resource-deprived communities, overcome adversity or coping problems and achieve good developmental outcomes (Benard, 2004). Yet the supports that contribute to resiliency and healthy emotional development, including the relationship between environmental protective factors and innate traits, are still not well understood. Further examination of the factors that contribute to high anxiety and low anxiety in youth, as explored in this investigation, is necessary to the design of successful SEL programs.

Limitations and delimitations of the study

Limitations on the study were considerable, primarily due to reduced practice in positive emotional refocusing and low compliance rates in the training group. In addition, an important limitation was the sample size of the High Anxious and Low Anxious groups, which may have affected the variance in the data and the significance of findings, particularly in findings based on smaller correlations.

The self-report measures used in the study relied upon the personal and subjective responses of adolescents, adding to the normal limitations of a self-report instrument. These limitations may apply particularly to the reporting of negative and positive life events on the LISRES-Y. A similar observation may be made of the subjective responses required by the EQ-i:YV; however, responses of all participants were screened for inconsistency using the index provided in the EQ-i:YV measure. Also, the limitations of the self-report instruments were somewhat mitigated by the physiological measures.

It is possible that other measures of anxiety may be more effective than the STAI. As Aldwin (1994) notes, approaches to stress measurement are not clear-cut and depend upon the research question and the way in which stress is conceptualized.

Personal interviews with participants may have provided pertinent information on mood and anxiety, particularly for High Anxious youth. These interviews will be conducted *post hoc,* and are not reported here.

Demographics and school culture

Several vital questions remain unanswered in the study, and these unknowns color the discussion of results. First, it is not known whether participants in the training group would show significant changes in HRV patterns if given additional training. Second, it is not known if additional training over a longer period would elicit changes in EI or trait anxiety in participants, as hypothesized in the study. The absence of answers to these questions is due in part to the limited practice time made available to students in the training group. As a result of scheduling and curriculum conflicts, students practiced an average of four sessions in each Advisory class, rather than the eight sessions originally designed into the study. In addition, whether further training would result in changes in HRV patterns or EI and trait anxiety variables in High Anxious students is not known. Findings indicate that training did impact HRV patterns in Low Anxious students, but it is not known whether additional training would increase their EI and EI subscale scores or lower their trait anxiety scores.

The study depended upon teachers in each of three Advisories to implement and practice positive emotional refocusing in the training group. Although all three teachers overseeing the training indicated enthusiasm and interest and willingly trained themselves in the intervention method, it was apparent that the teachers differed in their ability to teach a psychophysiological method to students. In general, the more successful teachers appear to be those who feel comfortable with students in small groups and who have facilitation skills—not universal abilities among educators. No significant differences for results were apparent among the three teachers; however, highest compliance rates were reported by the teacher who was considered most capable as a small group facilitator by the school, as indicated by the school principal (R. Lenz, personal communication, January 16, 2004).

These limitations in the study are the result of conditions commonly encountered in schools. Although the teachers initially agreed to the study and prepared themselves to teach the curriculum to the control and training groups, Advisory routines were consistently interrupted by unanticipated scheduling demands (a theft that called for school-wide discussions, cancellations due to minimum days, schedule changes to accommodate final exams). Also, as a newly opened school, the Advisory routines were not firmly established and thus could not be anticipated by the investigator or the principal of the school.

Further, the demographics of the students were not conducive to compliance with training. Both the training and control groups consisted solely of ninth grade students, approximately 65% of whom were males. The principal estimated that up to half of the students had arrived at the school with a negative view of schooling and with poor experiences in school. This led to diminished compliance in the training group during classroom practices. Compliance rates also differed among the three Advisory classes that comprised the training group. Estimates by the teachers ranged from 100% compliance in one group to 60% in the least compliant group. Although the study did not attempt to link school history and outlook with Low Anxious and High Anxious profiles, anecdotal observation indicated that many of the students with poor histories in school came to be identified through behavioral measures as High Anxious youth.

The above conditions are precisely those under which most schools operate, making it challenging for both research and SEL programs to be carried out successfully. However, it should be noted that in addition to gathering several significant findings, the study succeeded in involving nearly the entire student body of a comprehensive high school and also laid the foundation for a research-based Advisory program for SEL and stress management that will be implemented in other high schools.

Positive emotional refocusing and heart rate variability

Despite limited training, the training group showed significant ($p < .05$) mean differences in coherence after training, as compared to the control group. A review of between-group differences on HRV variables shows a pattern of higher coherence and a higher ratio of parasympathetic (LF/HF) activity in the training group. These results confirm predictions in the literature (McCraty, 2002b) as well as the assumption that the stress response is sympathetically driven.

Comparisons of High Anxious and Low Anxious participants in response to training provided a more fine-grained appraisal of training results. A comparison of mean differences in coherence during recovery from stress during the posttest showed that Low Anxious participants significantly increased coherence as a result of training, with an effect size of .77, while coherence in High Anxious students decreased. A comparison of within-group mean differences also showed a pattern of increased high frequency (HF) or parasympathetic activity in Low Anxious students after training.

An important question arises as to why Low Anxious students responded to training more readily than High Anxious participants. Prior to training there were no significant differences on HRV variables between the control and training groups. And, although Low Anxious students did show slightly higher mean levels of coherence, there were no significant differences between High Anxious and Low Anxious participants. The implication of these findings is that Low Anxious students did not respond to training as a result of physiological predisposition. Rather, it appears that behavioral differences may have been a decisive factor, as discussed later in the chapter.

Positive emotional refocusing, EI, and trait anxiety

Results showed that trait anxiety increased in both the control and training groups after training, while EI decreased in both groups after training. Changes in mean scores for overall EI were larger for students in the control group but substantial for both groups. Also, declines in EI stress management scores for the control group were significant ($p < .05$) but also evident in the training group.

The reduced number of practice sessions for the positive emotional refocusing method is the most apparent explanation for the findings on measures of EI and trait anxiety in the training group. However, it is also likely that the shifts in both EI and trait anxiety scores may be attributed to stressful activities within the school and could be a function of the relationship between trait anxiety and EI measures. The overall EI score is a composite of the five subscales; a low score on the stress management EI subscale thus significantly affects the overall EI score. The EI and trait anxiety measures were administered in October, two months after the beginning of the school year and prior to grading. However, the EI and trait anxiety posttest measures were administered during the three days before final exams and exhibitions in January—a period of increased stress for students.

Other possible explanations should be noted as well. The amount of practice required to create observable correlations between HRV patterns and behavioral differences has not been established in the literature. The original goal of eight practice sessions was set by the investigator, but more than eight sessions may be necessary for efficacy. In addition, the link between HRV patterns and behavior—and specifically between HRV and measures of EI and trait anxiety—is not well enough understood to know whether training will result in observable differences, regardless of the number of practices or length of training. In contrast to results for HRV, an examination of results for High Anxious and Low Anxious participants on EI and trait anxiety measures provides few clues to these questions. Although High Anxious and Low Anxious students both participated in the training, they showed fewer differences in mean scores than the control and training groups did overall, indicating that participation in the training itself may have mitigated declines in scores.

Mood, life events, and resiliency

The study yielded a number of findings that have implications for a transactional model of stress and coping that incorporates emotions, physiological response, individual differences, and person-environment interactions. Research issues in this field—as described by investigators such as Lazarus (1997), Aldwin (1994), and Saarni (1999)—are focused on three areas: (1) identification of core protective factors that decrease stress vulnerability and increase resiliency; (2) description of the causal directionality of stress, particularly in terms of the relationship between environmental stressors, physiological response, and emotional behavior; and (3) deeper understanding of the role of individual differences and emotions in coping styles. Further, the study findings allow some inferences to be made regarding interventions or stress management training for different populations of students, particularly High Anxious and Low Anxious youth.

Mood may be one indicator that is useful in assessing students. As measured on the EI subscale, mood is considered a facilitator of scores on the other subscales and of overall EI (Bar-On, 1997). Standardized scores below 80 indicate that participants may be overly pessimistic, thus influencing other scores and providing important information to clinicians who may use the BarOn EQ-i:YV for diagnosis. Data collection in this study did not include personal interviews with students who scored in the low range for the mood EI subscale, nor were mood scores included in hypotheses for the study. However, it was noted in baseline measurements that mean scores for mood EI were slightly lower for the control group ($M = 86.3$, SD = 15.5, n = 32) than for the experimental group ($M = 91.6$, SD = 15.5, n = 55) prior to training. The range in scores on EI also differed in the two groups (control group = 59, training group = 65). Further, when all participants were measured prior to training, scores on mood EI differed significantly between High Anxious students ($M = 83.3$, n = 32) and Low Anxious students ($M = 98.5$, n = 32).

The directionality of the association between mood and overall EI is well established: a pessimistic mood decreases EI scores. However, the source or cause of mood is an important question, particularly for adolescents, since mood can inhibit compliance or participation as well as test scores. The relationship between trait anxiety and affect is a prominent topic in the literature (Aldwin, 1994; Forgas, 2001; Lazarus, 1997).

In the present study, a regression analysis of findings showed that trait anxiety was a significant predictor of mood for High Anxious participants ($\beta = -.373$, $n = 32$) but did not predict mood in Low Anxious participants. At the same time, trait anxiety did not predict overall EI in High Anxious students but did significantly predict EI in Low Anxious students ($\beta = -.468$, $n = 32$).

One inference from the above results is that trait anxiety predicts mood in the absence of other factors. However, the data indicated that two protective factors may also be important: a higher number of positive life events and better stress management skills. For example, positive life events were a significant predictor variable for adaptability EI in High Anxious students, as compared to no significant relationship for Low Anxious students. These findings indicate that positive life events may act as a buffer against anxiety or stress by promoting problem-solving skills. This inference is strengthened by data for all participants ($n = 72$), which showed that positive life events significantly predicted higher adaptability EI, while negative life events were a significant predictor of lower adaptability EI.

One of the most prominent findings of the study was the strong negative correlation between disposition, in the form of trait anxiety, and EI and three EI subscales, with the strongest association occurring between stress management EI and trait anxiety ($r = -.584$, $p < .01$). In all participants trait anxiety also was a significant predictor variable for lower adaptability EI. This finding is supported by previous research showing that Low Anxious subjects respond more negatively to outside stress, while High Anxious subjects respond more positively by using a controlled emotional response to address stressful situations (Forgas, 2001).

Findings in the present study also show interesting contrasts between High Anxious and Low Anxious youth, with strong negative correlations for Low Anxious youth between EI ($r = -.458$, $p < .01$) and stress management EI, but no significant correlation between trait anxiety and mood EI. Conversely, High Anxious youth showed no correlations between trait anxiety and EI and the EI subscales, except on mood EI. Similar results were obtained through regression analysis.

The study findings indicate that the relationship between EI and trait anxiety cannot be explained by a purely linear relationship and that the expression of behaviors related to either EI or trait anxiety may be modulated by other factors. Some clues to the modulating factors may be evident in the comparisons of negative and positive life events in both groups, in which regression results show a stronger although not significant correlation between negative life events and trait anxiety in High Anxious participants. Further, High Anxious youth showed a significant positive correlation ($r = .405$, $p < .5$) between positive life events and adaptability EI, suggesting that positive events in their lives may serve as important buffers for managing crises in life.

At the same time, it should be noted that research has not demonstrated that trait anxiety (and personality traits in general) map onto coping styles, with some researchers asserting that state anxiety may be a better indicator of coping skills in specific situations (Aldwin, 1994). However, findings in this study support the inference that dispositions are expressed through habitual preferences that are formed through the influence of positive buffers or environmental stressors. Finally, the findings support arguments that EI measures may have incremental validity beyond traditional personality psychology measures (see Mayer, Salovey, & Caruso, 2000), since it appears that the relationship between anxiety, mood, and life events is complex.

The causal directionality of stress: Emotions and physiology

One chief question underlying the study—whether HRV coherence or other HRV activity generates positive EI, or whether EI directs HRV patterns—cannot be answered here. But the study findings support the hypothesis that affective states are associated with specific HRV patterns. They also suggest that there may be a relationship between HRV coherence and a relaxed state.

Correlations between HRV variables, EI, and EI subscales were not significant for High Anxious students. However, Low Anxious students showed a significant correlation (r = .394, $p < .05$) between coherence and EI prior to training. This was not true of the population as a whole or of High Anxious participants. In addition, regressions indicated that increased HF was a significant predictor variable for EI (β =.607, $p < .01$), intrapersonal EI (β =.611, $p < .01$), and adaptability EI (β =.463, $p < .05$). These findings indicate an association between increased parasympathetic activity—a sign of a more relaxed physiology—and EI. Similarly, regression analysis of sources of variance for interpersonal EI using HRV variables as predictor variables showed similar results for HF

(β = .463, $p < .05$). The link between higher coherence and EI, as shown in baseline variables for Low Anxious students, may contribute to the literature on emotion-specific ANS activity, which is considered the "enduring issue" in psychology (Christie & Friedman, 2003, p. 143).

Two other findings should be noted in regard to relationships between HRV and behavioral measures. First, regression analysis showed that faster heart rate, as measured by interbeat interval, negatively predicted (β = -.486, $p < .05$) EI and adaptability EI (β = -.581, $p < .05$). It might be expected that lower heart rate would be associated with higher emotional functioning—an expectation met in the comparisons of mean heart rates of High Anxious students (M = 78.7) with Low Anxious students (M = 76.7) as measured before training. Also, increased very low frequency (VLF) activity was a significant (β = -.696, $p < .05$) predictor of trait anxiety. The VLF band is generally associated with sympathetic activity, and it could be expected that lower trait anxiety would be associated with less sympathetic response. The explanations for this finding are speculative. Lower VLF scores may be a function of the measurement of increased coherence—a measure of improved autonomic functioning that may result in a different autonomic balance between the sympathetic and parasympathetic systems—as recorded in the Low Anxious group. Further, the VLF band is affected by factors other than sympathetic response and is the least understood of the frequency bands.

An important question to ask is why the Low Anxious students, even with minimal training, responded with increased levels of HRV coherence after training (mean difference = .535, $p < .05$), as compared to the High Anxious students. One answer may lie in differences between the two groups in scores on EI and the EI subscales prior to training. Low Anxious students scored at least one standard deviation higher on EI, stress management EI, and adaptability EI than did High Anxious students, with the largest differences in stress management EI. It is possible that Low Anxious participants were more skilled at stress management prior to training or that they used their EI capability to attend more to the training and practice. The Low Anxious students were more attentive to directions, more compliant, and more interested in outcomes. They also tended to have more positive school histories. *Post hoc* interviews will be conducted with these students to further explore this phenomenon.

Personality, emotions, and coping styles

A second important question revolves around the relationship between personality dispositions and the behaviors measured by the EQ-i:YV. To what extent is trait anxiety muted by emotionally intelligent behavior—or conversely, to what extent is emotionally intelligent behavior, particularly skillful stress management, diminished by anxiety? Finding the answer to this question is complicated by two aspects of the study. First, the significant negative correlations between trait anxiety and EI in the baseline data for all participants confirmed that the STAI and EQ-i:YV measure overlapping domains. Second, while the findings showed different levels of trait anxiety for the Low Anxious and High Anxious groups, it is important to note that both groups scored above the norms for trait anxiety for their age group. This suggests that the students in the study were more anxious than the normal population of students, or that anxiety has risen measurably in students in general since the norms were established in 1983.

The EI subscale scores, rather than the overall EI scores, are the most helpful in analyzing the relationship between anxiety and behavior. As noted earlier, trait anxiety was negatively associated with general mood in High Anxious students, suggesting that poor management of anxiety—perhaps because of the absence of stress management or problem-solving skills—may lead to depressed mood and lower EI. For Low Anxious students, higher stress management EI was significantly associated with less trait anxiety. In addition, there was a link ($r = .438$, $p < .05$) between higher stress management EI and intrapersonal EI in Low Anxious students, versus a zero correlation ($r = .006$) in High Anxious students. This suggests that the characteristics measured by the intrapersonal EI subscale—self-awareness, assertiveness, self-regard, self-actualization, and independence—may be associated with increased problem-solving abilities and improved stress management or coping skills. In turn, these skills may modulate the expression of trait anxiety.

Future directions

The picture that emerges from the findings is of two groups of students with distinct behavioral and physiological profiles. Low Anxious students had higher HRV coherence and increased parasympathetic activity at rest, along with higher overall EI and higher scores on all EI subscales. Their overall EI scores showed the highest correlation with intrapersonal EI and stress management EI, which appeared to modulate the effects of trait anxiety. Higher coherence significantly correlated with EI in Low Anxious students. These students also showed more response to training, with greater increases in coherence during autonomic recovery from stress after training.

While Low Anxious youth showed distinct patterns of behavior and physiology in the study, High Anxious youth could not be similarly described. High Anxious students showed levels of trait anxiety significantly above the norms for 10th grade boys (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) and above norms for the school population in the study. In addition, findings indicate a stronger association between mood and trait anxiety in High Anxious youth, with subsequent impacts on stress management skills and overall EI. EI scores for the High Anxious group were below norms for high school students. In addition, the High Anxious participants showed no significant response to training as measured by HRV, trait anxiety, or EI variables.

The study findings demonstrate that significant relationships exist between physiological and behavioral variables related to stress management in adolescents who are characterized by low anxiety and higher EI. These findings thus lead in three directions: (1) toward additional research in determining the directionality and interrelationships of the variables; (2) toward greater understanding of how the relationship between HRV, EI, and trait anxiety varies in other groups, particularly High Anxious youth; and (3) toward integrating study findings into SEL programs in schools.

The primary measures in the study provided a useful triangulation of data derived from disposition, behavior, and physiology. The associations between the variables appear significant, although the directionality is still unclear. Particularly, to what extent is trait anxiety responsible for EI? This question revolves around research issues in personality psychology (McCrae, 2000). Perhaps a more manageable question is how the expression of trait anxiety can be modulated in young people, either by developing stress management skills or by participating in training to change their HRV patterns. The question of whether increased coherence can decrease trait anxiety or increase stress management EI has not been answered in this study, as was hoped. Additional studies that include longer and more extensive training in positive emotional refocusing constitute a key research task.

Important research goals are to determine how and why High Anxious youth differ from Low Anxious youth, and to establish how these findings pertain to interventions for stress management and autonomic recovery. In particular, understanding the relationship between mood and anxiety is important. What determines mood, and how can mood be shifted to a more positive state? How does mood overwhelm stress management skills or present affective barriers to learning stress management skills? Negative life events appear to be associated with lower mood states for High Anxious youth (as opposed to Low Anxious youth), indicating additional environmental stressors. These findings can be incorporated into research on resiliency—in particular, research showing that resiliency is normative and that protective factors are more important than risk factors (Benard, 2004).

The findings in the study appear to be directly applicable to the design of SEL programs. First, the EI subscales appear to be useful in delineating aspects of EI that can easily be described to young people and thus incorporated into programs that teach stress management, social skills, and peer-mediated communication such as conflict resolution. Although the research base and conceptual models for EI may be legitimately debated by researchers, the mixed model of EI appears to offer a manageable, useful concept for instructing students. The five subscales are more useful than a global index of EI.

Because trait anxiety maps onto EI with strong correlations, it may not be necessary to include separate measures of anxiety.

It is clear to the investigator that positive emotional refocusing can be successfully taught in SEL programs if the following conditions are met: (1) teacher training and commitment; (2) an appropriate school-wide schedule; (3) and sufficient time to explain the program to students and create the conditions for success. The last point is crucial. High Anxious students with poor school histories can be particularly resistant to unfamiliar training methods and training that involves emotional change. Such programs must be accompanied by personalized dialogue with students to gain their trust and compliance. In this regard, it should be noted that computer-based HRV training appealed to both High Anxious and Low Anxious students.

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Appendix A

Advisory curriculum and training schedules

The MSAT Advisory Program

The purpose of the MSAT Advisory program is to support the mental, emotional, and physical well-being of students to encourage healthy living, self-expression and creativity, and optimal performance.

Key elements of the program include:

1. Emotional Intelligence

    - Core values
    - Awareness of self, including personality and learning styles inventory
    - Emotional awareness, self-management, and conflict resolution
    - Knowledge of family systems/dynamics
    - Stress inventory

2. Peak Performance

    - Listening/public speaking/communication skills
    - Goal setting
    - Teamwork and collaboration
    - Leadership/followership
    - Conflict resolution
    - Creativity
    - Physiology of performance
    - Stress management

3. Physical Well-Being

    - Knowledge of mind/body/brain
    - Health status inventory
    - Exercise plan
    - Nutrition and rest

Developing Emotional Intelligence – Training group schedule

Day	Activity	Notes
Day 1	Overview (Thom) *Emotions, stress, and performance* *Taking charge of your brain* *Developing emotional intelligence* *Hand out consent forms*	
Day 2	Are you stressed? *Introducing stress* *Stress/effect/solution* *Stress survey -- partners* *Collect consent forms*	
Day 3	What energizes you? *The Balance Sheet* *Collect consent forms*	Norms should be in place. If not, go back to basics.
Day 4	Measuring your stress *Administer LISRES*	45 minutes. Comprehensive inventory of what stresses you and what resources you have.
Day 5	What is your emotional intelligence? *Administer EI/STAI*	40 minutes for both. EI measures 5 aspects of EI. STAI is personality measure for state (how you feel) and trait (how you are) anxiety.
Day 6	The Freeze Frame method (Thom) *Review Balance sheets. Administer questionnaires.* *Generating positive emotions: What do I appreciate?* *Learn and practice the Freeze Frame method:* *Discussion: How could you use this?*	I will do all these sessions to get started. Questionnaire is very brief. Designed to identify anyone who has had relaxation training. Inform students that method reduces stress, increases clarity, and helps one be aware of emotions
Day 7	Active listening (Thom) *Types of listening* *Active Listening exercise* *How to listen with empathy* *Listening exercise with Freeze Frame*	Next four sessions are focused on improving communication skills. Inform students that they will practice Freeze Frame 12 times by mid-January in variety of exercise related to communication, stress, and performance.
Day 8	Taking responsibility for your feelings *Rethinking I-statements:* *Communication I-way worksheet* *I-statement exercise: Practice Freeze Frame*	

Day 9	Being real *Barriers to communication* *Body language exercise/Sentence completions* *Masking feelings exercise:* *Practice Freeze Frame: redo exercise with partner*	
Day 10	Dealing with putdowns *Going to neutral* *Activity* *Practice scenario: Practice Freeze Frame with partner*	Students will choose an issue and do a journal write. Then practice Freeze Frame and write down solutions. Share if desired. Note confidentiality agreement.
Day 11	Conflict and stress *Drawing a conflict web* *Choose a current issue: Practice Freeze Frame* *How would you solve this conflict?*	
Day 12	Dealing with bullying *Film?* *Discussion. Client-consultant activity* *Thought Seat exercise* *Practice Freeze Frame: Redo exercise*	This can be general discussion on bullying or use the more structured activity to discuss specific concerns.
Day 13	Managing stress *How open are you to stress? Freeze Frame worksheet.* *Choose a stressful issue. Practice Freeze Frame.* *Brainstorm solutions.*	
Day 14	Helping others: *Stress or communication challenges. How will you handle them?* *Client-consultant activity: Practice Freeze Frame as a group* *Assignment: Practice Freeze Frame at home or with friends*	Sharing issues: client-consultant or suggestion circle activities
Day 15	Improving performance *Brainstorming exercise. Continue after practicing Freeze Frame as a group*	Focus on upcoming final exams and projects
Day 16	What is your EI now? *Practice Freeze Frame* *Administer EI/STAI* *Discussion: What have you learned that will be useful to you?*	

Developing Emotional Intelligence – Control group schedule

Day	Activity	Notes
Day 1	Overview (Thom) *Emotions, stress, and performance* *Taking charge of your brain* *Developing emotional intelligence* *Hand out consent forms*	
Day 2	Are you stressed? *Introducing stress* *Stress/effect/solution* *Stress survey -- partners* *Collect consent forms*	
Day 3	What energizes you? *The Balance Sheet* *Collect consent forms*	Norms should be in place. If not, go back to basics.
Day 4	Measuring your stress *Administer LISRES*	45 minutes. Comprehensive inventory of what stresses you and what resources you have.
Day 5	What is your emotional intelligence? *Administer EI/STAI*	40 minutes for both. EI measures 5 aspects of EI. STAI is personality measure for state (how you feel) and trait (how you are) anxiety.
Day 6	How do you relax? *Review LISRES results.* *Discussion: How do you relax? What are your resources for help?*	I'll give you results of LISRES
Day 7	Active listening (Thom) *Active listening exercise* *How to listen with empathy* *Listening exercises*	Next four sessions are focused on improving communication skills. I will facilitate the first session.
Day 8	Taking responsibility for your feelings *Rethinking I-statements:* *Communication I-way worksheet*	
Day 9	Being real *Barriers to communication* *Body language exercise/Sentence completions* *Masking Feelings exercise:*	

Day 10	Dealing with putdowns *Going to neutral* *Activity* *Practice scenario*	Students will choose an issue and do a journal write. Then write down solutions. Share if desired. Note confidentiality agreement.
Day 11	Conflict and stress *Drawing a conflict web* *Choose a current issue: How would you solve this conflict?*	
Day 12	Dealing with bullying *Film?* *Discussion. Client-consultant activity* *Thought seat exercise*	This can be general discussion on bullying or use the more structured activity to discuss specific concerns.
Day 13	Managing stress *How open are you to stress?* *Choose a stressful issue. Brainstorm solutions.*	
Day 14	Helping others: *Stress or communication challenges. How will you handle them?* *Client-consultant activity*	Sharing issues: client-consultant or suggestion circle activities
Day 15	Improving performance *Brainstorming exercise: How can you improve your performance?*	Focus on upcoming final exams and projects.
Day 16	What is your EI now? *Administer EI/STAI* *Discussion: What have you learned that will be useful to you?*	

Appendix B

Instructions for training group participants

A. Instructions for positive emotional refocusing:

Step 1. Recognize stress and become aware of it.

Step 2. Make a sincere effort to shift your focus to your heart area. You can breathe in 'through' your heart to help focus your attention on your heart area.

Step 3. Recall a fun or positive event or feeling that you've had in your life. This can be a feeling of appreciation, love, or care for something, someone, or some place in your life. Attempt to re-experience the feeling.

Step 4. As you experience the feeling of care or appreciation, keep the focus on your heart. Maintain this focus and feeling while you continue to 'breathe' through your heart. Maintain the focus as long as possible.

Step 5. Notice any shifts in your body or thoughts after you are finished.

B. Instructions for heart rate variability data recording session.

<u>Before the test</u>:

1. Sign in your full name and age. Click OK.
2. Go to Mode on the pull-down menu. Click Heart Rhythms.
3. Click the small window with the columns (entrainment ratios) on the toolbar.
4. Attach finger sensor to your left forefinger. Make sure the soft part of your finger is pressing against the red window of the sensor. Use the Velcro attachment.
5. Relax your hand against a flat surface with your finger in solid contact with the sensor. Keep your hand still throughout.
6. With your right hand, click Start on the toolbar.

<u>During the test:</u>

The test will take 17 minutes. It will be divided into 7 minutes of baseline data, 5 minutes of stress, and 5 minutes for stress recovery. During the stress period, there will be loud background noise and you will read words from a sheet.

Baseline (7 minutes)

Keep finger still. Watch screen.

Stress (5 minutes)

When you are instructed to do so, begin reading the list of words—red, green, and blue. Choose the *color* of the letters of the word, which will be red, green, or blue. When you have identified the color of the letters for the word, use your right hand to press the letter R, G, or B on the keyboard.

Do not watch the screen. Work quickly, but accurately. If you finish the sheet, begin again at the top left of the page. Keep working until you hear the instruction to stop. Put down the sheet.

Recovery (5 minutes)

Begin looking at the screen again. Do whatever you normally to do relax. Continue until told to stop. Click STOP on the toolbar.

<u>After the test.</u>

Take off the finger sensor. Go to File menu. Click Save Data.

Appendix C

Supplemental tables and figures – Participant characteristics

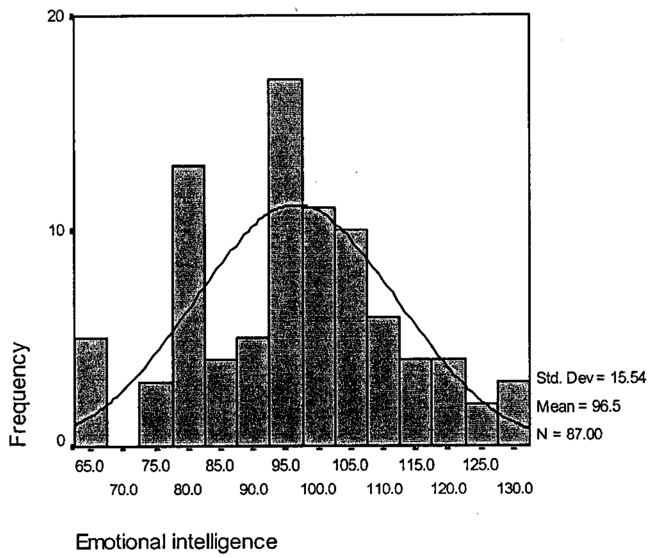

Figure A1. EI distribution for all participants prior to training

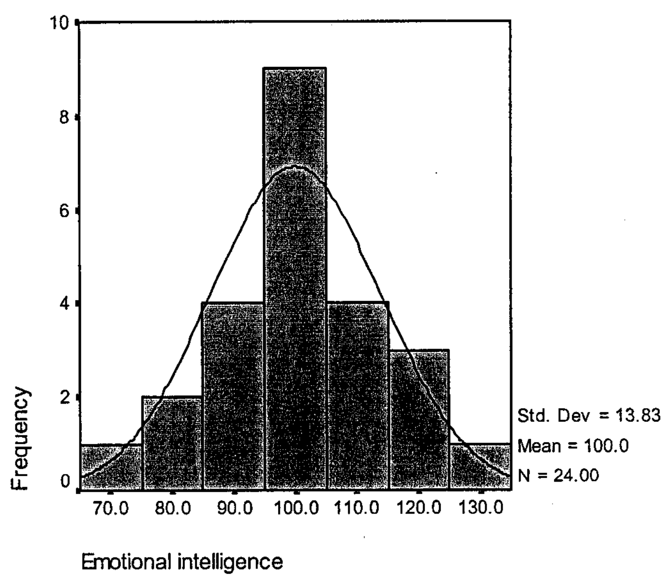

Figure A2. EI distribution for females prior to training

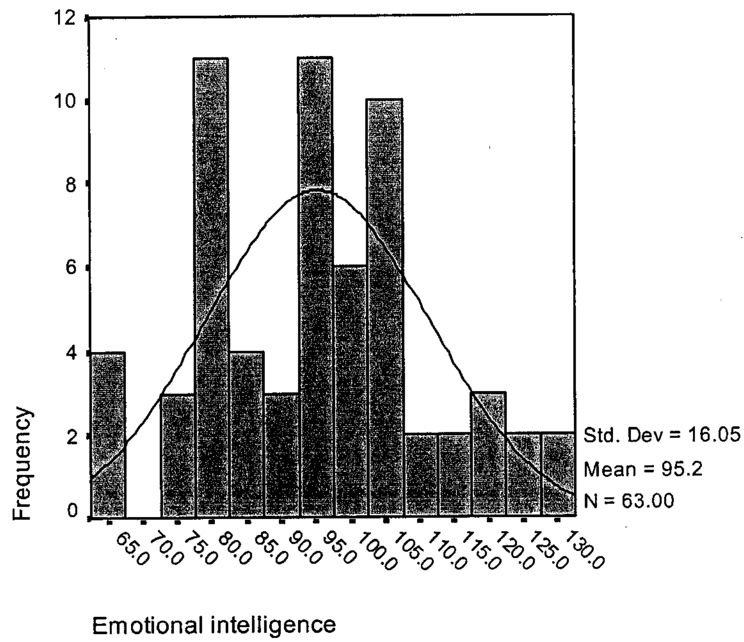

Figure A3. EI distribution for males prior to training

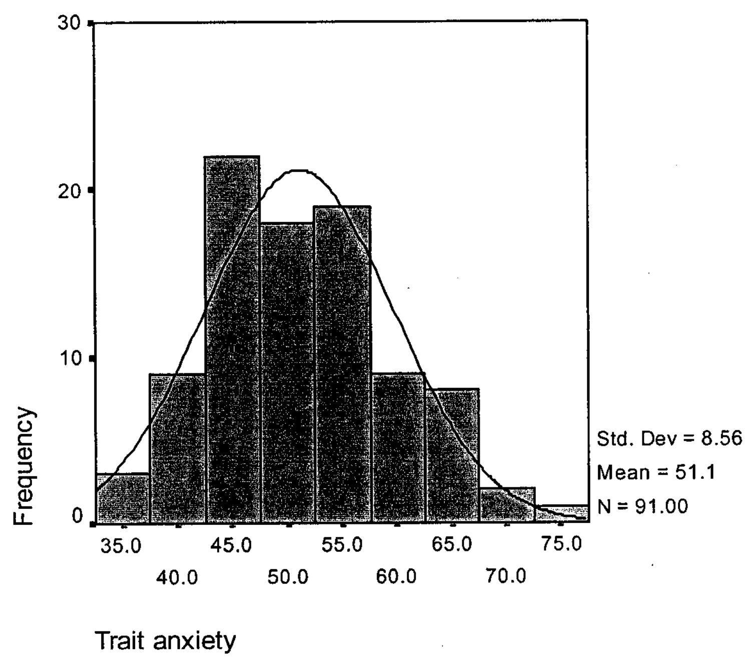

Figure A4. Trait anxiety distribution for all participants prior to training

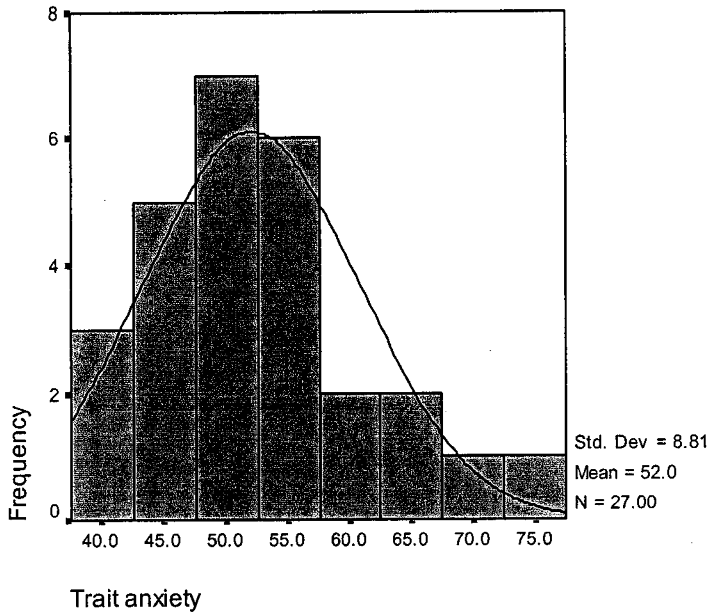

Figure A5. Trait anxiety distribution for females prior to training

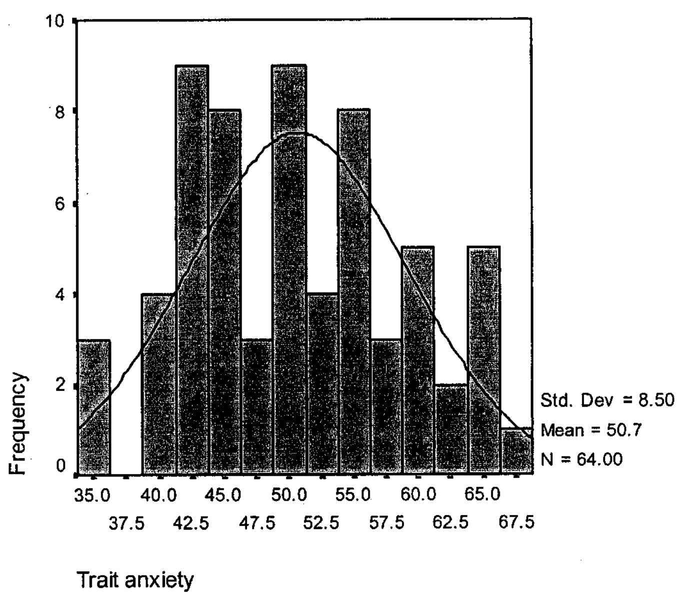

Figure A6. Trait anxiety distribution for males prior to training

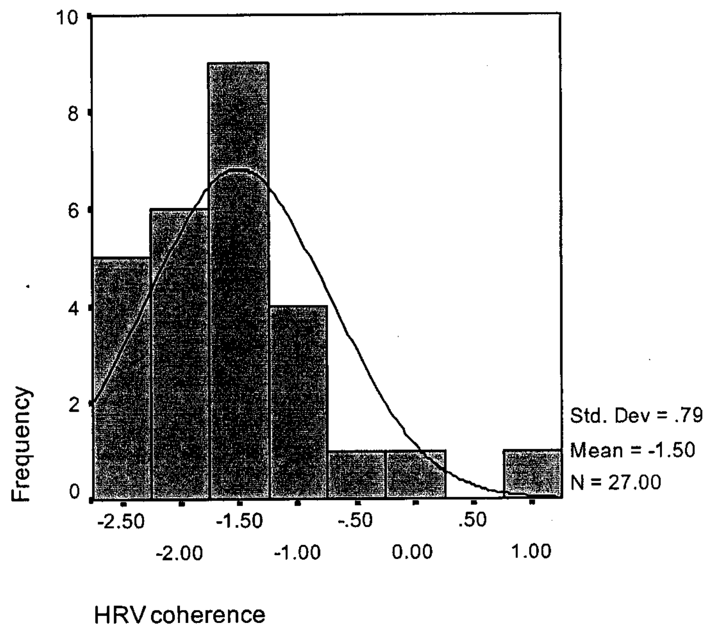

Figure A7. HRV coherence distribution for females prior to training

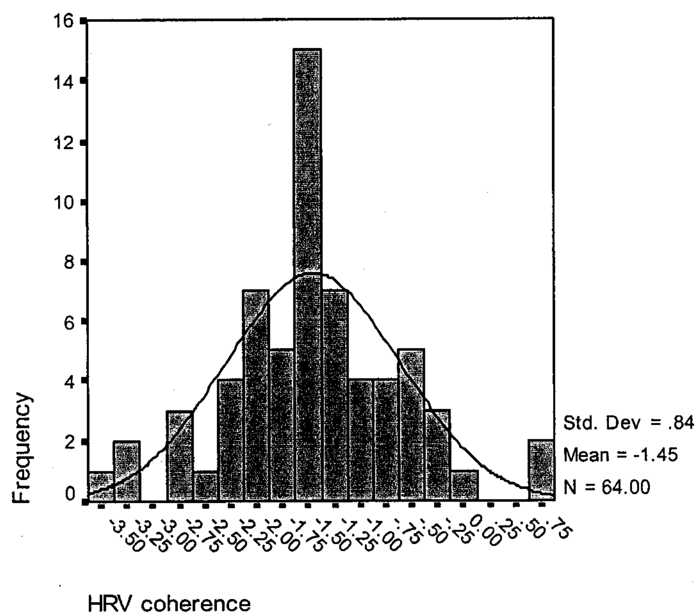

Figure A8. HRV coherence distribution for males prior to training

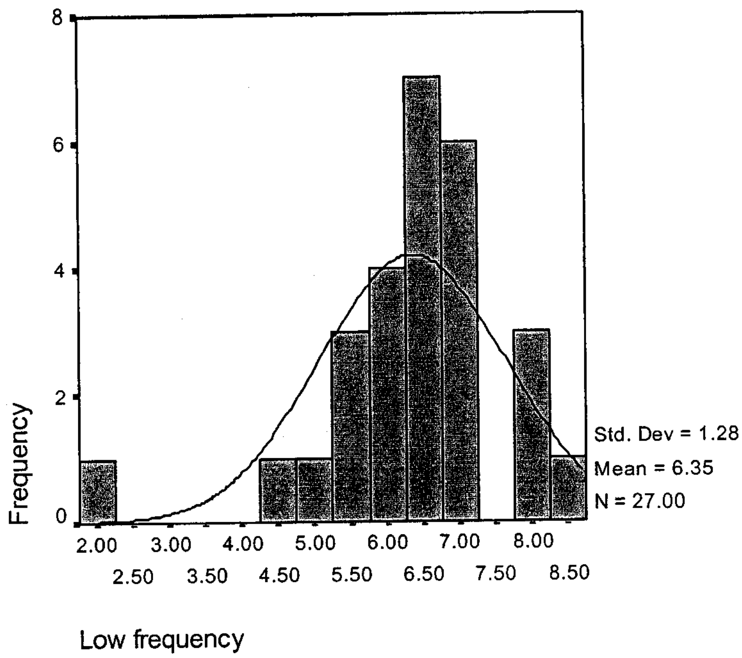

Figure A9. HRV low frequency distribution for females prior to training

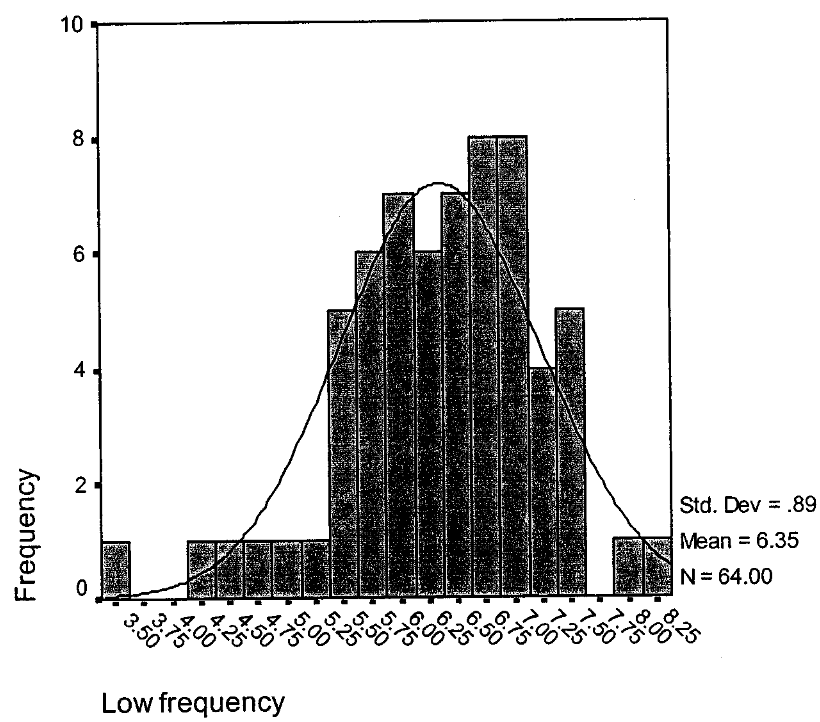

Figure A10. HRV low frequency distribution for males prior to training

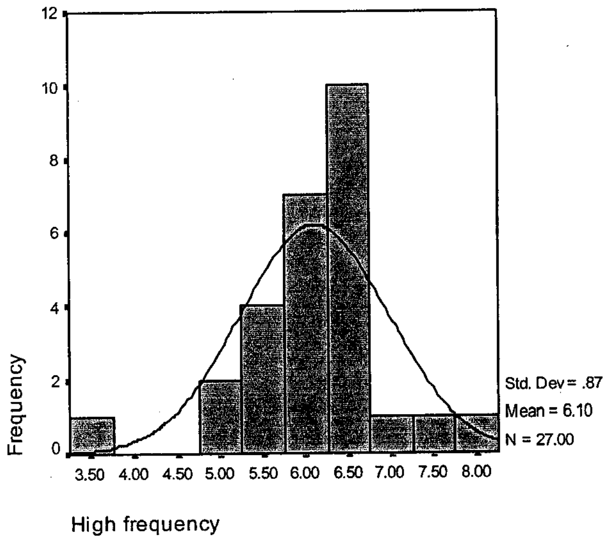

Figure A11. HRV high frequency distribution for females prior to training

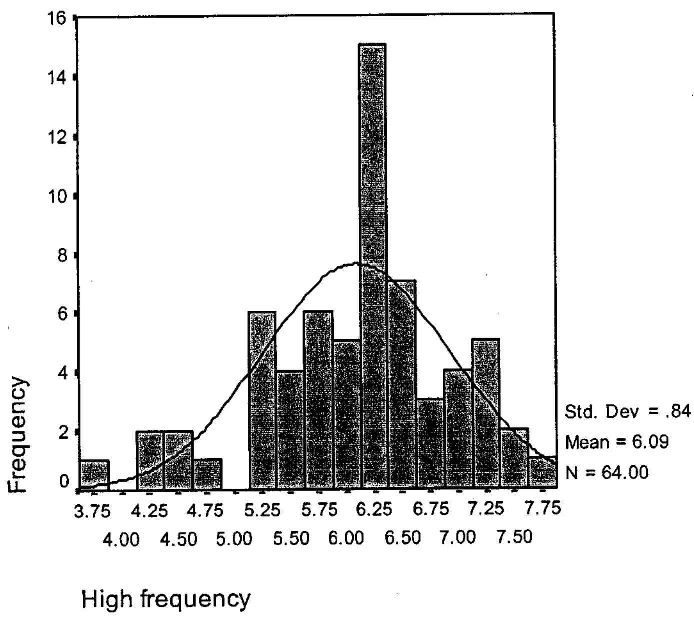

Figure A12. HRV high frequency distributions for males prior to training

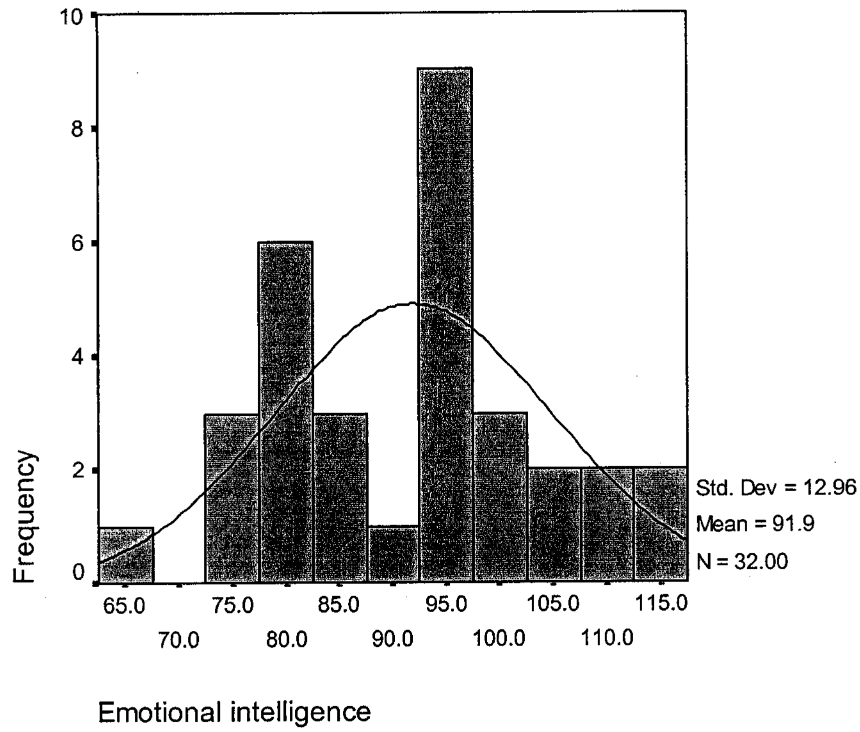

Figure A13. EI distributions for High Anxious participants prior to training

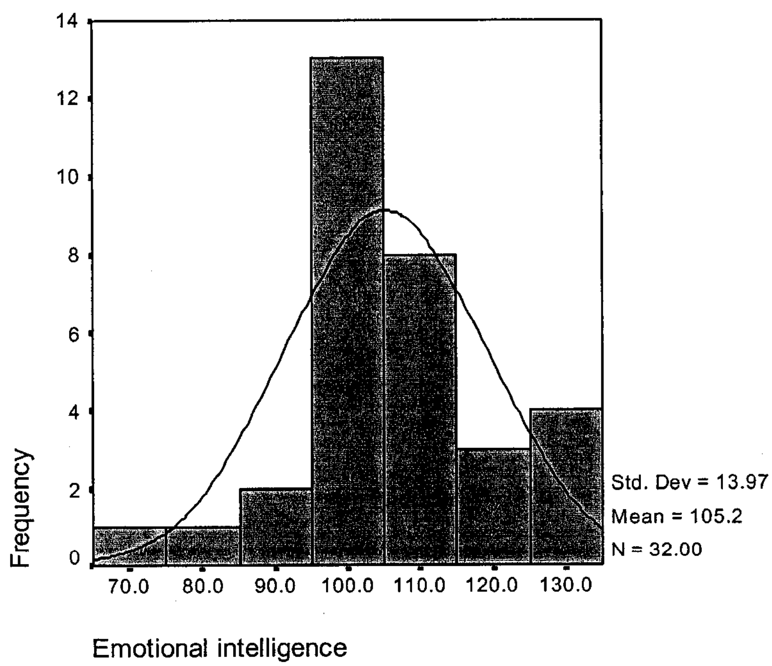

Figure A14. EI distributions for Low Anxious participants prior to training

Table A1

EI scores by Advisory before training

Advisory	Mean	n	S.D.
1	96.8	18	17.87
2	98.1	18	16.47
3	98.7	18	15.25
4	94.0	20	13.55
5	94.8	12	16.52
Total	96.5	86	15.63

Table A2

Mean EI and trait anxiety scores for males and females before training

M/F		EI	EIA	EIC	EID	T
F	Mean	100.04	103.50	99.04	94.17	52.04
	n	24	24	24	24	27
	S.D.	13.83	15.92	15.55	13.43	8.81
M	Mean	96.54	98.30	100.08	94.06	50.69
	n	63	63	63	63	64
	S.D.	16.05	11.82	13.34	15.41	8.50

Note: EI = emotional intelligence; EIA = intrapersonal EI; EIC = stress management EI; EID = adaptability EI; T = trait anxiety

Table A3

Correlations among selected HRV and behavioral variables for all participants before training

	EI	EIC	T	IBI	COH	VLF	LF	HF
EI (n = 87)	--	.689**	-.470**	-.010	-.127	.020	-.075	.126
EIC (n = 87)	.689**	--	-.584**	-.054	.029	-.027	-.038	-.052
T (n = 85)	-.470**	-.584**	--	.042	-.077	.023	.056	.039
IBI (n = 79)	-.010	-.054	.042	--	-.103	.400**	.459**	.612*
COH (n = 79)	-.127	.029	-.077	-.103	--	-.375**	.167	.058
VLF (n = 79)	.020	-.027	.023	.400**	-.375**	--	.706**	.434*
LF (n = 79)	-.075	-.038	.056	.459**	.167	.706**	--	.640*
HF (n = 79)	.126	-.052	.039	.612*	.58	.434**	.640*	--

Note: EI = emotional intelligence; EIC = stress management EI; T = trait anxiety; IBI = interbeat interval; COH = baseline coherence; VLF = very low frequency; LF = low frequency; HF = high frequency.
* = $p < .05$. ** = $p < .01$

Table A4

Group mean HRV scores before training

Group		IBI	TPWR	LF	VLF	HF	COH
Control (n = 33)							
	Mean	766.8	7.35	6.32	5.98	6.12	-1.49
	S.D.	122.9	.81	.94	.90	.87	.85
Training (n = 58)							
	Mean	805.3	7.40	6.35	6.04	6.10	-1.47
	S.D.	109.6	.91	1.06	1.20	.83	.81

Note: IBI = interbeat interval; TPWR = total power; LF = low frequency; VLF = very low frequency; HF = high frequency; COH = baseline coherence.

Table A5

Group mean EI and trait anxiety scores before training

Group		EI	EIA	EIC	EID	T
Control (n = 32)						
	Mean	94.3	98.0	100.3	92.9	52.9
	S.D.	14.5	10.5	12.9	14.3	8.7
Training (n = 55)						
	Mean	97.9	100.7	99.5	94.8	49.9
	S.D.	16.1	14.5	14.5	15.2	8.4

Note. EI = emotional intelligence. EIA = intrapersonal EI. EIC = stress management EI. EID = adaptability EI. T = trait anxiety

Table A6

Within-group mean HRV scores before training

Group		IBI	COH	VLF	LF	HF
High Anxious (n = 32)						
	Mean	790.9	-1.52	6.09	6.39	6.13
	S.D.	134.2	.87	1.47	1.33	1.54
Low Anxious (n = 32)						
	Mean	795.8	-1.33	5.96	6.32	6.12
	S.D.	71.3	.92	.85	.82	.80

Note: IBI = interbeat interval. COH = baseline coherence. LF = low frequency. VLF = very low frequency. HF = high frequency;

Table A7

Mean scores for trait anxiety, negative life events, and positive life events before training

Group	Variable	Mean	S.D.
All S's			
(n = 81)			
	NLE	52.7	13.5
	PLE	50.9	11.3
	T	51.09	8.5
High Anxious			
(n = 32)			
	NLE	57.4	13.7
	PLE	50.9	14.7
	T	54.6	4.6
Low Anxious			
(n = 32)			
	NLE	46.3	11.5
	PLE	50.4	10.4
	T	42.5	4.1

Note. NLE = negative life events. PLE = positive life events. T = trait anxiety.

Table A8

Trait anxiety, negative life events, and positive life events as predictors of EI in all participants before training (n = 87)

Predictor Variable	B	Std. Error	β	t	Sig.
T	-.750	.193	-.413	-3.886	.000
NLE	-.253	.127	-.220	-1.987	.051
PLE	.292	.147	.212	1.990	.051

Note. NLE = negative life events. PLE = positive life events. T = trait anxiety

Table A9

Trait anxiety, negative life events, and positive life events as predictors of stress management EI in all participants prior to training (n = 87)

Predictor Variable	B	Std. Error	*β*	*t*	Sig.
T	-.894	.164	-.551	-5.448	.000
NLE	-.132	.108	-.128	-1.222	.226
PLE	1.10	.125	.009	.088	.930

Note. T = trait anxiety. NLE =negative life events. PLE = positive life events.

Table A10

Trait anxiety, negative life events, and positive life events as predictors of EI in High Anxious participants prior to training (n = 32)

Predictor Variable	B	Std. Error	*β*	*t*	Sig.
T	-.169	.406	-.077	-.416	.680
NLE	-.144	.175	-.158	-.822	.418
PLE	.261	.192	.265	1.364	.183

Note. NLE = Negative Life Events. PLE = Positive Life Events. T = trait anxiety

Table A11

Trait anxiety, negative life events, and positive life events as predictors of EI in Low Anxious participants prior to training (n = 32)

Predictor Variable	B	Std. Error	*β*	*t*	Sig.
T	-1.579	.564	-.468	-2.082	.009
NLE	-.179	.251	-.132	-.714	.481
PLE	-	.251	.046	.249	.805

Note. T = trait anxiety. NLE = negative life events. PLE = positive life events.

Table A12

Trait anxiety, negative life events, and positive life events as predictors of adaptability EI High Anxious participants prior to training (n = 32)

Predictor Variable	B	Std. Error	β	t	Sig.
T		.413	-.043	-.242	.811
NLE	-.149	.178	-.154	-.835	.411
PLE	.424	.195	.405	2.174	.038

Note. T = trait anxiety. NLE = negative life Events. PLE = positive life events.

Table A13

Trait anxiety, negative life events, and positive life events as predictors of adaptability EI in Low Anxious participants prior to training (n = 32)

Predictor Variable	B	Std. Error	β	t	Sig.
T	-.847	.448	-.325	-1.89O	.069
NLE	-.337	.200	-.322	-1.687	.103
PLE	--	.199	.089	.468	.643

Note. T = trait anxiety. NLE = negative life events. PLE = positive life events.

Appendix D

Supplemental tables – Group comparisons

Table B1

Group differences in mean scores on EI, EI subscales, and trait anxiety, pre- and posttraining

Group	Variable	Mean	S.D.	*t*	*df*	Sig.
Control	EI	2.83	13.13	1.032	22	.313
	EIA	2.348	13.31	.846	22	.407
(n = 23)	EIC	4.00	8.42	2.278	22	.033
	EID	1.48	15.70	.451	22	.656
	T	-2.08	9.63	-1.079	24	.291
Training	EI	1.18	12.40	.594	38	.556
	EIA	-1.051	11.57	-.567	38	.574
(n = 39)	EIC	2.46	12.25	1.255	38	.217
	EID	3.05	13.95	1.366	38	.180
	T	-1.49	6.80	-1.434	42	.159

Note. EI = emotional intelligence. EIA = intrapersonal EI. EIC = stress management EI. EID = adaptability EI. T = trait anxiety.

Table B2

Group differences in mean baseline HRV scores, pre- and posttraining

Group	Variable	Mean	S.D.	t	df	Sig.
Control	IBI	-18.175	84.02	-1.165	28	,254
	COH	.1257	.7237	.935	28	.358
(n = 25)	TPWR	.0278	.7195	.208	28	.836
	VLF	-.0027	1.1099	-.013	28	.990
	LF	.0393	.8304	,255	24	.801
	HF	.0451	.9418	.258	28	.799
Training	IBI	.1437	99.85	.010	48	.992
	COH	-.0571	.8450	-.473	48	.638
(n = 41)	TPWR	.0140	.6201	.158	48	.875
	VLF	.0141	1.0740	.092	48	.927
	LF	-.0170	.7340	-.162	40	.872
	HF	.0132	.7993	.116	48	.908

Note.: IBI = interbeat interval. COH = coherence. TPWR = total power. VLF = very low frequency. LF = low frequency. HF = high frequency. Sig. = Two-tailed significance.

Table B3

Within-group differences in mean scores on EI, EI subscales, and trait anxiety, pre- and post-training

Group	Variable	Mean	S.D.	*t*	*df*	Sig.
High Anxious	EI	.00	10.54	.000	15	1.00
	EIA	-.625	9.89	-.253	15	.804
(n = 23)	EIC	-.44	8.82	-.198	15	.845
	EID	1.25	14.83	.337	15	.741
	EIE	.75	10.24	.293	15	.774
	T	-2.06	7.43	-1.110	15	.285
Low Anxious	EI	.13	12.95	.039	15	.970
	EIA	-.875	14.59	-.240	15	.814
(n = 16)	EIC	1.69	13.93	.484	15	.635
	EID	4.81	12.03	1.600	15	.131
	EIE	4.94	10.84	1.822	15	.088
	T	-.16	6.20	-.111	18	.913

Note. EI = emotional intelligence. EIA = intrapersonal EI. EIC = stress management EI. EID = adaptability EI. EIE = mood EI. T = trait anxiety.