The Impact of a New Emotional Self-Management Program on Stress, Emotions, Heart Rate Variability, DHEA and Cortisol

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Abstract—This study examined the effects on healthy adults of a new emotional self-management program, consisting of two key techniques, "Cut-Thru" and the "Heart Lock-In." These techniques are designed to eliminate negative thought loops and promote sustained positive emotional states. The hypotheses were that training and practice in these techniques would yield lowered levels of stress and negative emotion and cortisol, while resulting in increased positive emotion and DHEA levels over a one-month period. In addition, we hypothesized that increased coherence in heart rate variability patterns would be observed during the practice of the techniques.

Forty-five healthy adults participated in the study, fifteen of whom acted as a comparison group for the psychological measures. Salivary DHEA/DHEAS and cortisol levels were measured, autonomic nervous system function was assessed by heart rate variability analysis, and emotions were measured using a psychological questionnaire. Individuals in the experimental group were assessed before and four weeks after receiving training in the self-management techniques.

The experimental group experienced significant increases in the positive affect scales of Caring and Vigor and significant decreases in the negative affect scales of Guilt, Hostility, Burnout, Anxiety and Stress Effects, while no significant changes were seen in the comparison group. There was a mean 23 percent reduction in cortisol and a 100 percent increase in DHEA/DHEAS in the experimental group. DHEA was significantly and positively related to the affective state Warmheartedness, whereas cortisol was significantly and positively related to Stress Effects. Increased coherence in heart rate variability patterns was measured in 80 percent of the experimental group during the use of the techniques.

The results suggest that techniques designed to eliminate negative thought loops can have important positive effects on stress, emotions and key physiological systems. The implications are that relatively inexpensive interventions may dramatically and positively impact individuals' health and well-being. Thus, individuals may have greater control over their minds, bodies and health than previously suspected.

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Introduction

THE PATHOGENESIS, progression, and mortality from a wide variety of diseases cannot be predicted from biological factors alone. There is now substantial evidence to indicate that psychosocial risk factors, common to all chronic diseases, may be equally important. Thus, an individual's perception, emotional responses to stress, social support, and social class can play a critical role in the evolution of diseases (Fackelman & Raloff, 1993; Gruman & Chesney, 1995; Watkins, 1995). While the role of psychological factors has been recognized for more than twenty years (Engel, 1977), the evidence suggesting that perception and an individual's response to chronic stress plays a central role in the development of chronic diseases, until very recently has been largely overlooked (Watkins, 1997).

The mechanism by which perception may alter physiology and lead to pathology has been elucidated recently by a number of cytoarchitectural and electrophysiological studies investigating how we process information. These studies have mapped the pathways linking perception with the command centers that regulate the autonomic, neuroendocrine, and immune systems (Gray, 1993; LeDoux, 1993) and thus help to explain the abundance of data documenting how changes in perception can influence autonomic (Sloan et al., 1994; McCraty et al., 1995a), neuroendocrine, and immune function (Ader et al., 1990; Watkins, 1995). If we constantly perceive the world as a threatening and stressful place, then our ability to cope and adapt eventually exceeds our physiological reserves, resulting in imbalance and detrimental changes in all these systems. This sets the stage for the development of disease (Cooper & Marshall, 1976; Karasek, 1979; Frese, 1985; Grossarth-Maticek et al., 1988; Fackelman & Raloff, 1993). In contrast, techniques that promote a healthier, more balanced perception and dampen the stress response have been associated with improved health and recovery (Spiegel et al., 1989; Fawzy et al., 1993; McCraty et al., 1995a; Watkins, 1997).

In recent years, there has been much debate on the role of the limbic system in emotional experience, memory and learning. It is clear that there is a complex interplay between a number of brainstem nuclei and cell groups in the processing of information and the interpretation of experience. However, a number of authors have suggested that the amygdala plays a pivotal role within the emotional system and may coordinate behavioral, immunological, and neuroendocrine responses to environmental threats (LeDoux, 1993, 1996; Watkins, 1997).

In assessing our environment, the amygdala and associated nuclei, hereafter called the amygdaloid complex, is thought to play a key role in comparing new incoming information with information stored in the emotional memory banks, and thereby determine the significance of an event (LeDoux, 1993). Thus, the amygdaloid complex makes an instantaneous decision about the potential threat that incoming sensory information may pose (LeDoux, 1993; Bechara et al., 1995). Because of its extensive projections to the motor cortex, the lateral hypothalamus, and other brainstem autonomic nuclei, the amygdala is able to "hijack" all other neural pathways to initiate a behavioral response (Gray, 1993; Goleman, 1995). Each behavioral response leads to specific changes in immunity (Hauger et al., 1993), heart rate, blood pressure, stress hormone and catecholamine production (Hauger et al., 1993; Roozendaal et al., 1993).

Since the amygdaloid complex is programmed to respond instantaneously, for the sake of survival, its comparative function is very imprecise. New incoming information is compared to memories of past experiences, many of which are wordless emotional impressions from childhood when our language was poorly developed and many events were bewildering (LeDoux, 1996). These stored memories automatically trigger stereotyped emotional reactions to present circumstances that are often outdated and inappropriate. Thus, how we respond to the challenges in our environment is often not driven by rational thought, but by instantaneous, imprecise emotional programs. These programs, if repeatedly triggered, may provoke detrimental behavioral, physiological and immunological responses, thereby reducing resistance to future disease (Cooper & Marshall, 1976; Karasek, 1979; Frese, 1985; Grossarth-Maticek et al., 1988; Fackelman & Raloff, 1993).

The repeated triggering of negative emotional responses can lead to chronic elevation of cortisol levels while decreasing levels of dehydroepiandrosterone (DHEA) (Manolagas, 1979; Parker & Baxter, 1985; DeFeo, 1989). This is due to pregnenolone and progesterone being channeled into cortisol production at the expense of DHEA under chronically stressful conditions (Manolagas, 1979; Parker & Baxter, 1985; DeFeo, 1989). It has been proposed that the cortisol/DHEA ratio is a good biological marker of stress and aging (Kerr et al., 1991; Namiki, 1994). While cortisol is essential for proper metabolism, chronically elevated levels can impair immune function (Jabaaij, 1993; Hiemke, 1994), reduce glucose utilization (DeFeo, 1989), increase bone catabolism and promote osteoporosis (Manolagas, 1979), reduce muscle mass, increase fat accumulation, especially around the waist and hips (Marin, 1992; Ebeling & Koivisto, 1994), impair memory and learning, and destroy brain cells (Kerr et al., 1991; Namiki, 1994). In contrast, DHEA, the body's natural antagonist of the glucocorticoids (Parker & Baxter, 1985), enhances immune function, stimulates bone deposition, lowers cholesterol levels, and promotes muscle deposition (Shealy, 1995).

Low levels of DHEA have been found in individuals with many major diseases, including obesity (Marin, 1992), diabetes (Nestler et al., 1992), hypertension (Shafagoj et al., 1992), coronary artery disease (Barrett-Connor et al., 1986), HIV-related disease (Wisniewski et al., 1993), cancer (Bhatavdekar et al., 1994; Bhatavdekar et al., 1992; Feo & Pascale, 1990), and Alzheimer's (Roberts & Fitten, 1990; Nasman, 1995). Clinically, DHEA has been found to have antidiabetic, antiviral, and antibacterial properties and has also been reported to have anti-aging effects (Shealy, 1995). Further evidence suggests that DHEA may have an antidepressant effect, may improve memory and cognition (Morales et al., 1994), may enhance immune function (Yen et al., 1995), may protect against coronary atherosclerosis (Herrington, 1995), may reduce angina in animals (Shealy, 1995), and may have anti-cancer properties (Schwartz, 1979; Nyce et al., 1984; Mayer et al., 1990).

Excessive levels of DHEA, in contrast, have been associated with adrenal carcinoma, congenital adrenal hyperplasia (CAH), Cushing's syndrome, and hirsutism (Velicheti et al., 1996).

In addition to their effects on neuroendocrine balance, perceptions that trigger negative emotional responses can result in an increase in sympathetic and a reduction in parasympathetic activity. Heightened sympathetic activity increases the risk of ventricular fibrillation (Lown et al., 1978) while increased parasympathetic activity is cardioprotective (Lown & Verrier, 1976). We have previously shown that emotional self-management techniques can improve sympathovagal balance, as assessed using heart rate variability technology (McCraty et al., 1995a), and can promote entrainment between heart rate variability, respiration, and blood pressure waves (Tiller et al., 1996).

This study was designed to investigate the effects of a new emotional self-management program involving two techniques called Cut-Thru (Childre, 1996) and the Heart Lock-In (Paddison, 1992). Cut-Thru is specifically designed to modify the automatic negative emotional responses that occur, due to the emotional programming in our brainstem nuclei, by changing the afferent sensory input to these nuclei. The Heart Lock-In technique enables people to "lock in" to sustained positive feeling states in order to boost their energy, heighten peace and clarity, and effectively retrain their physiology to sustain longer periods of coherent function. Specifically, we investigated whether regular practice of these techniques by a healthy population could reduce stress levels, decrease negative affect, and increase positive affect. Additionally, exploratory physiological measurements were performed to determine whether practice of these techniques would decrease salivary cortisol and increase salivary levels of DHEA over a one-month period. We also investigated whether the interventions would induce concurrent shifts in autonomic function, as measured by heart rate variability analysis.

Methods

The Emotional Self-Management Program

The Cut-Thru technique: During a one-day training session, subjects were taught a new behavioral intervention called "Cut-Thru." The Cut-Thru technique is designed to address the negative "thought loops," self-perceptions and set emotional responses that are frequently triggered by novel situations. Thus, individuals are taught to alter their automatic responses to stress that are generated by old emotional programs involving hostility, guilt and anxiety. They are taught to generate new, more appropriate responses through the induction of a positive emotional state. This is achieved by the practice of a number of specific steps that help reorient perception of past, present and future stressors and reduce or eliminate unproductive mental and emotional responses.

Step 1: Individuals take an "inner weather report" and identify their current emotional state. If their current emotional state involves worry, anxiety, or distress ("rain"), then individuals are shown how to shift their mood and choose a more positive perspective ("sunshine").

Step 2: Individuals focus attention in the area of the heart, holding any remaining uncomfortable feelings in that area. This aims to prevent any mental attempts to analyze the feelings of discomfort, worry, anxiety, or guilt which would lead to a reentry into the negative thought loop. If unpleasant feelings still remain, individuals are instructed to "stir" or "blend" them in with the positive feelings generated in Step 1 while maintaining their focus of attention in the area around the heart. While it is difficult to develop scientific descriptions for subjective experiences, many individuals report that they perceive a mixing or stirring sensation in the area of the heart during the practice of this step. One physiological correlate that was commonly observed during this step was the appearance of a sinusoidal heart rate variability pattern (see Results).

Step 3: Individuals consciously generate a feeling of inner peace and calm. This state promotes increased coherence in a number of physiological systems and facilitates a clearer perspective on the situation that led to the emotional turmoil.

Step 4: Once individuals are in a state of increased physiological and emotional coherence, they go back in time to reexperience the original feeling of care they had about the situation or person and examine how the negative emotional state developed. The purpose of this step is to understand the difference between care and caring too much, or "overcare" (Childre, 1996), which is associated with emotions such as anxiety, worry, and guilt. This step helps the person discriminate the fine line between a balanced, healthy caring perspective and the dysfunctional worrying, over-attachment, and disappointment that characterizes "overcare." It has been suggested that "overcare" underlies many well-recognized negative emotional states, such as anxiety, guilt, and hopelessness (Childre, 1996). Such states, if left unchecked, can lead to exhaustion and burnout.

Step 5: Having generated feelings of positivity, calm, and understanding, individuals determine what a more efficient response or solution to the situation would be and enact it.

Once people have released negative emotions and achieved clearer insight at any point during Steps 1–4, they proceed directly to Step 5. As people become familiar with the technique, Step 1 or 2 is often all they need to find emotional release and a more balanced response to a given situation. (For a full description and explanation of the Cut-Thru technique, see Childre, 1996.)

The Heart Lock-In technique: The use of music intentionally designed to help generate a positive emotional state and facilitate the maintenance of this state while using a heart-focused technique has been termed a "Heart Lock-In" (Paddison, 1992). In this study, subjects in the experimental group were asked to practice the Cut-Thru technique during a Heart Lock-In for thirty minutes while listening to music called *Speed of Balance* (Childre, 1995) five times a week for four weeks. This music was designed to promote increased mental and emotional balance and physiological coherence in the listener. Once individuals had experienced the desired emotional shift, they were asked to sustain or "lock-in" that positive emotional state while considering what would constitute a more balanced, healthy and caring response to the situation or person in question. The Heart Lock-In technique has previously been shown to improve autonomic nervous system balance and to boost salivary IgA (McCraty et al., 1996).

Subject Population

Participants consisted of 45 healthy, working adults who were recruited from the local community. All participants were recruited during the same four–week time period. There were 30 individuals in the experimental group (15 male, 15 female, mean age 38) for whom both physiological and psychological parameters were assessed. Experimental group subjects were recruited by distributing letters to employees of several local companies in the Boulder Creek, California, area, after obtaining approval from the management of these organizations. These companies were contacted because of their convenient location within several miles of the HeartMath Research Center. This was the site where the training program was conducted and where ambulatory ECG (Holter) recorders were fitted and physiological samples were collated. Entry criteria required that the subjects were in good health, were not taking hormonal supplements of any kind, had a regular daytime work schedule and were willing and able to attend the training programs, practice the emotional self-management interventions for a month, and have physiological parameters assessed.

Fifteen members of a local church choir group (10 female, 5 male, mean age 43) were recruited as a comparison group for the psychological variables. These individuals formed a convenient sample, as they were an intact social group that gathered weekly for meetings. Most of these individuals lived and worked in the Santa Cruz, California, area (within twelve to fifteen miles of Boulder Creek). Due to time and funding constraints, physiological parameters were not measured in the comparison group.

All subjects in the experimental group received a one-day training session in the Cut-Thru and Heart Lock-In techniques after baseline measurements were taken (see below). At that training session all participants listened to and were given a Cut-Thru guidebook and a *Speed of Balance* music cassette. In addition to practicing the Cut-Thru technique during a thirty–minute Heart Lock-In at least five times a week for the study's duration, participants were also instructed to use the Cut-Thru technique at any time during the day or night when they felt emotional distress. Subjects in the comparison group did not receive any training or the *Speed of Balance* music.

Psychological Measures

All subjects in the experimental and comparison groups were asked to complete a psychological questionnaire entitled "Personal Opinion Survey" (POS) (Barrios-Choplin et al., 1997). The POS was chosen for this study over other existing mood surveys due to the time and length constraints imposed by other longer surveys and this study's objective to assess a large number of constructs which were not measured by any other single survey. The experimental group completed the questionnaire just prior to their training program and again four weeks later. The comparison group completed the questionnaire at the same times but received no training in emotional self-management. The psychological measures used in this study included assessments of stress levels and an assessment of both positive and negative emotional states. The stem for the questions was: "Below are words that describe the way people sometimes feel. Please indicate how often you feel the following emotions by circling the appropriate number for each item." There were five possible answers, ranging from never (0) to always (4).

Stress levels were determined by assessing two constructs: Anxiety (anxious, tense, nervous, afraid) and Stress Effects ("stress is hurting my work performance," "I experience physical symptoms due to stress," and "other people's problems cause me stress").

The measures of emotion followed the two-factor mood structure described by Watson & Tellegen (1985). Scales were subjected to internal consistency reliability analysis (Tables 1 and 2) as follows: Vigor (excited, energetic, active, vigorous, lively); Happiness (happy, glad, cheerful, delighted, joyous); Contentment (calm, pleased, relaxed, satisfied, contented); Caring (loving, friendly, affectionate, warm, passionate); Depression (sad, hopeless, worthless, miserable, unhappy); Guilt (blameworthy, guilty, ashamed, regretful, remorseful); Hostility (angry, irritable, resentful, enraged, bitter); Burnout (used up, burned out, fatigued, exhausted, end of my rope); Warmheartedness (represented by kindness, appreciation, love, care, tolerance, forgiveness, acceptance, harmony, compassion); and Overcare (represented by over-critical, over-sympathetic, over-responsible, self-pitying). Reliabilities for the entire sample are reported in both Table 1 and Table 2.

Neuroendocrine Measures

Over 90 percent of the circulating DHEA is in its sulfate form, DHEAS. DHEAS has a long biological half-life (20 hours) and is converted to DHEA, which has a plasma half-life of less than 30 minutes (Rosenfield, 1975). Since DHEA, DHEAS, and cortisol are hydrophobic and are plasma protein-bound, total plasma cortisol or DHEA levels can be misleading. In the case of cortisol, the unbound, biologically active fraction is estimated to represent about 1 to 15 percent of the entire circulating cortisol pool (Galard, 1991). It has been suggested that salivary cortisol levels may actually be more representative of the biologically active fraction available to the cells than plasma levels (Laudat, 1988; Bolufer et al., 1989). Therefore, this study measured cortisol, DHEA, and DHEAS levels in the saliva using the Adrenal Stress Index (ASI) test (Diagnos-Techs, Inc. Seattle, Washington). This test measures the free bioactive salivary cortisol and combined DHEA/DHEAS levels and has been closely correlated with the free plasma levels (Lac et al., 1993). Hereafter, we use the term "DHEA(S)" to denote the combined measure of the free fraction salivary DHEA and DHEAS.

Since cortisol has a daily circadian cycle, with peak levels occurring in the morning and trough levels occurring at midnight (Raczkowska, 1988), the test requires that 4 samples be taken throughout a 24-hour period: The first sample is taken in the morning (between 7 A.M. and 8 A.M.), the second at noon (between 11 A.M. and noon), the third in the afternoon (between 3 P.M. and 4 P.M.), and the fourth at midnight (between 11 P.M. and midnight). The value for each cortisol measurement is plotted, providing an assessment of the cortisol circadian rhythm, and the area under the curve is calculated to determine the cortisol time integral or total cortisol output for the day. DHEA(S) does not have a significant circadian rhythm. Therefore, the noon and afternoon levels are averaged to determine the daily DHEA(S) level.

All subjects in the experimental group provided four salivary samples during the day prior to the behavioral intervention program and four further samples a month after the training program. Both collection days occurred mid-week. Subjects were asked to rise between 7 A.M. and 8 A.M. and to go to sleep between 11 P.M. and 12 midnight both on the collection days and for at least the two preceding work days. This schedule generally did not deviate from subjects' normal daily agenda. Once obtained, salivary samples were immediately frozen and shipped to an independent laboratory for analysis. Participants' pre-training salivary samples were compared to a large database of historical controls to ensure that they were within normal ranges.

Autonomic Nervous System Measures

Autonomic function was assessed in keeping with the recently published International Task Force Report (1996), which standardized the nomenclature, analysis methods, and definitions of the physiological and pathological correlates of heart rate variability (HRV) measures (HRV Task Force Report, 1996). The electrocardiogram (ECG), obtained from the 24-hour ambulatory (Holter) recording, was converted into an RR interval tachogram. This HRV signal was sampled at 256 Hz and subjected to time and frequency domain analysis in addition to circadian rhythm analysis (McCraty & Watkins, 1996). Time domain measures were 24-hour heart rate, SDNN (standard deviation of all normal RR intervals), SDANN (standard deviation of the average normal RR intervals of each 5-minute segment), SDNN index (mean of the standard deviation of all normal RR intervals of all 5-minute segments), and RMS-SD (root mean square of successive differences). The frequency domain measures calculated were high frequency (HF) and low frequency (LF) power and the LF/HF ratio. HF power is reflective of parasympathetic activity and LF power is primarily reflective of sympathetic activity (Akselrod, 1995). Analyses of HRV, Fast Fourier Transforms (FFT), PSD (calculated as $[ms]^2/Hz$), and time domain measurements were performed using DADiSP/32 digital signal processing software.

Autonomic function was assessed for all subjects in the experimental group using three-channel Holter recorders (Del Mar Avionics, Irvine, California), which incorporate a time-lock control circuit to ensure accurate HRV analysis. Data were acquired prior to and four weeks after subjects attended the training program. Disposable silver/silver chloride ECG electrodes were placed at the standard locations for Holter recording. Participants were asked to log activities such as exercise, use of the Cut-Thru and Heart Lock-In techniques, and any significant changes in emotional state. Subjects were asked to practice the Cut-Thru technique during a Heart Lock-In at least once during the 24-hour recording and to use the Cut-Thru technique whenever they felt out of balance emotionally throughout the day. The HRV indices of the experimental group were compared to a large database of age-matched controls to ensure that all subjects' HRV measures fell within the normal range.

In healthy populations, 24-hour HRV measures are known to be stable over time (Kautzner, 1995), and thus in this study no changes were expected over a one-month period. However, it was postulated that changes in HRV patterns would be seen during practice of the emotional management interventions.

Results

Psychological Changes

Paired sample *t* tests were performed to analyze mean differences in the psychological measures from time one to time two. A p value of $< .05$ was considered significant. There were no drop-outs in either the experimental or comparison groups.

There were no significant changes in any psychological parameters over the course of the month in the comparison group (Table 1 and Figure 1).

In contrast, there were significant increases in the positive affect scales of Caring (p <

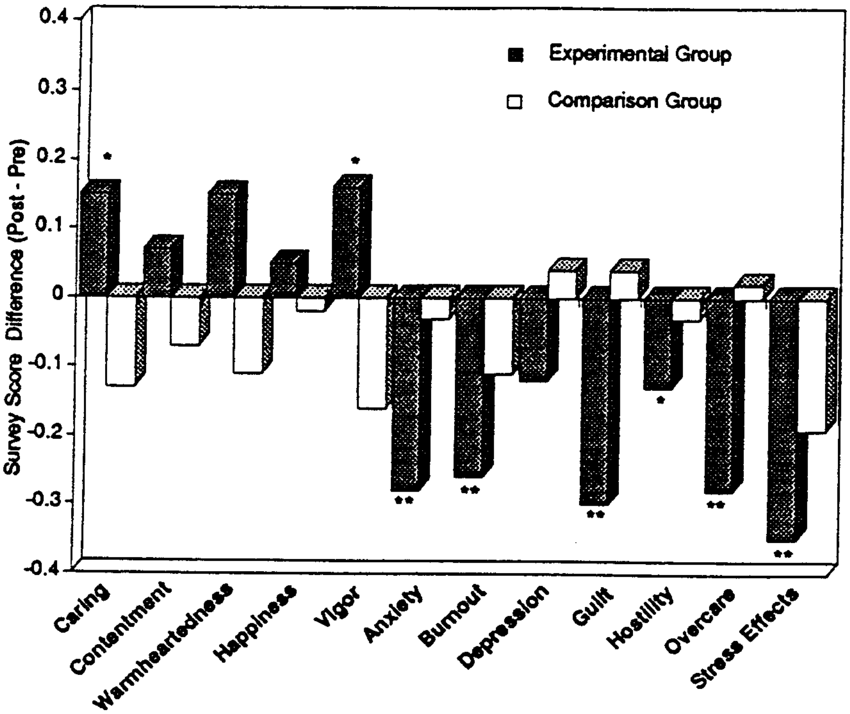

FIG. 1. Changes in stress, positive and negative emotion in the experimental and comparison groups. Compares the differences between the mean pre- and post-values for each psychological variable measured. Experimental group participants (n = 30) were assessed before receiving training in the emotional self-management techniques and after practicing the techniques for four weeks. Comparison group participants (n = 15) were measured at the same time points but received no training in the self-management techniques. *p < .05; **p < .01.

TABLE 1
Comparison Group Psychological Measurements: Means and Standard Deviations

Variable	*Reliability*	*Pre* *Mean ± SD*	*Post* *Mean ± SD*	*t*	*p<*
Caring	.75	2.84 ± .51	2.71 ± .50	0.79	NS
Contentment	.86	2.60 ± .75	2.53 ± .74	0.42	NS
Warmheartedness	.92	3.06 ± .62	2.95 ± .54	1.44	NS
Happiness	.86	2.46 ± .63	2.44 ± .56	0.13	NS
Vigor	.84	2.51 ± .65	2.35 ± .55	1.33	NS
Anxiety	.81	1.83 ± .75	1.80 ± .79	0.2	NS
Burnout	.89	1.79 ± .57	1.68 ± .66	0.75	NS
Depression	.91	1.43 ± .71	1.47 ± .79	-0.24	NS
Guilt	.85	1.33 ± .73	1.37 ± .75	-0.3	NS
Hostility	.83	1.52 ± .67	1.49 ± .69	0.15	NS
Overcare	.87	1.71 ± .60	1.73 ± .65	-0.19	NS
Stress Effects	.76	1.83 ± .79	1.64 ± .81	1.27	NS

TABLE 2
Experimental Group Psychological Measurements: Means and Standard Deviations

Variable	*Reliability*	*Pre* *Mean ± SD*	*Post* *Mean ± SD*	*t*	*p<*
Caring	.75	3.10 ± .39	3.25 ± .38	2.71	.05
Contentment	.86	2.98 ± .33	3.05 ± .31	1.1	NS
Warmheartedness	.92	3.26 ± .36	3.41 ± .35	1.94	NS
Happiness	.86	3.01 ± .34	3.06 ± .36	0.8	NS
Vigor	.84	2.86 ± .41	3.02 ± .37	2.74	.05
Anxiety	.81	1.36 ± .43	1.08 ± .49	3.27	.01
Burnout	.89	1.42 ± .45	1.16 ± .46	2.87	.01
Depression	.91	0.58 ± .46	0.46 ± .48	1.86	NS
Guilt	.85	0.84 ± .57	0.54 ± .40	3.21	.01
Hostility	.83	0.77 ± .38	0.64 ± .41	2.49	.05
Overcare	.87	1.13 ± .55	0.85 ± .41	3.15	.01
Stress Effects	.76	1.23 ± .56	0.88 ± .56	3.3	.01

.05) and Vigor ($p < .05$) in the experimental group. In addition, there were significant reductions in Guilt ($p < .01$), Hostility ($p < .05$), Burnout ($p < .01$), Overcare ($p < .01$), Anxiety ($p < .01$), and Stress Effects ($p < .01$) one month after the behavioral intervention program. Increases in Warmheartedness, Happiness, and Contentment and a decrease in Depression were also noted, although these changes did not reach statistical significance (Table 2 and Figure 1).

Salivary Cortisol and DHEA(S) Levels

The Wilcoxon signed-rank test was used to analyze differences in DHEA(S) and cortisol levels from time one to time two. A p value of <.05 was considered significant. Subjects' pre-training DHEA(S) and cortisol levels were found to fall within normal ranges. Post-intervention DHEA(S) and cortisol measurements were available from 28 of the 30 subjects in the experimental group; one subject's saliva sample was too small to be

TABLE 3
Experimental Group DHEA(S) and Cortisol Levels: Means and Standard Deviations

Variable	*Pre* *Mean* ± *SD*	*Post* *Mean* ± *SD*	*Z*	*p<*
8AM Cortisol (nM)	36.36 ± 23.73	27.54 ± 13.28	1.51	NS
Noon Cortisol (nM)	14.11 ± 15.49	7.79 ± 4.22	2.19	.05
4PM Cortisol(nM)	11.14 ± 10.05	9.93 ± 16.68	1.22	NS
Midnight Cortisol (nM)	6.79 ± 6.58	7.50 ± 15.39	0.86	NS
Total Integral Cortisol (nM)	68.39 ± 35.05	52.75 ± 33.96	2.32	.05
DHEA(S) (ng/ml)	2.82 ± 1.52	5.64 ± 3.94	3.3	.001

Notes: Wilcoxon Signed-Rank Test. Z=(Sum of Signed Ranks) / Square Root(Sum of Squared Ranks).

analyzed and another participant was ill at the time the measurement was taken and therefore was excluded from the analysis.

There was a significant decrease in total salivary cortisol of 23 percent ($p < .05$) four weeks after the program, as assessed by total integral cortisol. At the same time there was a significant increase in DHEA(S) levels of 100 percent ($p < .001$) four weeks after the behavioral intervention program. There was also a significant decrease of 45 percent in the noon cortisol levels ($p < .05$) (see Table 3 and Figure 2).

To further understand the relationship between DHEA, cortisol, affect and stress, correlation and regression analyses were performed. Table 4 shows correlations among this study's variables. Cortisol was significantly and negatively correlated to Contentment and Warmheartedness. It was significantly and positively correlated to Anxiety, Burnout, Depression, Guilt, Hostility, Overcare and Stress Effects. DHEA(S) was significantly and positively correlated to Warmheartedness.

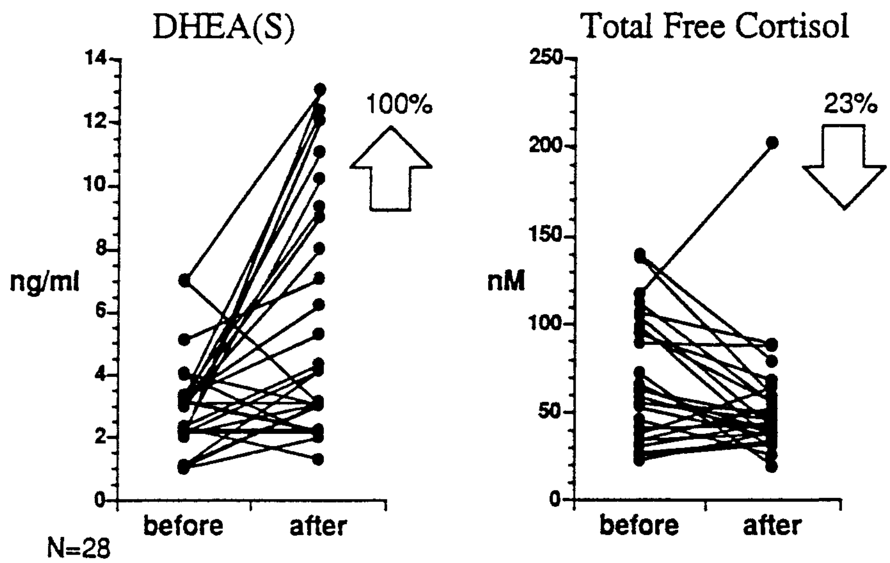

FIG. 2. Changes in free fraction salivary DHEA/DHEAS and cortisol levels before and four weeks after the behavioral intervention program. There was a mean increase in DHEA(S) of 100 percent and a mean reduction in cortisol of 23 percent in the experimental group who used the Cut-Thru and Heart Lock-In techniques for a one-month period (n = 28).

TABLE 4
Correlations

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
1. Caring													
2. Contentment	.58***												
3. Warmheartedness	.39***	.48***											
4. Happiness	.69***	.62***	.22										
5. Vigor	.73***	.68***	.43***	.69***									
6. Anxiety	–.21	–.41**	–.37**	–.19	–.21								
7. Burnout	–.28*	–.51***	–.46***	–.23	–.33*	.56***							
8. Depression	–.38**	–.62***	–.38**	–.34**	–.44***	.59***	.78***						
9. Guilt	–.38**	–.54***	–.43**	–.21	–.46***	.62***	.67***	.74***					
10. Hostility	–.14	–.41**	–.29*	–.07	–.20	.55***	.62***	.71***	.52***				
11. Overcare	–.26	–.44***	–.55***	–.22	–.42***	.64***	.60***	.63***	.73***	.62***			
12. Stress Effects	–.09	–.45***	–.35**	–.10	–.26*	.74***	.52***	.53***	.61***	.48***	.71***		
13. DHEA(S)	.23	.20	.27*	.13	.21	–.19	–.06	–.09	–.25	–.22	–.15	–.12	
14. Cortisol (average)	.00	–.28*	–.39**	–.01	–.14	.58***	.34**	.29*	.37**	.36**	.51***	.63***	–.01

Note: *p < .05;**p < .01;***p < .001

TABLE 5
DHEA(S) Regression Analysis

Stepwise Regression for DHEA(S)			
Multiple R		.27	
R^2		.07	
Adjusted R^2		.06	
Standard Error		3.19	
F		4.32	
p of F		<.05	
Variable	B	SE B	Beta
Warmheartedness	2.49	1.20	.27

To investigate the relationship between affect and DHEA, a multiple regression analysis was performed with the affect states as independent variables and DHEA(S) as the dependent variable. Because little research has been conducted on affect and DHEA, an exploratory stepwise method was used with an entry criteria of .05. Warmheartedness was the only affective state that was significant (positively related) (Table 5).

A second stepwise regression was performed with the affective states and stress as the independent variables and cortisol as the dependent variable. The overall model was significant, and Stress Effects was the only variable to meet the .05 criteria (positively related), although Warmheartedness approached significance at .09 (negatively related) (Table 6).

Autonomic Function

Heart rate variability analysis was performed on 25 of the 30 participants. Three individuals failed to complete the logs properly; therefore an accurate correlation could not be made between use of the techniques and changes in autonomic function. An additional two participants were unable to provide HRV data because schedule conflicts precluded the fitting of a Holter monitor. The remaining data were assessed in two ways. First, it was determined whether subjects were able to generate clear shifts in their HRV tachograms during practice of the emotional self-management techniques. These shifts are characterized by the development of more coherent cardiac rhythms or the entrainment mode, which has been defined elsewhere (Tiller et al., 1996). Entrainment, which is indicative of enhanced sympathovagal balance, occurs spontaneously during deep relaxation and sleep but can also be seen during the practice of heart-focused emotional management techniques such as those described in this study (McCraty et al., 1995a, 1995b; Tiller et al., 1996). Second, paired sample t tests were performed to analyze mean differences from time one to time two of the 24-hour time and frequency domain HRV measures. A p value of $< .05$ was considered significant.

In 20 of the 25 participants, clear changes in the HRV tachograms could be seen that correlated with the log book entries, indicating they had used the techniques at that time. Twelve of the 25 subjects developed the entrainment mode while using the Heart Lock-In and Cut-Thru techniques.

Figure 3 illustrates a typical HRV tachogram from one of the participants who was able to favorably alter his autonomic balance but did not develop the entrained mode. Figure 4 shows the tachogram from a participant who did enter the entrainment mode.

TABLE 6
Cortisol Regression Analysis

Stepwise Regression for Cortisol (average)			
Multiple R	.63		
R^2	.40		
Adjusted R^2	.39		
Standard Error	6.86		
F	36.02		
p of F	<.0001		
Variable	B	SE B	Beta
Stress Effects	9.56	1.59	.63

The pre-training 24-hour time and frequency domain measures were first compared to a historical database of age and sex-matched healthy controls (McCraty & Watkins, 1996). All subjects were found to be within the normal range for all parameters. The pre-training and the post-training data collected four weeks later were then compared. As expected in a healthy population, there were no significant changes in any of the 24-hour time or frequency domain measures (Table 7).

Discussion

We propose that the significant psychological improvements observed in the experimental group, combined with magnitude of changes measured in the neuroendocrine parameters, suggest that the intervention program was successful in helping subjects revise

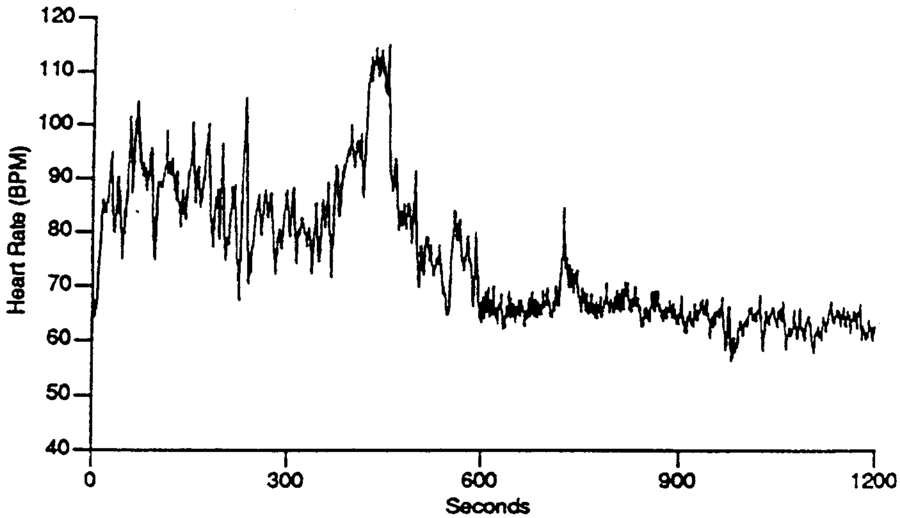

FIG. 3. Illustrates an example of the change in the HRV tachogram when using the Cut-Thru technique. This subject did not enter the entrainment mode. Beginning at approximately 600 seconds, there is a decrease in the subject's mean heart rate and an increase in the frequency of beat-to-beat variability, indicating increased parasympathetic activity. The data are from a Holter recording of one of the participants while using the technique.

TABLE 7
Experimental Group 24-Hour Time and Frequency Domain HRV Measurements: Means and Standard Deviations

Variable	*Pre* *Mean ± SD*	*Post* *Mean ± SD*	*t*	*p<*
Heart Rate (bpm)	81.30 ± 5.50	81.31 ± 6.33	–0.02	NS
SDNN (ms)	129.70 ± 23.29	132.33 ± 26.48	–0.77	NS
SDANN (ms)	113.32 ± 23.62	115.49 ± 26.38	–0.64	NS
SDNN index (ms)	60.05 ± 10.87	60.72 ± 11.08	–0.55	NS
RMS–SD (ms)	28.48 ± 8.45	29.51 ± 8.28	–0.76	NS
Ln (RMS–SD)	3.31 ± 0.30	3.34 ± 0.30	–0.86	NS
5-Min. High frequency (ms^2)	238.13 ± 152.43	249.53 ± 144.21		
Ln (5-Min. High frequency)	5.25 ± 0.72	5.31 ± 0.73	–0.74	NS
5-Min. Low frequency (ms^2)	1123.30 ± 465.86	1127.79 ± 488.81		
Ln (5-Min. Low frequency)	6.93 ± 0.49	6.93 ± 0.49	–0.03	NS
LF/HF	6.08 ± 3.52	5.81 ± 3.41		
Ln (LF/HF)	1.67 ± 0.53	1.62 ± 0.53	0.99	NS

perceptual tendencies that generate and propagate negative emotional states and their ensuing physiological responses.

The significant reductions in stress levels and in nearly all the negative affect scales combined with the significant increases in Caring and Vigor in the experimental group must be interpreted with caution. There were no psychological changes in the comparison group, but its smaller size decreased the likelihood of finding statistically significant changes. However, eight out of the twelve scales improved in the experimental group, while the trend in the comparison group was in the opposite direction in eight of the twelve

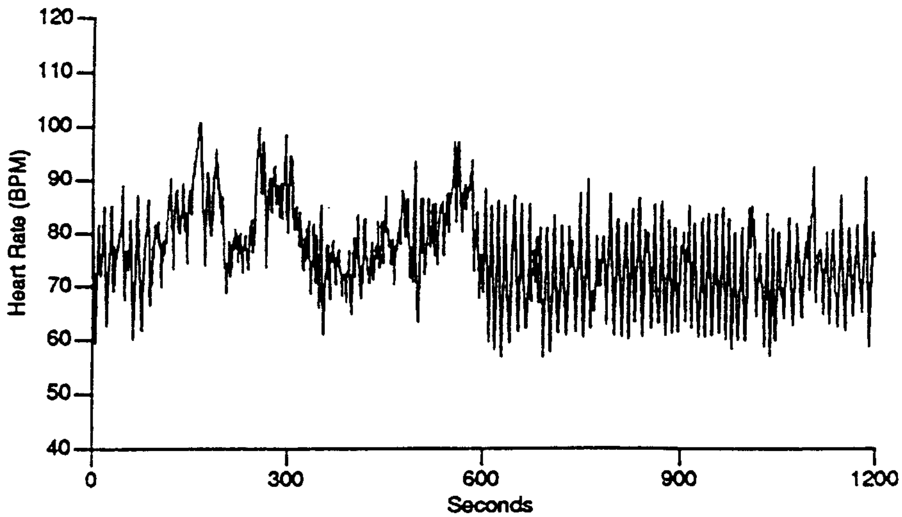

FIG. 4. Illustrates a typical example of the entrainment mode in the HRV tachogram of a subject using the Cut-Thru technique during a Heart Lock-In. Entrainment is indicative of enhanced sympathovagal balance. Here entrainment begins at approximately 600 seconds and continues to the end of the record.

scales measured. This suggests that the improvements seen in the experimental group were not merely the result of trends in the general population.

The psychological changes in the experimental group were accompanied by a significant increase in DHEA(S) and a concurrent decrease in salivary cortisol. Although the changes seen were substantial, they must also be viewed with caution since no simultaneous measurements were made in the comparison group. However, clinical experience and historical data suggest the changes seen warrant further investigation since changes of such magnitude over a one-month period would not be expected in a normal population (Nicolau et al., 1985; Urban, 1992). Although these data are only preliminary, they have raised a number of exciting research possibilities that we are currently pursuing. These research questions bring together a number of previously disparate areas of investigation, and we believe they may stimulate further exploration and exchange.

For example, there is substantial evidence to suggest that emotional memories play a large part in shaping our behavior. Recent evidence suggests that emotionally "charged" memories are more vividly recalled (Cahill et al., 1994), and memories with a negative emotional "charge" have more influence over us than memories perceived as positive (Damasio, 1994). It has been proposed that negative, emotionally charged experiences become written into the neural architecture as emotional memory traces. If repeatedly evoked, they become reinforced through a process called long-term potentiation and can influence perception, coloring our day-to-day thoughts and feelings and dominating our responses to future situations (LeDoux, 1996). Thus, our response to novel events and situations can become automatic, with stereotyped behavioral, physiological and immunological reflexes occurring in much the same way as physical movements can become stereotyped. We suggest that individuals become emotionally conditioned by their early experiences (LeDoux, 1993). Their stereotyped emotional responses that occur later in life are therefore often outdated and inappropriate. These emotional conditioned reflexes are plastic and susceptible to enhancement or extinction in much the same way as any other memory trace (Davis, 1992).

The Cut-Thru technique is intended to help individuals recognize and re-program the subconscious emotional memory traces which have led to stereotypic repetitive "thought loops," negative affect states and detrimental neuroendocrine, autonomic and immunological changes. We propose that these mental and emotional loops or memory traces, and their hormonal and autonomic consequences, can be reprogrammed at the neural circuitry level through intentional re-direction of emotional states. One of the fundamental advantages of the Cut-Thru technique is that it does not require individuals to consciously re-live past traumas or "get in touch" with the emotional pain of those events. Our experience suggests that unconscious emotions often surface on their own at different stages during the practice of the technique. If and when they surface and become conscious, the goal is to see how the perception of a situation or person changed from a balanced, positive state to a detrimental, dysfunctional state resulting in worry, anxiety, fear or distress. This insight often enables negative feelings to be released in the moment, and a more positive emotional state of compassion, contentment, warmheartedness, appreciation or forgiveness to develop. This, we suggest, is facilitated by increased coherence in heart rate variability rhythms (Tiller et al., 1996), which modifies the afferent neurological signals sent from the heart (Armour, 1994) to the cortical, amygdaloid, and hypothalamic neurons via the vagus and baroreceptor network (Rau et al., 1993; Oppenheimer & Hopkins, 1994).

There is evidence in both animals and humans to support the suggestion that central emotional processing is altered by afferent input. For example, activity in the central nucleus of the amygdala has been shown to be dependent on afferent input from the aortic depressor or carotid sinus nerves (Zhang et al., 1986). Similarly, data from humans undergoing surgery for epilepsy demonstrated that cells within the amygdaloid complex specifically responded to information from the cardiac cycle (Frysinger & Harper, 1990). Thus, given the fact that afferent input reaches many of the subcortical areas that are involved in emotional processing, it is quite feasible that increased order in the afferent information input to the brainstem could affect emotional state, neurological processes and perception. This concept is supported by recent evidence suggesting that the psychological aspects of panic disorder are actually often created by unrecognized paroxysmal supraventricular tachycardia (Lessmeier et al., 1997).

We suggest that the increased coherence of the afferent signal to the brainstem nuclei observed in many subjects in this study, in conjunction with the intentional releasing and re-directing of the emotions, facilitates the re-programming of emotional memories, imbuing them with a positive emotional inflection and new perceptual understanding. The sinusoidal HRV waveform seen in 12 out of the 25 experimental subjects has been shown to occur during periods of entrainment between heart rate variability, blood pressure waves, respiration, and brainwave activity. This entrainment is facilitated by the regular practice of positive emotional focus techniques (McCraty et al., 1995a, 1995b; Tiller et al., 1996). Furthermore, it has been our experience, based on the analysis of hundreds of 24-hour Holter recordings of healthy subjects, that the entrainment pattern does not spontaneously occur during the waking hours unless individuals are highly practiced in positive emotional focus techniques (Umetani et al., 1997).

Preliminary data from our laboratory have demonstrated that the entrainment of physiological systems also affects cortical activity (McCraty et al., 1995b). The improved mental clarity that accompanies coherent vagal afferent traffic has been called cortical facilitation, while the narrowed perception accompanying chaotic afferent traffic has been termed cortical inhibition (Lacey & Lacey, 1978). We propose that in this study, the increased coherence measured in subjects' heart rhythms during the practice of the Cut-Thru and Heart Lock-In techniques facilitated sustained perceptual shifts that permitted the long-term psychological improvements and ensuing positive changes in hormonal balance.

It is our view that the changes in the salivary DHEA(S) and cortisol levels demonstrated in this study are noteworthy, given that there is normally little physiological variability in these levels from month to month (Nicolau et al., 1985; Urban, 1992). The average DHEA(S) increase of 100 percent and the 23 percent reduction in cortisol occurred in conjunction with significant psychological improvements. It is interesting to note that positive affective states were significantly associated with increased DHEA(S) levels and negative affect states with increased cortisol levels. For example, DHEA(S) was significantly and positively associated with the Warmheartedness construct, which contained items representing appreciation, kindness, love, care, tolerance, forgiveness, acceptance, harmony, and compassion. Stimulating these same affective states is, in fact, a primary objective of the Cut-Thru technique. Similarly, the negative affective states were positively correlated with cortisol, while the positive affective states were inversely correlated. The strongest relationship was between cortisol and Stress Effects, with a lesser inverse relationship between cortisol and Warmheartedness. These results indicate that the relationship between affective states and hormones offers rich opportunities for further research.

We suggest that there may be a mechanistic link between the changes in HRV observed during practice of the techniques and the associated decrease in cortisol. This is based on previous evidence demonstrating that increased afferent vagal activity reduces plasma cortisol levels by inhibiting the release of ACTH from the pituitary (Gann, 1966; Gann et al., 1981; Drinkhill & Mary, 1989).

To our knowledge, there is little published data documenting neuroendocrine shifts of the magnitude observed in this study following psychological interventions. In fact, it is generally accepted that shifts of this nature can normally only be achieved through the use of hormonal supplements. Our data, although only preliminary and requiring replication, would suggest that it is possible for people to favorably alter their neuroendocrine balance without pharmacological intervention.

Clearly, there are several methodological limitations to this study which restrict the interpretation and generalizability of the results. The sample size was small, the experimental and comparison groups were of different sizes and were not randomly assigned, and the short duration of the study does not allow us to draw conclusions regarding the sustainability of the psychological and physiological changes observed. However, in a separate study using similar emotional management techniques we were able to demonstrate significant improvements in stress levels, affect, blood pressure and resting autonomic activity for up to six months after a two-day training program (Barrios-Choplin et al., 1997). Clearly, the current study needs replication with a more robust experimental design and a longer follow-up period in order to determine the significance of the findings reported here.

Conclusion

This study has demonstrated that new behavioral techniques that target emotional programming and alter afferent neural traffic may have a significant impact on psychological and physiological well-being. Furthermore, improvements can be systematically achieved at low cost and in a relatively short period of time. Of course, longer-term studies with a more robust methodological design are required to confirm whether the neuroendocrine shifts observed in this study are significant. However, if managing perceptions and emotions can be shown to substantially alter the cortisol/DHEA balance, then these results may have considerable implications for a number of chronic diseases.

The importance of afferent vagal traffic in setting the neuroendocrine milieu remains to be established. However, we have shown that individuals who learned to "reprogram" their conditioned emotional responses experienced significantly lower stress levels, less negative and more positive emotions. Thus, individuals may have a greater control over their psychological and physiological health than was previously recognized. Carefully designed interventions may increase an individual's ability to manage the hormonal and autonomic consequences of stress and build a healthier lifestyle.

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