In: Peper, E., Harvey, R., Takabayashi, N., & Hughes, P. (2009). How to do clinical biofeedback in psychosomatic medicine: An illustrative brief therapy example for self-regulation. *Japanese Journal of Biofeedback Research.*˙*36* (2), 1-16.

How to do Clinical Biofeedback in Psychosomatic Medicine: An Illustrative Brief Therapy Example for Self-Regulation [1]

Erik Peper[1], Richard Harvey[1,] Naoki Takabayashi[2] and Phillip Hughes[3]
[1] San Francisco State University, San Francisco, California U.S.A.
[2] Institute for Holistic and Integrative Medicine, Kobe, Japan
[3]Our Lady of the Lakes University, San Antonio, Texas U.S.A.

Abstract

Biofeedback interventions, based on the psychophysiological principle that thoughts, emotions, and body interact, affecting each other, have been shown to be powerful clinical tools for use in psychosomatic medicine settings and primary care settings where 75% of patients may present with symptoms of unknown causes. This paper describes both overt and covert factors supporting successful biofeedback training. Highlighted biofeedback approaches addressed are: a) dynamic uses of the stress profiling; b) reframing the patients' experiences as a result of normal or even excessive biological reactions; and, c) details of cardio-respiratory feedback practices. The clinical example is illustrated by the description of a two session intervention for a 20 year old woman to reduce symptoms of chronic anxiety and crying. This case illustrates that clinical biofeedback is more than just attaching sensors or having the person mechanically practice some prescribed behavior.

Keywords:
Biofeedback
Hypertension
Anxiety
Clinical practice
Respiration

"So now I have learned to use the computerized biofeedback equipment and I have read some of the scientific studies describing the specific applications. I have even completed the Biofeedback Certification Institute of America (BCIA) exam. Although I understand some of the concepts of biofeedback and have

[1] Correspondence should be addressed to:
Erik Peper, Ph.D., Institute for Holistic Healing Studies/Department of Health Education, San Francisco State University, 1600 Holloway Avenue, San Francisco, CA 94132 Tel: 415 338 7683 Email: epeper@sfsu.edu

> received supervision, sometimes I find myself wondering "What do I do now with my client who is not quite the same as the subjects described in the research papers?" I am not fully confident about how to proceed and achieve success with patients."
>
> – a recently certified therapist

Biofeedback is a subset of applied psychophysiology that can be used as a single procedure or as a group of procedures embedded within other clinical treatments or educational methods (Peper, Harvey, & Takebayashi, 2009; Friman, 2008; Nestoriuc, Martin, Rief, & Andrasik, 2008; Penberthy, Cox, Breton, Robeva, Kalbfleisch, Loboschefski, & Kovatchev, 2005). Biofeedback procedures have been used for effectively treating a wide variety of illnesses ranging from attention deficit and hyperactivity disorders (ADHD) (Huang-Storms, Bodenhamer-Davis, Davis & Dunn, 2007; Yucha, & Montgomery, 2008) to urinary incontinence (Glazer & Laine, 2006). In addition to treating health problems, biofeedback has been equally applied in the training of peak performance in sports and business (Allen & Blanchard, 1980; Kennedy, & Pretorius, 2008; Thompson, Steffert, Ros, Leach & Gruzelier, 2008). Biofeedback strategies depend upon the goals of the assessment and training, the severity of the illness symptoms as well as the skills of the biofeedback practitioner. This paper describes many of the overt and covert processes that underlie successful biofeedback training in psychosomatic medicine. The process is illustrated through a detailed case example of the treatment of anxiety.

Biofeedback process

Biofeedback has been described as a 'psychophysiological mirror' by which clients monitor and learn from physiological signals produced by their bodies (Peper et al, 2008). Biofeedback procedures utilize electronic sensors to measure the physiological signals. The biofeedback sensors come in a variety of sizes and shapes and almost every type of sensor is noninvasive. In addition, specialized needle/wire electrodes are used to monitor specific muscle activity. Regardless of the type of sensors used for physiological monitoring, all biofeedback procedures include a training component that supports developing self-awareness and control over a person's physiology. As self-awareness increases, the person may achieve insight and control over how he or she moves, thinks, emotes, and reacts. At the same time, a coach, teacher, experimenter, educator, or clinician may use the signal information to facilitate a particular educational or therapeutic goal (Peper et al, 2008).

Using biofeedback in psychosomatic medicine--making the unconscious conscious

Biofeedback is a useful tool for practitioners in the field of health promotion and psychosomatic medicine. For example, Astin, Shapiro, Eisenberg and Forys (2003) have suggested that clients see their doctor because they believe that the illness is only a phenomenon of body processes, even though the healthcare provider is aware that psychological factors such as stress and other psychosocial factors often contribute to or maintain an illness process. Referring such clients for psychotherapy is often

unsuccessful even though the health practitioner perceives that the ideology and the maintenance of the disorder are modulated by the client's ongoing emotional and behavioral patterns. The clients reject the psychological interpretations and the referrals because it is not congruent with the with their illness beliefs. Biofeedback, because it monitors their physiology, is congruent to the clients' beliefs, and thus increases the chance that clients accept the awareness about the link between psyche and soma (mind and body).

During actual assessments and physiological training sessions, clients observe and accept that symptoms of an illness are more than purely physical phenomena and conclude that the symptoms need to be treated by changing behaviors, thoughts and emotions. For psychosomatic clients, biofeedback is a "Trojan Horse"—the client accepts the biofeedback procedure and is introduced to the emotional or psychological effect that thoughts have on their body, and that an illness is fundamentally more than a body dysfunction (Wickramasekara, 1988). The physiological feedback provides clients with the evidence they need to connect cognitive and emotional factors that affect their body. As biofeedback training progresses, clients learn that controlling physiology implies learning emotional and cognitive control as well.

Rationale for using biofeedback for psychosomatic illness

The majority of diseases in the industrialized first world countries are illnesses that are caused or aggravated by stress, depression, anxiety and unhealthy life patterns (Cohen, Tyrrell & Smith, 1992; Figueira, & Ouakinin, 2008). Most of physician visits are for symptoms for which there is no known organic cause (Katon & Walker, 1998, Kahn et al, 2003; Kroenke & Mangelsdorff, 1989) as shown in Figure 1.

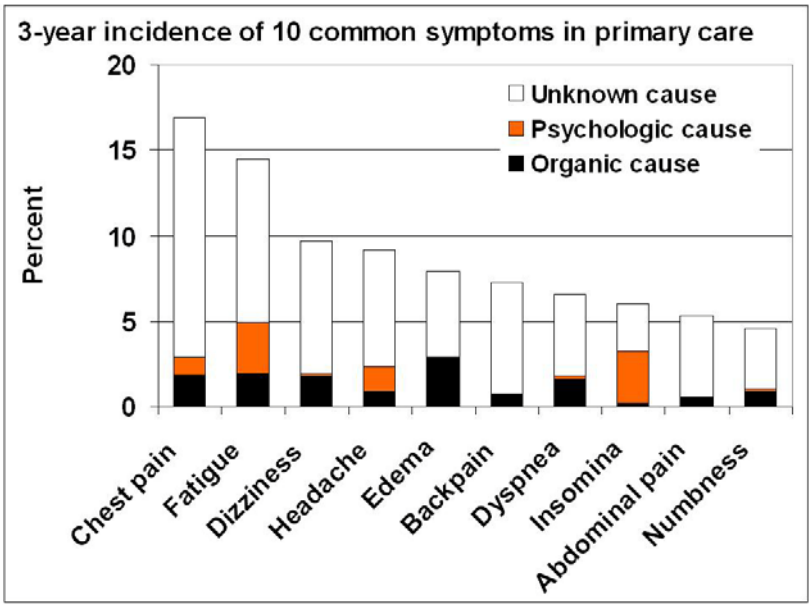

Figure 1. Three-year incidence of ten common symptoms observed in primary care. 16% of the symptoms have organic causes and 10% of the symptoms have

psychic causes while 74% of the symptoms have unknown causes. Most likely, the symptoms are a manifestation of stress, anxiety and depression. Graph drawn from the original data in Kroenke & Mangelsdorff, 1989

A physician's role includes identifying or ruling out life threatening and organic causes of symptoms for which there may be successful treatments. When the exact causality of an illness is unknown, the physician may still prescribe medication to ameliorate discomfort. Because the average physician visits is between 17 to 22 minutes, there is usually not enough time to explore the personal and lifestyle factors that contribute to an illness, (National Ambulatory Medical Care Survey, 1998; Mechanic et al, 2001; Geraghty, 2008). It takes significantly less time to prescribe medication to lower hypertension than it does to teach the client a set of lifestyle skills which may take twenty hour long sessions to learn (Dusek, Hibberd, Buczynski, Chang, Dusek, Johnston, Wohlhueter, Benson & Zusman, 2008). In a modern world where people are on call 24 hours a day, 7 days a week (a '24/7' lifestyle), and where both patient and physician education has been influenced by pharmaceutical companies, patients demand quick solutions to their problems. Medication appears to be a perfect solution since getting a prescription affirms that the problem is outside the patient's mental or emotional control, and that the problem is due mainly to a dysfunctioning biological system. As a result, clients and patients begin to believe they have no responsibility for their health, and thus remain unaware of how their own thoughts, emotions, behaviors, and stress-responses contribute to the development and maintenance of the illness.

Many unexplained disorders can be successfully treated with a variety of self-control treatment strategies such as autogenic training, progressive relaxation, mindfulness training, psychotherapy, stress management techniques, diet and life style modifications, and biofeedback (Luthe, 1969; Linden, 1994; Carlson, & Hoyle, 1993; Lehrer et al, 2007; Kabat-Zinn, 2003; Grossman et, 2004; Schwartz, & Andrasik, 2004; Yucha, & Montgomery, 2008). For example, heart disease has been reversed through a combination of diet, exercise, breathing and meditation (Ornish et al, 1990; van Dixhoon & White, 2005); abdominal pain in children ('belly ache' kids) has been successfully treated through heart rate variability training (Humphreys & Gevirtz, 2000; Sowder, et al, 2005: Shapiro et al, 2006); hypertension has been reversed through a combination of relaxation, hand and feet warming, slow respiration and emotional awareness and life style change (Fahrion et al, 1986; Linden, W. & Moseley, J.V., 2006); type 2 diabetes has been successfully reversed through diet, exercise and stress reduction (McGinnis et al, 2005); tension and migraine headaches have been successfully treated with biofeedback (Andrasik, 2007), etc. Many of the very successful approaches were based upon an integrated/holistic approach that utilized a variety of complementary and alternative health practices.

Whereas randomized placebo-controlled clinical research studies tend to focus on one type of disorder or use one medication in comparison to a placebo, patients often have comorbid disorders and take multiple medications (polypharmacy). Future research studies must consider the interacting role that emotions and cognitions have in illness progression. In addition, many patients are unaware of the impact of emotional and

cognitive factors upon their disease onset and maintenance, so treatments that raise awareness about interactions with emotional and cognitive factors are the most useful.

One of the useful applications of biofeedback is to demonstrate how thoughts, emotions and body are all interconnected as illustrated in the following case example of a 35 year old client with borderline hypertension (135-150/85-95 mm Hg). The client's blood pressure increased whenever the physician monitored his blood pressure (white coat hypertension). It was not until the client observed a visual display of his own physiological reaction to a cognitive stressor that he realized the extent to which his emotions and cognitions affected his own physiological reactions and health. During a physiological assessment, respiration patterns, blood flow through the fingers and, heart rate were measured while the client was sequentially guided to first sit relaxed, then think of work stress, then relax again while breathing diaphragmatically, followed by coaching about relaxing even more fully, as is shown by Figure 2.

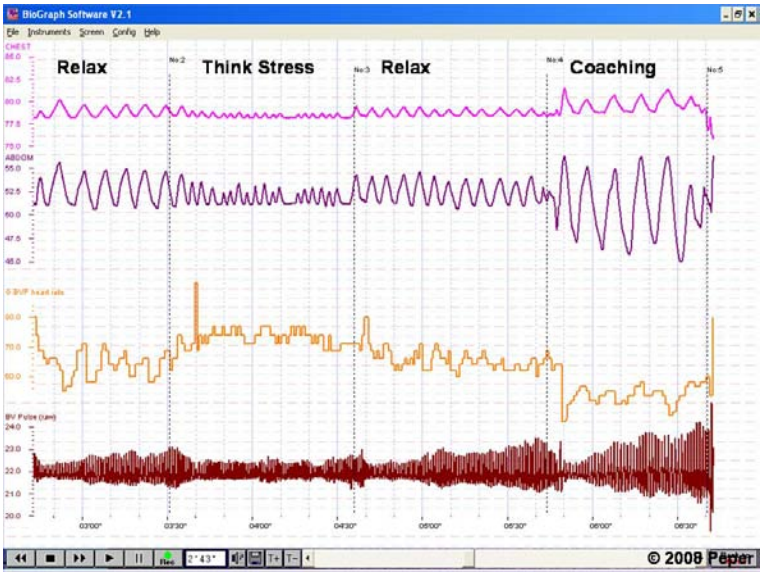

Figure 2. Physiological stressor profile showing how thinking about a stressor increases respiration rate and heart rate and decreased peripheral blood flow as measure by blood volume pulse amplitude

When the therapist showed the physiological recording, the patient was totally surprised how much his body had reacted to the thoughts about workplace stress--the reactions occurred beneath conscious awareness. Using a graphic display, the therapist showed how, during the thoughts about workplace stress, the breathing quickened, the peripheral blood flow decreased, the heart rate increased, and the heart rate variability (HRV) decreased, which is a known cardiac risk factor (Kleiger et al., 1987; Carney, et al., 2001). In contrast during the relaxation and guided breathing, the heart rate decreased, heart rate variability increased and blood volume increased--all signs of healthy response (Kleiger et al., 1987; Carney et al., 2001).

The physiological recording was used to explain how his stress response pattern could contribute to the etiology and maintenance of high blood pressure. A coaching session began, educating the client about ways for influencing his own reactions to stress. For example, using the concepts of increased peripheral resistance, an indicator of increased sympathetic arousal that increased blood pressure, the client was able to observe the dynamic relationship between his thoughts and his physiological reactions. In particular, the client learned that by changing his breathing pattern, he could increase pulse amplitude and thus decrease peripheral resistance which resulted in lowering blood pressure. During the breathing coaching session during which he practiced slower, almost effortless diaphragmatic breathing, his systolic blood pressure decreased by 22mm Hg and diastolic by 5mm Hg.

Without the use of a biofeedback protocol, the client may have remained ignorant of the relationship between thoughts of workplace stress and their hypertension. The physiological response to thoughts about workplace stress, as shown by the physiological recording, was surprising for the patient since he was unaware that any changes in his blood pressure had occurred in relation to the thoughts about workplace stress. The patient reported that he now realized that he was an unaware, yet an active participant in his own disease process. This became the basis for a treatment strategy that focused on slower breathing, increased awareness of stressors, strategies for the resolution of stressors, and using awareness of the stressors to trigger a relaxation response. Thus, the patient became an active participant in treating his illness.

Biofeedback for reducing anxiety and uncontrolled crying: A case example

The clinical uses of biofeedback include: (1) assessment as a diagnostic strategy; (2) explaining illness processes and healing strategies that are congruent with the client's perspective; (3) reframing the clients' illness beliefs; and, (4) physiological training with homework practices to generalize the skills. The actual educational and clinical process varies with each client although there are a number of common themes that enhance the clinical success. These factors are described in the following case example of a highly anxious young woman with daily uncontrolled crying spells.

The client was a 20 year old, high achieving university student in her 3rd year. Her specific goals for the biofeedback treatment were immediate: to reduce anxiety and reduce the daily crying before she left to go to Spain in six days. She had always wanted to learn self-healing strategies to cope with her anxiety. Previous to her intense crying symptoms, she was very anxious about her grades and school performance. She also became extremely anxious before exams, thinking that she would perform poorly. She tended to procrastinate about completing her school work. Nevertheless, she performed superbly on the exams and never received less than an A- in any of her classes. She experienced anxiety during college lectures that caused her difficulty in grasping the materials. Often, she would drink coffee during stressful periods such as exams. When she felt rushed, she would delay or avoid eating, and when the hunger grew she would quickly eat an energy bar. She is very sensitive to other people's feelings and emotions. When friends were upset with her, she would get upset at herself by self-judging that she

had disappointed them. She described herself as having anxiety and stated that 'something is wrong with me'.

In addition to her anxiety and crying, she often experienced neck and shoulder tension and had a history of very severe menstrual pain. Her severity of menstrual pain has decreased as she is on the birth control pill; however, she experiences strong emotional reactivity before her menstruation that was quickly forgotten until the next period. For example, during each menstruation she was surprised that the emotional reactivity occurs until she realizes that it was related to the menstrual cycle. The initial experiences of dysmenorrhea started at age 14 and included insomnia. Her insomnia was so severe that she could only fall asleep if she was sleeping next to her mother. However, at college she has learned to fall asleep by herself but still experienced sleep difficulty before exams and during stressful periods in school. She is very slim and has had many years of training as a ballerina. She also practices Pilates (Pilates, 1998) in conjunction to her ballet training which encouraged her to continually tighten her abdomen and thus breathe thoracically.

Her specific goals for the biofeedback treatment included learning skills to reduce anxiety and reduce the daily crying before she left to go to Spain in 6 days. She had always wanted to learn self-healing strategies to cope with her anxiety.

First session process:
The goals for the first session were to: (1) develop rapport, identify and define the problem(s); (2) reframe the problem(s); (3) offer a psychobiological model for her symptoms; (4) perform a psychophysiological assessment; (5) create an experience that she could be in control and feel better; and, (6) teach homework practices that fostered self-control and healing. Although these steps are sequentially listed, the therapeutic/teaching process is dynamic and homework is developed to suit the particular needs of the patient based on discussions and observations.

The goal of the biofeedback healing approach is to have the client become an active participant in her own healing process. Thus the session has a significant educational component that focuses on explaining mechanisms by which symptoms are aggravated and what can be done to reverse and ameliorate the disorder. The purpose is to have the client 'buy into" the model and accepts the explanation for her past experiences and as a treatment strategy for healing.

Describing Goals
During the first session, she was asked to describe what she wanted to achieve in the next two sessions before leaving to go Spain in 6 days. After explaining her history and goals, the therapist, reframed her anxiety problem as hypersensitivity (fear reaction); namely, her sensitivity allowed her to be aware of other's people emotions and energy fields. The therapist suggested that when she was very little, she stated she felt as if she was 'punched in the stomach' by the emotions projected from anyone who was angry around her. As a young child, she would not know what had happened to have such as strong body reaction. As the therapist described her emotional reactions and experiences as

being hypersensitive (although she had not described this to the therapist), she agreed and physically relaxed.

Developing a 'Yes Set'

The clinical strategy used was to develop a 'Yes Set' (Peper & Fuhs, 2005). By describing how the client felt, the patient felt understood. Then the therapist reframed the experiences not as a failure or deficit but as a "gift" and special skill. As a result, the person feels understood versus defective or blamed. In clinical settings, the therapist might use the analogy of being color blind versus normally sighted. For example, with normal vision one can see all the rich colors in the world while a color blind person can not. Whereas the normally sighted person can wear sunglasses to block out some of rich colors, the color blind person cannot learn to see the colors. By analogy, the client may be like the normally sighted person who needs to find some 'sunglasses' to modulate the overwhelming visual stimuli. In this case, the client needs to learn some skills to inhibit and control her hypersensitivity. Using the color blind metaphor was the first step in the reframing of anxiety into hypersensitivity (reframing from being damaged and deficient to being special and competent). Thus when she became aware of describing or thinking of herself as anxious, her task was to reframe it to "I am more sensitive than most other people." This reframing shifted the client from having a binary perspective of 'healthy versus anxious' to an analog scale with non-pathological labels, for example 'less sensitive to more sensitive". The reframing approach also implies that some things can be changed. For example, the words, "more sensitive than other people," suggested that she could learn skills to master her sensitivity and be less reactive to stimuli.

Understanding Hypersensitivity

The next step included a short discussion about the biological basis that contributed to her anxiety and crying spells. The discussion included a reframing of the premenstrual symptoms as well as describing an interaction between diet, breathing and stress that increases emotional reactivity. The reframing also included identifying of the time of premenstrual symptoms as a period for increased sensitivity which is an intrinsic biological process that included changes in blood flow and olfactory functions to protect the fertilized egg from danger. For better success in managing hypersensitivity, she would have to remember to pre-plan on a calendar the next time premenstrual period when she would because more hypersensitive. Then, therapist described the relationship between anxiety and diet (e.g. hypoglycemia) as well as how it was possible to observe changes in brain activity (EEG changes) and breathing activity (respiratory changes) as a result of anxiety. The therapist explained that stressful thoughts may lead to hyperventilation, which may affect brain function, each of which may be a major mechanism contributing to her anxiety episodes. Knowing some of the physiological basis for anxiety helped to reframe her self-description from being deficient and defective (anxiety) to being more sensitive and biologically reactive, which were reactions she could learn to control.

Reactive Brain States

Using the graph shown in Figure 3, the therapist described how, by influencing blood glucose levels through diet, and by reducing hyperventilation through breathing exercises,

the EEG frequency indicative of anxiety/reactivity could be decreased. The therapist explained that decreased EEG frequency (a reactive brain state) was indicative of increased emotional reactivity. The therapist suggested avoiding hyperventilation as well as avoiding energy bars and caffeine because the caffeine directly made her anxious, the energy bars, which consist mainly of glucose, would increase the probability of hyperglycemia, and the hyperventilation would decrease oxygen flow, all of which would decrease EEG frequency which would increase the likelihood of triggering anxiety (Goldin, Manber, Hakimi, Canli, & Gross, 2009; Sequeira, Hot, Silvert, & Delplanque, 2009).

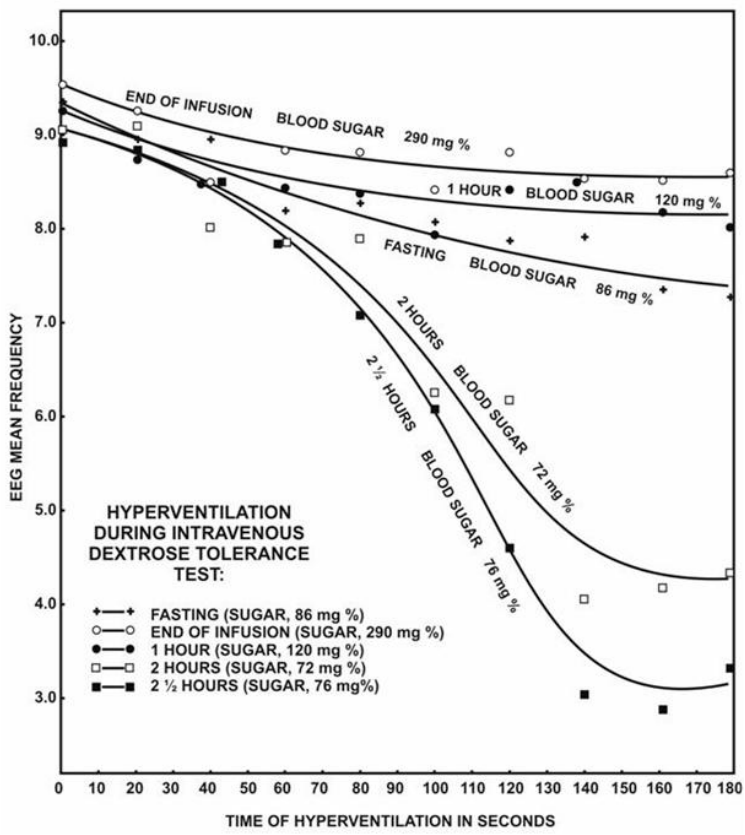

Figure 3. EEG mean frequency change at different blood-sugar levels in response to hyperventilation (redrawn from Engel, Ferris, & Logan, 1947).

A therapeutic model that underlies our work is to consider any symptoms as the consequence of normal biological responses that are being excessively evoked, maintained or suppressed. For example, a symptom of cold hands may be caused by thoughts that are evoking and maintaining vasoconstriction, as well as caffeine a vasoconstricting agent. Framing symptoms in terms of biological mechanisms makes it more acceptable to the client because such a framing avoids blaming the client for their symptoms. At the same time the therapist can proceed with psychophysiological assessment and training by showing the client that thoughts and emotions do contribute to changes in their physiological patterns.

Understanding the biological process

The client accepted the physiological model of her symptoms since it explained her past experience. For example, the client reported that during stressful times she often drank coffee, ate more carbohydrates and had shallow breathing, and could then explain back to the therapist that the coffee and sugar in combination with shallow breathing increased her sympathetic reactivity. In addition, the client realized that stress would affect her thinking as she reacted more with the primitive brain instead of being able to process information with the cortex. As a result of understanding the model of psychophysiological reactivity, the client was better able to identify when she was stressed, as well as why she had more difficulty grasping information during class. The process that the client's brain went through was illustrated by an example of blood flow changes that occur in the brain during hyperventilation, as shown in Figure 4.

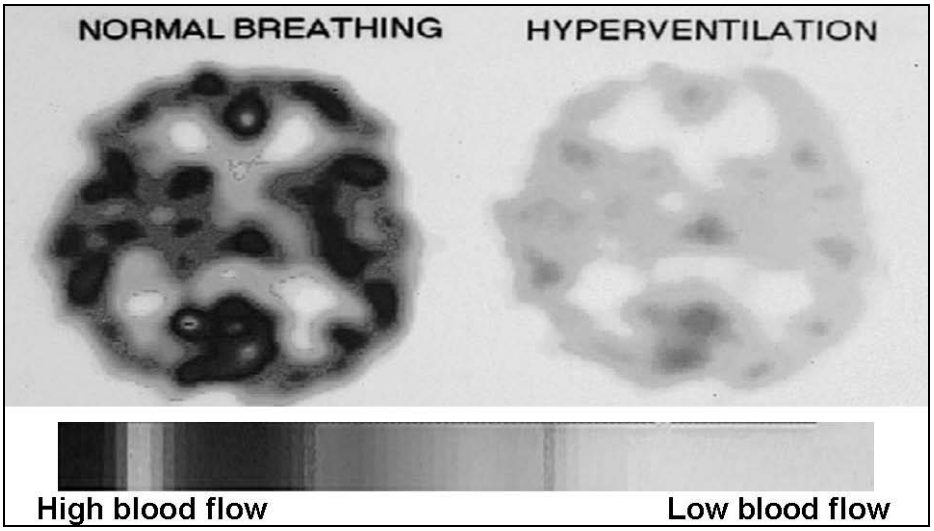

Figure 4. Blood flow through the brain in healthy subjects as measured with single photon emission computed tomography (SPECT) by looking at the brain from above during normal breathing and hyperventilation. The darker color indicates increased blood flow. During hyperventilation ($PCO_2 < 20$ torr) there was a significant decrease in blood flow throughout the brain. By permission from Scott Woods, M.D., Yale University, unpublished data, 1987. (For detailed methodology see, Wallace et al, 1996)

The information provided by the therapist about the physiological basis for her emotional reactivity and anxiety formed the foundation for reframing and initial behavioral dietary recommendations, which included reduction of caffeine and glycemic foods (e.g., no energy bars, bagels or white pasta) and, an increase of protein, fruits and vegetables (e.g., egg, salmon, nuts), as well as practicing slow, diaphragmatic breathing.

Stress profile considerations

The psychophysiological stress profile was the next step. The purpose of completing a profile is to: (1) identify physiological reactivity; (2) explore how physiology could contribute to illness; (3) demonstrate that she could change her physiology; and, (4) assign the learned skill as a homework practice. The challenge of psychophysiological profiles is to measure the relevant physiological parameters that are associated with psychological processes. Although standardized protocols are commonly used, these protocols often need to be adapted in the clinic for the individuals because of time limitations and to make the stressors personally relevant (Nixon, 1989; King, Rosen, & Nixon, 1990; Peper et al, 2008).

The psychophysiological stress profile is an assessment procedure typically conducted at the start of biofeedback therapy and usually separate out assessment from treatment. Many of today's advanced biofeedback systems contain stress profiles as scripted protocols within their software making the procedure easy to perform. In addition to ease, these scripted protocols provide exact reproduction across clients in terms of timing and events.

The assessment procedure begins with the attachment of recording sensors from the modalities typically utilized in biofeedback therapy. The client is then introduced to timed stressful events via the computer, followed by recovery periods. Pre- and post-baselines complete the structure of the common profile. Frequently, these events are set for two minutes periods.

Interpretation of the results is not formally standardized. Still, analysis proceeds across three primary areas: baselines, physiological reactivity during the stressor presentations and the observation of recovery or not during the recovery periods. For example, baseline investigation may reveal elevations in physiological resting levels. Reactivity investigation may reveal reactivity in one physiological system across all stress and little or no reactivity in others. Finally, recovery periods may reveal self-regulatory abilities or not following the stress experience.

As with most assessments, the stress profile is commonly performed in one session, and the results discussed with the client in the next session. Training goals can then be created in line with the findings, setting improvements for baseline levels, physiological reactivity patterns and recovery. It is the assumption that this training leads to enhanced self regulatory skill and reduction in stress related symptoms.

Researchers have often repeated the stress profile at the end of experimental paradigm with an eye on comparing ending physiological data to initial data as a means of supporting or not the intervention variable of interest. For clinical and educational purposes, it is often more useful to use the assessment data within the first session to show to the client how they react and develop appropriate intervention practices and homework exercises that the client can do. Thus, even in the first session, clients know that they are active participants in the training and healing process. It also transforms the covert cognitive set developed from previous clinical experiences which states, "I get

tested and assessed and did not get better." In this case, "I get assessed and am taught new skills to mobilize my health."

In this case, the stress profile moves from an assessment tool to a more dynamic clinical intervention. The stated goals of the first session: (1) develop rapport, identify and define the problem(s); (2) reframe the problem(s); (3) offer a psychobiological model for her symptoms; (4) perform a psychophysiological assessment; (5) create an experience that she could be in control and feel better; and, (6) teach homework practices that fostered self-control and healing are achieved through the coaching phase.

In many cases, the therapist may identify which physiological systems reacts on the covert observations made during an initial handshake and discussions. The handshake may indicate the possible physiological reactive patterns (cold hands-vascular reactivity, sweaty palm-excessive sympathetic arousal as measured by skin conductance, hand arm movement-neck and shoulder muscle tension). The client's breathing patterns (gasping, shallow thoracic breathing) are often observed while talking to the client. Whereas a standard stress profile may suggest monitoring sweat response and skin temperature for a client with dry and warm hands it may not be the useful measures. Instead, the therapist could select other modalities such as heart rate, breathing and brain activity. In addition, a client is often worried and wonders what will be occurring during the session. Thus, establishing a baseline for comparison to later sessions may be problematic. The initial meeting may be more stressful for the client than would be any subsequent meetings, or any simulation of stress (e.g. serial subtraction, talk stress...) that is part of a stress profile. Therefore, the therapist may want to incorporate situation specific (e.g. a test related to situations of crying, or to breath holding such as recalling times of feeling hopeless, collapsing downwards reducing abdominal breathing) to establish a baseline measure in addition to any test that would ordinarily be suggested by the standard profile protocol.

Psychophysiological stress profile procedures

This specific stress profile, recorded with a Procomp Biograph Infiniti™ (version 5.0). monitored the following: (1) thoracic respiration was measured with strain gauges around the chest (above the breasts and under the axilla); (2) abdominal respiration was measured with a strain gauge around the waist at the level of the umbilicus; (3) single channel SEMG was recorded from the neck and shoulder muscle tension with the active electrodes placed on the left scalene muscle and right upper trapezius muscle and band-pass filter set 100 to 200 Hz; (4) blood volume pulse was recorded from the left thumb; and, (5) skin conductance was recorded from the left ring and index fingers.

After sensors were calibrated, the procedure consisted of: a) Sitting quietly in the chair; b) talking; c) sitting relaxed without the therapist in the room; d) talking; e) collapsing downward while recalling hopeless, helpless and powerless memories; e) then while continuing sitting collapsed recalling positive empowering memories; f) sitting up erect while looking upward and recalling hopeless, helpless and powerless memories; followed by; g) recalling positive empowering memories. This was followed by asking her to relax and being coached with tactile and verbal cues to evoke slow diaphragmatic breathing.

The specific procedure of collapse and erect positions with the recall of either helpless, hopeless, and powerless memories or positive empowering memories was chosen because of her description of uncontrolled crying. Wilson and Peper (2004) had shown that physical collapse while looking down amplifies the recall of hopeless, helpless and powerless memories while looking up inhibit recall of these negative memories and enhances the recall of positive empowering memories and makes it almost impossible to cry.

Observations from the physiological stress profile

The major observations were rapid breathing of 20 breaths/minute during the initial relaxed condition, with almost no heart rate variability, a significant thoracic component during respiration, increased scalene-to-trapezius SEMG activity during breathing and tension, as shown in Figure 5.

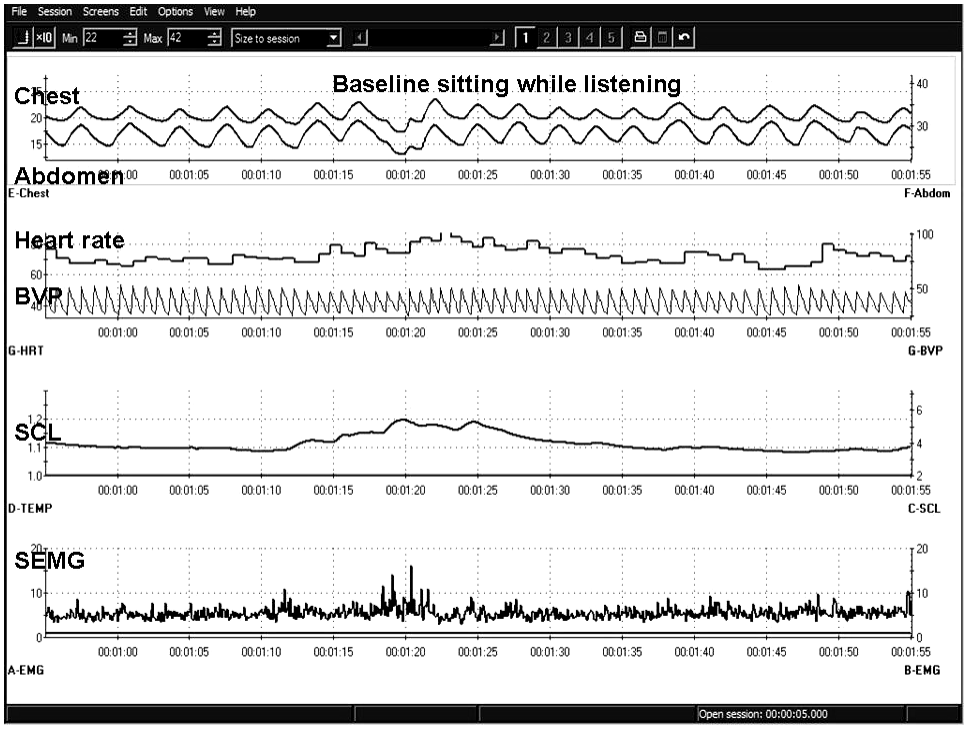

Figure 5. Baseline recording during the stressor profile. While the person was relaxed her breathing rate was 20 breaths per minute with almost no heart rate variability.

During the relaxation period the therapist left the room and she breathed slower with increased heart rate variability (HRV), however the skin conductance level (SCL) increased at the beginning of the instruction to relax and, scalene-to-trapezius surface electromyograph signal (SEMG) increased with each inhalation, as shown in Figure 6.

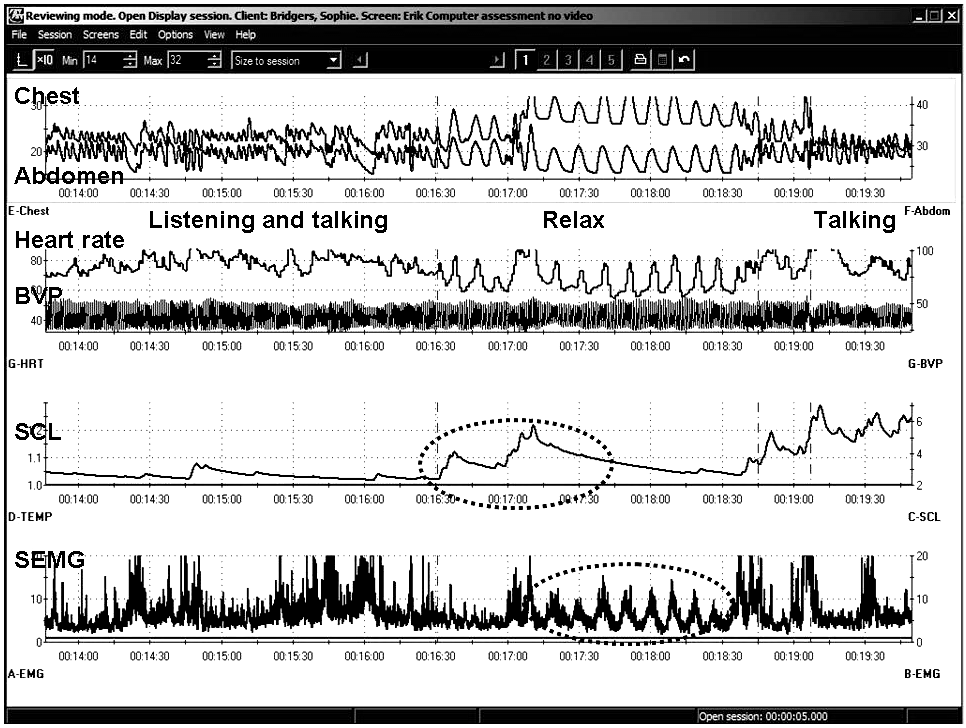

Figure 6. Phyiological recording of self relaxation during the stressor profile. When breathing slower during the relax condition, she had increased scalene-to-trapezius SEMG with every inhalation and an initial increase in skin conductance level (SCL)

How the stress profile was used with the client

The presence of rapid shallow breathing with significant chest components as indicated by the combination of strain gauge displacement and the scalene-to-trapezius SEMG suggest sub-clinical chronic hyperventilation (Lum, 1975; Fried, 1987; Litchfield, 2003; Litchfield, 2006). For this client, the chronic hyperventilation would interact with low glucose levels brought on by stress and poor diet and could explain the reports of anxiety, crying, and wandering thoughts. This psychophysiological model was explained to the client and she acknowledged it made sense to her. The client reported that her typical breathing pattern, thoracic shallow breathing, was encouraged through her ballet training and practicing Pilates. Ballet and Pilates focus on strengthening the core muscles, and she internalized this ballet and Pilates training by holding her abdomen tight and flat. Holding the abdomen tight and flat caused her breathing to become more thoracic. Healthy breathing occurs when the abdomen expands during inhalation and contracts during exhalation.

The increased skin conductance activity occurred when she received the instructions to relax as the therapist left the room, suggested that she was judging herself and trying to do the task well, suggesting a sense of perfectionism. The skin conductance level (SCL) took about 90 seconds to return to baseline after her self-judgment, “Can I do it well enough?” This interval of 90 seconds suggests that even when she began an intervention to reduce her anxiety; it would take a minimum of 90 seconds before it may have an

effect on calming her system. We often use the slow return to baseline as recorded by the SCL to explain that stress, emotions and even thoughts trigger biochemical changes which take time to metabolize and dissipate. It is similar to a person feeling high after drinking alcohol and now wants to be sober. Even after stopping drinking, the person is not instantly sober because the alcohol requires hours to metabolize. Thus, recognizing a stress response and then interrupting the response means that it takes some time before the physiology returns to baseline. Understanding the delay in body recovery allowed the client to interrupt the ongoing self-judgment, and give herself more time before asking, "Is what I am doing, helping me?"

Finally, the therapist suggested that she probably had chronic neck and shoulder stiffness because of the increased SEMG recording. The client immediately replied, "Yes." By speaking for the client's experience, the therapist was able to build on and deepen the 'Yes Set'. This therapeutic strategy of speaking for the client was very helpful to increase rapport because she agreed with the observations and amplified them and felt understood. This discussion formed the basis for the behavioral homework, described next.

The home practices included breathing slower and lower during the day; eating three meals a day and breakfast containing protein and low glycemic foods, not drinking coffee, practicing slow diaphragmatic breathing without thoracic components and scalene-to-trapezius SEMG activity; allowing more time to occur after doing some stress management technique such as slower breathing before judging its success. She was reminded that it takes a while for the body to come back to baseline; namely, expect your body to react and do not react to your own reaction, which would escalate the process. Finally, she was to observe neck and shoulder tension and whenever she noticed any tension to become aware of the cognitive, social and external trigger and at the same time relax the neck and shoulders.

Body position and emotional recall assessment

The client reported that it was much easier to evoke hopeless, helpless and powerless memories in the collapsed position and than sitting up position and equally much easier to evoke positive memories looking upward than in the collapsed position. While in the upward position, it felt impossible to cry. Physiologically, evoking positive memories allowed the SCL to decrease while evoking hopeless, helpless and powerless images did not allow the SCL level to decrease. In addition, evoking positive empowering memories in both positions decreased the breathing rate and increased HRV as shown in Figure 7.

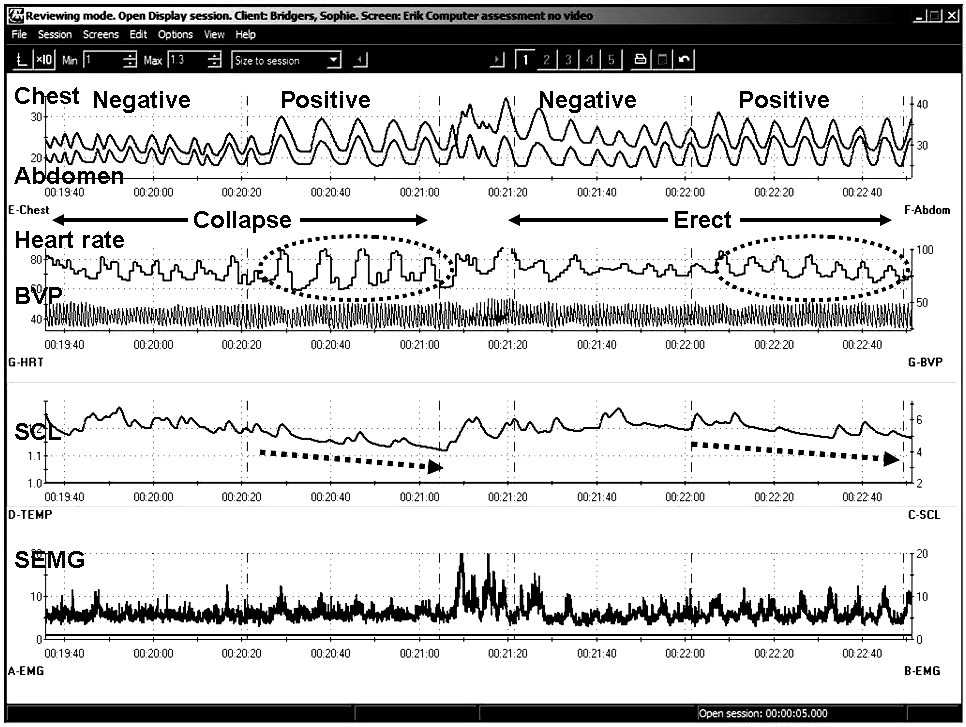

Figure 7. Physiological recording of recalling hopeless, helpless, powerless versus positive empowering memories in two different body positions.

By having the client experience both a illness producing state and an illness reducing state, the client now 'knows' how a body pattern can induce health or illness. The client was able to compare the subjective experience and then has objective information, rather than simple belief, that one pattern is more health promoting and the other pattern more illness promoting. Thus the client can make a choice.

How the body position and emotional recall recording was used with the client.

The recording was shown to client and she could see that in a collapsed position she breathed much more rapidly and also experienced the sad emotions and tearing. In contrast, while evoking positive emotions, she did not cry and felt better. The graphs showed an increase in respiratory sinus arrhythmia (RSA) during the evocation of positive emotions. The therapist pointed out that looking upward to feel positive and inspired is a common posture in many western religions-- people kneel and then look up at the cross while praying in church, or it is covertly evoked when looking at the alter priest or minister who is speaking from a physically elevated position.

The therapist emphasized that she already had the innate capacity to shift her thinking from hopeless, helpless and powerless to positive empowering memories. This again was a strategy to change her perception of self; namely, she shifted from self-talk such as "I am just overwhelmed and not in control" to "I can have control". Here she had the experience that she could change and the emotions, crying and memories could stop and shift. This discussion resulted in another home practice assignment. Whenever she

experienced anxiety, negative emotions, bad thoughts or crying, she was to sit up straight and look up and begin to breathe slower and lower and think of positive empowering memories.

Practice of effortless diaphragmatic breathing

After the assessment and discussion, the last component of the session focused upon teaching slower diaphragmatic breathing with less thoracic components and increased HRV to enhance sympathetic/parasympathetic balance (Lehrer, & Vaschillo 2003; Moss, 2004). The training consisted of looking at the screen, tactile coaching with the therapist slowly breathing in rhythm and diaphragmatically with the client while touching her abdomen and waist and slightly push it in during exhalation then allowing it expand during inhalation as well as auditory cues of asking as a whispered "sheeeee" sound during exhalation.

While exhaling she imagined the air flowing down and through her arms and out of her hands and fingers and also down her legs and out her feet and toes. As she exhaled, the therapist stroked her arms and legs from the center outward in rhythm with her exhalation (Peper, 1990; Peper & Tibbetts, 1993; Kajander & Peper, 1998). To be able to breathe diaphragmatically, she needed to loosen her belt because she had "designer's jean syndrome"; namely, her tight clothing limited her abdominal inhalation and forced her to breathe into her chest (MacHose & Peper, 1991). After loosening her waist belt, she easily mastered the skill because she had practiced yoga and breathing previously as shown in Figure 8.

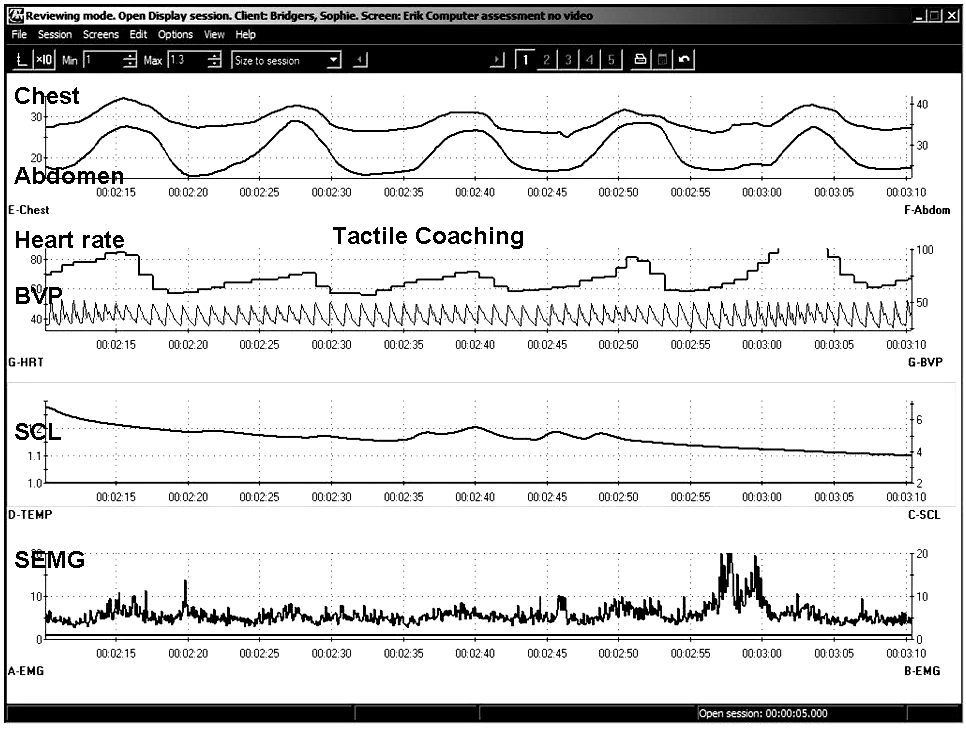

Figure 8. Physiological recording with tactile coaching for teaching diaphragmatic breathing.

After breathing diaphragmatically she felt much quieter and at peace. This type of tactile coached breathing facilitates client learning and includes the therapist modeling behavior by breathing slowly and imagining breathing down their own arms and legs as they guide the client. This coached breathing experience formed the basis of her final home work assignment: to breathe lower and slower many times during the day and during exhalation imagine breathing down and through the arms and legs.

Covert factors underlying the teaching of breathing

There are a number of factors that underlie this breathing practice and they include the therapists self experience and the role attention and mindfulness. Self-experience by the therapist is critical and significantly increases clinical success. The simultaneous practice of the skill which is being taught to the client means that the client can learn covertly through imitation (Tibbetts & Peper, 1993, Fried, 2000; Lehrer & Woolfolk, 1994). If a therapist can do the skill that they have asked the client to master, the client appears to learn more easily. This process may be modulated through mirror neurons (Billard & Arbib, 2002). Self-experience gives the therapist a sense of authenticity and inner confidence that impacts skill acquisition by the client. Just imagine the emotional experience of a woman who has had a mastectomy being told by a male therapist that the mastectomy must have been terrifying but you will be okay versus the experience of a client being told by a woman therapist who herself has had a mastectomy, and sharing that it is both difficult but survivable. Who is more believable as a source of information?

The directed breathing also includes training in passive attention. Namely, the client was guided to focus only on breathing down her arms and legs. Simultaneously, her attention to breathing down her arms and legs was reinforced through specific tactile movement down the arms. Tactile reinforcement is a powerful tool for focusing attention. Implicit in this homework practice is the process of global desensitization. Whenever the attention wanders, she was to bring it back to the breathing task.

The session ended with a review of the homework practices. The assigned homework was an experiment to see if it could impact the problem by reducing both the anxiety and the crying. We usually use the term ‘experiment’ for a certain time period. Patients are more willing to practice if the assignment is perceived as time limited. Usually, if the person practices the skill for two or three weeks, some slight improvement will be observed. If the client does psychophysiological homework practices that support system regeneration and restoration of sympathetic/ parasympathetic balance, the result is a subjective sense of control where the client reports feeling better.

If the client does not do the breathing homework many times a day, the therapist needs to explore the factors that prevented the client from carrying out the homework or, including understanding the benefits of not doing the homework. If the client faithfully did the homework and reported no benefits, however small, it is possible that the person did the homework with too much effort, had not mastered the skill or, needs to learn a more

passive attentive style. In addition, it suggests that the disorder has other contributing components.

Second session process

The goals of the second session were to review the previous week's experience and practice physiological mastery with the biofeedback. The session started with a review of her homework practices. She reported feeling much better during the last five days and there was only one time when time she gave in to her sad feelings, she cried and felt worse afterwards even though she previously thought that crying should make her feel better. She reported that during the day she had enough energy to do the practices and then the sad feelings would totally disappear. This resulted in a discussion of the difference between catharses and conditioned chained behavior. She realized that a significant component of her crying was linked to other behavior as she had previously observed in the memory recall and position exercise.

Through the practice of breathing she felt quieter and observed that when her boyfriend criticized her she would begin to feel sad and 'at fault'. This led to the discussion of the benefits of crying. Namely, she realized that her boyfriend gave more support when she cried, and the problem was temporarily sidestepped, even though it was not resolved. Similar to the first session, she had an increased awareness greater skill with diaphragmatic breathing allowed her to observe the process she was going through. The results of her homework experience and observations of the second session led to the discussion and practice of communication skills related to her biofeedback training. For example, she learned that using "I messages and responsive listening" helped her breathing practices.

She observed at home and in her past that when she got upset, the experience felt overwhelming and she even said things she did not believe. This was again integrated in the biological model presented in the previous session. Encouraged by her improved control and successful performance, the therapist took the opportunity to integrate in the biological model presented in the previous session. Namely, under stress, the blood flow goes to the deep muscles and out of the executive function of the brain to the cortical areas involved in movement and balance. Furthermore, when people are too upset, angry or frustrated, the body triggers a flight/flight response as the world is dangerous. During stressful times, the relative blood flow shifts away from the frontal cortex and the viscera such as the kidneys and other abdominal organs which are active during regeneration, and more blood will flow to the areas needed for motor control and balance, as shown in Figure 9. Whereas the absolute blood flowing to the brain remains the same, the distribution of blood throughout the brain may vary (Delp et al, 2001)."
Whereas the absolute blood flowing to the brain remains the same, the distribution of blood throughout the brain may vary (Delp et al, 2001).

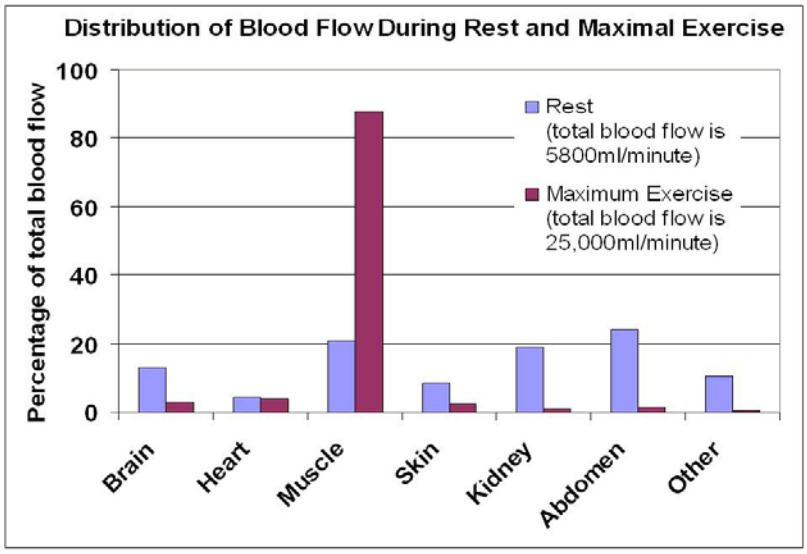

Figure 9. Relative blood flow to various body organs and tissue during rest versus maximum exercise; however, the absolute quantity of blood flow to the brain is remains relatively constant. Graph drawn from the data by Chapman and Mitchell, 1965 as cited by Papillo & Shapiro, 1990.

Attention and close awareness allows the option to create solutions. Thus she could explore options such as: (1) when upset, take time out and do physical exercise to complete the fight/fight response and then once the emotions have been dissipated then discuss the problem; (2) do problem solving early in the day when your subjective energy is higher and not before going to bed when the energy is low; (3) do modified progressive relaxation before going to sleep as a ritual instead of talking about negative emotions; practice slow breathing many times during the day even when you feel good; or (4) practice communication skills for fun.

Biofeedback training

The specific biofeedback training strategies included practicing effortless (abdominal) breathing, breathing and HRV in synchrony with feedback and breathing and HRV in synchrony with and without feedback and teach specific home practice to generalize the skill with a small heart rate variability feedback device (StressEraser®).

The biofeedback for breathing was monitored with strain gauges for thoracic and abdominal breathing and blood-volume pulse photoplethysmograph (BVP) for heart rate. Once connected to all the training modalities, the client was asked to demonstrate diaphragmatic breathing. “Similar to the first session, she had an increased awareness greater skill with diaphragmatic breathing allowed her to observe the process she was going through.

After a moment of orientation, she practiced breathing at about six breaths a minute while attempting without effort to maximize the cardio-respiratory synchrony. During the training she practiced this with visual feedback and also without feedback. Before

finishing, the trainee was asked to demonstrate her mastery of cardio-respiratory synchrony without as is shown in Figure 10.

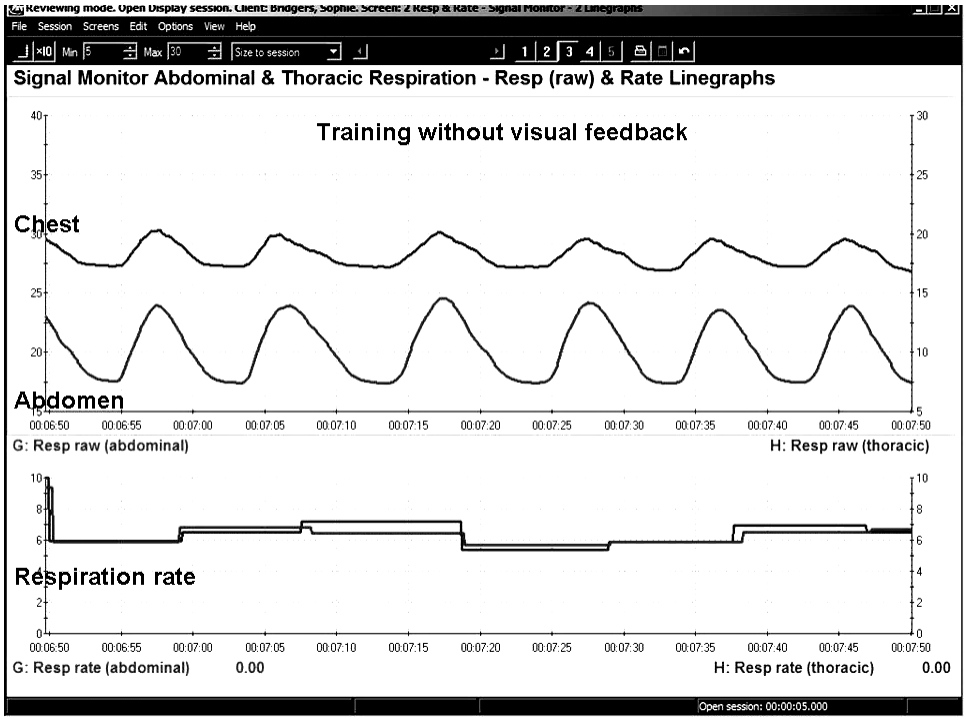

Figure 10. Physiological recording of diaphragmatic breathing without auditory, visual or tactile feedback.

Follow-up

At six week follow-up, the client reported, "Overall I have been doing very well in Spain. I have been more relaxed, and I definitely do not still refer to myself as an anxious person--I have accepted the idea that I am just more sensitive than others. I have also been good about keeping an eye out for the week before my period, and I prepare myself mentally before that week, reminding myself that I may be more emotional and sensitive during this time. I have also been good about not drinking coffee regularly (although I do have a cup from time to time...but I try to have one when I am in a relaxed state of mind). I try to remember the breathing but as the day goes on I lose focus and tend to forget about it. I have used it when I am upset."

Conclusion

Biofeedback is a useful tool in the treatment of psychosomatic illness. It confirms to the patients that the "disease" is in their body. At the same time it acts as a 'Trojan Horse' and allows the client to experience and see that thoughts, emotions and internal/external stressors all contribute to symptom initiation and maintenance. The biofeedback protocol acknowledges that clients have physiological responses to stressful thoughts and documents (graphs) that clients also can develop mastery over their physiological response patterns. Thus when biofeedback is used within an integrated approach, clients

are active participants in mobilizing their self-healing potentials. The biofeedback approach was to create a psychobiological model that explained the occurrence of the client's symptoms and teach specific skills were taught to reverse and change these psychosomatic patterns. Through the use of a biological model to explain contributing factors to the disease/symptom process, the client did not feel blamed and could also experience and see from the feedback that thoughts and emotional patterns contributed to the symptom occurrence. By learning awareness and specific skills--which the client actually practiced during her daily life--she experienced significant clinical improvement.

These positive changes are the result of numerous covert factors that underlie successful biofeedback training. These include physiological changes that enhance sympathetic-parasympathetic balance as indicated by:

- Increased heart rate variability and effortless diaphragmatic breathing at about six breaths per minute
- Self- training in mindfulness by bringing the client's attention to observing wandering thoughts and, bringing the passive attention (consciousness) back to the physiological control task such as breathing
- Shifting feelings of helplessness and hopelessness into hope and empowerment through the experience of physiological mastery
- Inhibition of escalating psychological and physiological flight/flight patterns by interrupting the initial response through slow exhalation
- Feeling respected and understood by the practitioner that the symptoms are real and not in "my head"
- Changing the cognitive framework how to interpret illness by seeing the symptoms as an exaggeration of normal biological reactions which can be controlled

This report illustrates that clinical biofeedback is more than just attaching sensors and having the person do the training. Biofeedback, like any other clinical/educational health practice, implies integrating the appropriate procedures at the right time for the patient. The ongoing challenge is know what, how and when to apply the integrated holistic techniques.

References:

Allen, J.K. & Blanchard, E.B. (1980). Biofeedback-based stress management training with a population of business managers. *Biofeedback and Self Regulation*, 5(4), 427-38.

Andrasik, F. (2007). What does the evidence show? Efficacy of behavioural treatments for recurrent headaches in adults. *Neurological Sciences, 28*, Suppl 2, S70-7.

Billard, A. & Arbib, M. (2002). Mirror neurons and the neural basis for learning by imitation: Computational modeling. In: Mirror neurons and the evolution of brain and language. Stamenov, Maxim I.; Gallese, Vittorio; Amsterdam, Netherlands: John Benjamins Publishing Company, 344-352.

Carlson, C. R. & Hoyle, R.H. (1993).Efficacy of abbreviated progressive muscle relaxation training: A quantitative review of behavioral medicine research. *Journal of Consulting and Clinical Psychology*. *61*(6), 1059-1067.

Carney, R. M., Blumenthal, J. A., Stein, P. K., Watkins, L., Catellier, D., Berkman, L. F., Czajkowski, S. M., O'Connor, C., Stone, P. H., & Freedland, K. E. (2001). Depression, heart rate variability, and acute myocardial infarction. *Circulation, 104* (17), 2024-8.

Cohen, S., Tyrrell, D.A. & Smith, A. P. (1992). Psychological stress and susceptibility to the common cold. *New England Journal of Medicine*, *326*(9), 645-646.

Delp, M.D., Armstrong, R.B., Godfrey, D.A., Laughlin, M.H., Ross, C.D., & Wilkerson, M.K. (2001). Exercise increases blood flow to locomotor, vestibular, cardiorespiratory and visual regions of the brain in miniature swine. *The Journal of Physiology, 533*, 849-859.

Dusek, J.A., Hibberd, P.L., Buczynski, .B, Chang, B.H., Dusek, K.C., Johnston, J.M., Wohlhueter, A.L., Benson, H., & Zusman, R.M. (2008). Stress management versus lifestyle modification on systolic hypertension and medication elimination: a randomized trial. *Journal of Alternative and Complementary Medicine, 14*(2), 129-38.

Engel, G.L., Ferris., E.G., & Logan, M. (1947). Hyperventilation: Analysis of clinical symptomatology. *Annals of Internal Medicine*, *27* (5), 690.

Fahrion, S.L., Norris, P.A., Green, A.M., Green, E.E., & Snarr, C. (1986). Biobehavioral treatment of essential hypertension: A group outcome study. *Biofeedback and Self-Regulation*, *11*(4), 257-277.

Figueira, M.L., & Ouakinin, S. (2008). From psychosomatic to psychological medicine: what's the future? *Current Opinion in Psychiatry*, *21*(4), 412-6.

Fried, R. (1987). *The hyperventilation syndrome: Research and clinical treatment.* Baltimore, John Hopkins University Press.

Fried, R. (2000). Breathing as a clinical tool. In: The management of stress and anxiety in medical disorders. Mostofsky, David I.; Barlow, David H.; Needham Heights, MA, US: Allyn & Bacon, 100-118.

Geraghty, E.M., Franks, P., & Kravitz, R.L. (2008). Primary care visit length, quality, and satisfaction for standardized patients with depression. *Journal of general internal medicine. 22*(12):1641-7

Goldin, P.R., Manber, T., Hakimi, S., Canli, T., & Gross, J.J. (2009). Neural bases of social anxiety disorder: emotional reactivity and cognitive regulation during social and physical threat. *Archives of General Psychiatry*, *66*(2),170-80.

Grossman, P. Niemann, L., Schmidt, S., & Walach, H. (2004). Mindfulness-based stress reduction and health benefits: A meta-analysis. *Journal of Psychosomatic Research*, 57 (1), 35-43.

Humphreys, P.A., & Gevirtz, R.N. (2000). Treatment of recurrent abdominal pain: components analysis of four treatment protocols. *J Pediatr Gastroenterol Nutr, 31*(1): p. 47-51.

Kabat-Zinn, J. (2003). Mindfulness-Based Interventions in Context: Past, Present, and Future. *Clinical Psychology: Science & Practice*, *10*(2),144-156.

Kajander, R., & Peper, E. (1998). Teaching diaphragmatic breathing to children. *Biofeedback*. 26 (3), 14-17+.

Katon, W.J., & Walker, E.A. (1998). Medically unexplained symptoms in primary care. *J. Clin. Psychiatry, 59* (Supp.20), 15-21.

Khan, A. A., Khan, A., Harezlak, J., Tu, W., Kroenke, K (2003). Somatic symptoms in primary care: Etiology and outcome. *Psychosomatics, 44*, 471-478

Kennedy, J. J. & Pretorius, M. (2008). Integrating a portable biofeedback device into call centre environments to reduce employee stress: Results from two pilot studies. *Journal of Workplace Behavioral Health*, *23*(3), 295-307.

King, J.C., Rosen, S.D., & Nixon, P.G. (1990). Failure of perception of hypocapnia: physiological and clinical implications. *J R Soc Med*. *83*(12). 765–767.

Kleiger, R.E., Miller, J.P., Bigger, J.T., et al., and the Multicenter Post Infarction Research Group. (1987). Decreased heart rate variability and its association with increased mortality after acute myocardial infarction. *American Journal of Cardiology, 59*, 256-262.

Kroenke, K. & Mangelsdorff, D. (1989). Common symptoms in ambulatory care: Incidence, evaluation, therapy, and outcome. *Am J. Med, 86*(3), 262-266.

Lehrer, P. M. & Woolfolk, R. L. (1994). Respiratory system involvement in Western relaxation and self-regulation. In: Behavioral and psychological approaches to breathing disorders. Timmons, Beverly H.; Ley, Ronald; New York, NY, US: Plenum Press, 191-203.

Lehrer, P.M, Woolfork, R.L., & Sime, W.E. (eds). (2007). *Principles and Practice of Stress Management, Third Edition.* New York: Guilford

Lehrer, P., &Vaschillo, E. (2003). Heart rate variability: A new tool for improving autonomic homeostasis and treating emotional and psychosomatic diseases. *Japanese Journal of Biofeedback, 30*, 7–16.

Linden, W. (1994). Autogenic Training: A narrative and quantitative review of clinical outcome. *Applied Psychophysiology and Biofeedback*, 19 (3), 227-264.

Linden, W., & Moseley, J.V. (2006). The Efficacy of Behavioral Treatments for Hypertension. *Applied Psychophysiology and Biofeedback.*31 (1), 51-63..

Litchfield, P. M. (2003). A brief overview of the chemistry of respiration and the breathing heart wave. *California Biofeedback, 19*, 1, 6–11, 14–15, 22.

Litchfield, P. M. (2006). Good breathing, bad breathing. In: P. M., Tsuda, A., & Izawa, K. (2006). Good breathing, bad breathing. *L'ESPRIT D'AUJOURD'HUI, 8*, 47–57.

Lum, L.C. (1975). Hyperventilation--The tip of the iceberg. *J. Psychosomat. Res. 19*, 375-383.

Luthe, W. (ED). (1969). *Autogenic Therapy (Vols. I, II, III, IV, V & VI).* New York: Saunders.

MacHose, M., & Peper, E. (1991). The effect of clothing on inhalation volume. *Biofeedback and Self-Regulation*. 16 (3). 261-265.

McGinnis, R.A., McGrady, A., Cox, S.A., & Grower-Dowling, K.A. (2005). Biofeedback-assisted relaxation in type 2 diabetes. *Diabetes Care, 28*(9), 2145-2149.

Mechanic,D., McAlpine, D.D., & Rosenthal,M. (2001). Are Patients' Office Visits with Physicians Getting Shorter? *New England Journal of Medicine, 344* (3) 198-204.

Moss, D. (2004). Heart rate variability and biofeedback. *Psychophysiology Today: The Magazine for Mind-Body Medicine, 1,* 4-11.

National Ambulatory Medical Care Survey (NAMCS), 1993, 1994, 1995, 1996, 1997, 1998. Hyattsville, Md.: National Center for Health Statistics, 1998. (See http://www.cdc.gov/nchs/datawh/ftpserv/ftpdata/ftpdata.htm.)

Nixon, P.G.F. (1989). Human functions and the heart. In *Changing Ideas in Health Care.* Ed by D. Seedhouse and A. Cribb. New York: John Wiley & Sons, 31-65.

Ornish, D., Brown, S.E., Scherwitz, L.W., Billings, J.H., Armstrong, W.T., Ports, T.A., McLanahan, S.M., Kirkeeide, R.L., Brand, R.J., & Gould, K.L. (1990). Can lifestyle changes reverse coronary heart disease? The Lifestyle Heart Trial. *Lancet, 336*(8708), 129-33.

Papillo, J., & Shapiro, D. (1990). The cardiovascular system. In J.T. Cacioppo & L.G. Tassinary (Eds.) *Principles of Psychophysiology: Physical, Social, and Inferential Elements.* New York: Cambridge University Press.

Peper, E. (1990). *Breathing For Health*. Montreal: Thought Technology Ltd.

Peper, E. & Fuhs, M. (2005). Place yourself in your client's shoes with biofeedback to promote healing: Part 1. *Biofeedback, 23*(3), 106-108.

Peper, E., Harvey, R., & Takebayashi, N. (2009). Biofeedback an evidence based approach in clinical practice. *Japanese Journal of Biofeedback Research, 36*(1), 3-10.

Peper, E., Tylova, H., Gibney, K.H., Harvey, R., & Combatalade, D. (2008). *Biofeedback Mastery-An Experiential Teaching and Self-Training Manual*. Wheat Ridge, CO: AAPB.

Pilates, J. (1998). *Pilates' Return to Life through Contrology*. Incline Village: Presentation dynamics.

Schwartz, M.S. & Andrasik, F.(2004). *Biofeedback: A Practitioners guide, 3nd Ed.* New York: Guilford Press.

Shapiro, W., Sowder, E., Gevirtz, R., and Kotay, A. (2006) A new biobehavioral treatment approach for recurrent abdominal pain: heart rate variability biofeedback. Presidential Poster Award at the 71st American College of Gastroenterology Annual Scientific Meeting and Postgraduate Course, Las Vegas, NV.

Sequeira, H., Hot, P., Silvert, L., & Delplanque S. (2009). Electrical autonomic correlates of emotion. *International Journal of Psychophysiology*, *7*(1), 50-6.

Sowder, E., Kotay, A., Cannon, C., Gevirtz, R.N., Shapiro, W. (2005) Heart rate variability biofeedback for recurrent abdominal pain: A multiple case study. Applied Psychophysiology and Biofeedback. 30, (4), 409-410(abstract)

Thompson, T., Steffert, T., Ros, T., Leach, J., & Gruzelier, J. (2008). EEG applications for sport and performance. *Methods*, *45*(4), 279-88.

Tibbetts, V., & Peper, E. (1993). The effect of therapist breathing style on subject's inhalation volumes. *Biofeedback and Self-Regulation*. 18 (2), 115-120.

van Dixhoorn, J. & White, A. (2005). Relaxation therapy for ehabilitation and prevention in ischaemic heart disease: a systematic review and meta-analysis. *European Journal of Cardiovascular Prevention and Rehabilitation, 12*,193-202

Wallace, E.A, Wisniewski, G., Zubal, G., vanDyck, C. H., Pfau, S. E., Smith, E.O., Rosen, M. I., Sullivan, M. C., Woods, S. W., & Kosten, T. R. (1996). Acute cocaine effects on absolute cerebral blood flow. *Psychopharmacology, 128*(1), 17-20.

Wilson, V.E., & Peper, E. (2004). The Effects of upright and slumped postures on the generation of positive and negative thoughts. *Applied Psychophysiology and Biofeedback.*29 (3), 189-195.

Woods, S. (2009). Personal communication June 1, 2009.

Yucha, C. & Montgomery, D. (2008). *Evidence-Based Practice in Biofeedback and Neurofeedback.* Wheat Ridge, CO: Association for Applied Psychophysiology and Biofeedback.