Biofeedback as a Viable Somatic Modality for Trauma and Related Comorbidities

A New Methodology

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ABSTRACT

Biofeedback is a behavioral modality that focuses on the interconnection between psychological and physiological phenomena in real time. Its main premises are that emotional and cognitive behavior begets physiological behavior, vice versa, and that the conscious connection between the two augments healing. To achieve this learning, the client is coached using operant conditioning learning models while recording heart rate, breath rate, distal temperature, muscle activity, electrodermal activity, and/or brain waves. Each modality relates to the person uniquely, and it is the skill of the practitioner to know which one(s) to train to enhance the psychological process and encourage mental, social, and emotional growth. This paper explores these modalities and their best uses.

Keywords: biofeedback; neurofeedback; applied psychophysiology; learning theory, somatic modality

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As somatic psychologists, we know that the phenomena of cellular memory (Pert, 1997), psycho-somatization, and living our fears (Van der Kolk, 2014) are not new. Talk, massage, somatic movement, felt sense, and the many other modalities that we use to lure the symptoms of physiological remembering up to the surface and out of the person have evolved because we know these phenomena are possible, very real, and trained away. A newer approach to augment these interventions is known as biofeedback. Biofeedback is the tool a practitioner uses to connect the somatic to the often intangible emotional experience at the person's consciousness (Schwartz & Andrasik, 2016). Because it is technologically based, biofeedback is often considered a Western approach to the ancient Eastern understanding of mind and body.

Biofeedback is used in real time to help the person connect the real feeling, whether in the chest (heart and breathing), gut (breathing and electromyograph), muscles (electromyograph), hand (galvanic skin response and temperature), or brain (electroencephalography or neurofeedback) with the conscious, unconscious, and/or emotional content (Sherlin, Arns, Lubar, et al, 2011). This is done by amplifying the actual minute measures of the electrical potential of body systems as they are happening using sophisticated equipment. These changes in physiology are barely noticed until, in many cases, too late – such as a panic attack or regrettable aggressive reaction. The process of real-time observation teaches the person to know what the earlier symptoms are, and the clinician will use this information to teach the client to break old habits and self-regulate in order to avoid an upcoming unwanted and regrettable reaction.

This author was in clinical practice in Northern California for close to 20 years, specializing in biofeedback and neurofeedback, and helping children and adults with issues such as PTSD, anxiety, depression, ADHD, learning disabilities, stroke, and brain injury. A typical client experience included an assessment of all body systems in which we measured the electrical potential of their behaviors during certain tasks, some of which were meant to stress (Arena & Schwartz, 2016). The trends during stress and recovery are the most important in the assessment, and guide the clinician to the modalities and learning style of the client. For example, an adult with PTSD will understand biofeedback very differently than a child with ADHD.

Coupling the state of relaxation with the noxious element teaches the client that he can experience the stressor while also experiencing relaxation.

The first few sessions include an acclimation to the modalities and to the concept of self-regulation. For example, a hand-held mirror is often used for the client to see what was happening from a new perspective. Once the client became aware of their reactions, and how they actually felt from their earliest stages, we would then practice preventing them. The easiest example is desensitization, when one presents with a phobia. Coupling the state of relaxation with the noxious element teaches the client that he can experience the stressor while also experiencing relaxation.

Almost always, biofeedback clinicians start with breathwork. Clients usually present breathing too shallowly and fast. Or they may be capable of fire- or other yogic-breathing styles that don't always yield calmness. Coupling this with heart rate and heart-rate variability training is usually indicated. (Further in this article, there is an explanation of the modalities.) Usually, the almost immediate change in state is recognizable and informative. But there are times when the feeling of calmness can be upsetting, a phenomenon known as relaxation-induced anxiety, and thus, these steps need to be taken with precaution.

One would normally do about 4 to 6 sessions of biofeedback for the client to feel confident she can self-regulate and apply the newly-learned skills. Each time the client comes in, a mini-assessment is done. Typically, we meet weekly, and the skills learned during each session are practiced at home, once or twice each day. This might include 3-5 minutes of diaphragmatic breathing, temperature regulation, or skin conductance reduction, and could be practiced in conjunction with a cognitive behavioral skill. For example, I worked with a couple who were both OCD, and one of their at-home tasks was to go out for their morning walk without cleaning the breakfast dishes. They both found it very challenging at first, but when coupled with some diaphragmatic breathing, were able to "let it go." This introduced them to their OCD in a new way, and coupled with biofeedback, helped both of them to have a less compulsive lifestyle.

At each session, this important home-training is discussed in order to assess progress. Over the years I was in practice, I was interested in the reasons (excuses?) for why the 3-minute breathing session was not done. For example. in the case of the couple above, the experiences / body feelings when they could, as well as when they couldn't, leave the dishes, were meaningful. The explanation of the lack of time to complete a 3-minute exercise is quite revealing to the motivation and "stuckness" of the client. Discussing this is an essential part of the process.

Importantly, when doing biofeedback, it is an important skill of the practitioner to get the client "out of their frontal lobes." After a 15-minute breathing session, I ask how the client is feeling; the typical response is "calmer" or "so relaxed" or "grounded." These are meaningful responses and experiences, but with biofeedback, the clinician is not seeking definitions of feelings that come from the frontal lobes; the biofeedback clinician asks about how it feels physiologically. The improved responses, which are often gotten when prodding, are "I don't feel the pang in my chest when I inhale," or "My shoulders are not as tight." The clinician is looking for physiologically-felt sensations. Once these are recognized, at-home training becomes more successful, because the sensations are attended to from a new perspective, and are followed and regulated in real life. This often couples with frontal lobe explanations, and from a biofeedback perspective, the physiological experience is what's important.

Biofeedback Modalities

- **Temperature:** Temperature training involves training temperature up or down from the surface of a finger. This is known as distal temperature because finger location is furthest from the core (Peper, Tylova, Gibney, et al, 2008a). Typical temperatures at presentation are between 70 and 90*. The general goal is to increase distal temperature to the low 90s. The reason for monitoring and training distal temperature is because the temperature at our furthest extremity is indicative of blood flow, which is further indicative of blood vessel diameter, which is influenced by muscle contraction. And finally, muscle contraction occurs when the muscle is activated. This can be due to movement or the stress response, the latter being pathological if chronic. When a set of muscles is chronically constricted, those muscles clamp down on the blood vessels that pass through it, and where there is no blood flow, there is no warmth.

  The instrument used is a thermistor, which is applied to the middle finger of either hand with an elastic band, a Velcro enclosure, or medical tape. It measures temperature with very little time lapse and within a tenth of a degree. Temperature fluctuations represent changes in muscle constriction that reveal one's experience with particular tasks. Temperature changes are slow compared to other measures. For example, one can be monitoring temperature while discussing a very emotional event. The fluctuations in temperature, which can range from a tenth of a degree to 10 degrees, are an indication of the person's reaction to the content of the emotional discussion on a global scale.

Temperature training is indicated in stress reduction and Reynaud's syndrome, as well as migraine. Reynaud's syndrome is caused by a constriction of blood flow to the affected hand(s). If one can learn to open up the constriction, usually by muscle relaxation, the compression of blood flow is eliminated. Since migraine is a vascular issue, regulating blood flow can revive symptoms, severity, and duration of migraine headaches.

- **Muscle Electromyograph:** Electromyograph (EMG) measures the tension/use of muscles. The more constrained a muscle, the higher the value. Typical values at presentation are between 5 and 25μV (microvolts). The goal, generally, is to be below about 3μV during relaxation, but this is dependent on specific muscle groups (Bolek, Rosenthal, & Sherman, 2016; Peper, Tylova, Gibney, et al, 2008b).

  Myograph is the measure of the electrical output of muscles as they are activated. Muscles are activated during common tasks, such as moving, posturing, carrying, etc. If the electromyographic output at the relaxed state is high — meaning if the patient is sitting in a reclining chair and the muscle activity is high — there likely is residual muscle activity that is emotionally driven. The clinician can use modalities such as Jacobson's progressive relaxation, autogenics, and/or mindfulness, along with monitoring the EMG to teach the client how it feels to have relaxed muscles.

  One client reported feeling relaxed, specifically in her forearms, yet the sensor measured quite the opposite. This is a perfect example of cognitive dissonance in that the sensation of activated muscles was considered relaxation. The client needed to learn that her sense of relaxed forearm muscles was, in fact, incorrect. She was shown that every time she thought her muscles were relaxed, they were not. As she learned how to relax those muscles, which was a challenge, she needed to constantly remind herself that she "had it backwards," and, in fact, once accomplished, relaxed forearm muscles felt completely different to her. In this case, the association was of holding on, as with a clenched fist. This metaphor served the therapeutic process well because holding on to past familial experiences was hindering her personal growth.

- **Skin Conductance:** Skin conductance is the measure of the clamminess of one's hands (or feet). The purpose of measuring clamminess is to assess the level of arousal or agitation one is currently experiencing. It is measured by placing two sensors (they could be either on the palmar surfaces of the hand or foot, or on the fingers or toes, separated by a few inches (if on the fingers/toes, on two separate ones on the same side). The sensor sends a very small electrical current, which can be accentuated by clamminess or attenuated by dryness. Typical presenting values are between 2 and 10μSiemens. Optimal levels at rest should be under 1.5μSiemens (Peper, Tylova, Gibney, et al, 2008c).

  For example, when doing a psychophysiological assessment, monitoring the skin conductance as it changes between the typical stress and recovery tasks can be revealing to how one responds to stressors, and, more importantly, how well one recovers from it. The usual assessment stressors are Stroop and Series 7s.

While skin conductance measure is often confounded by medications, it is an excellent insight to how one relates to stress, and how one can recognize the stressed state when in it. Skin conductance is quite responsive and labile. For example, while doing any body modality, monitoring the skin conductance will inform of a reaction (both positive and negative) to a protocol well before the client or clinician can observe a response to it.

- **Breathing:** Breathing is measured with a sensor known as a strain gauge. It is strapped around the waist with Velcro, just above the belly button. As one inhales and exhales, the gauge expands and contracts and measures in µmeters of mercury (like a thermometer). This informs the length of time of each phase of the breath cycle (inhale, exhale, and hold), and whether the breath has traveled as low as the abdominal muscles.

  When one breathes shallowly, the movement of the breath does not make it to the abdominal area, where the diaphragm sits (just above the kidneys). And the breath itself doesn't satiate the lungs, providing gas exchange (O_2 and CO_2) to the upper areas only. The strain gauge confirms this, because there is little change between the diameter of the abdomen during inhale, when it should be largest, and exhale, when it should be smallest.

  Breathing diaphragmatically, also known as relaxation, or deep breathing, is necessary for optimal gas exchange, as well as helping to regulate heart rate (more on this below). A healthy relationship between breathing and heart rate is vital to well-being and success. When the heart rate increases with inhale and decreases with exhale, we name this coherence. Slowing one's breath, as well as consciously (at least, at first) breathing more deeply so gas exchange can be done at all surface areas of the lungs increases parasympathetic tone. Parasympathetic tone (the opposite of sympathetic tone – or flight/fight) is optimal for both objective and subjective experience and behavior.

  In the literature, a goal of 6 breaths per minute is typical. However, one can also train the person to breathe at what is known as resonance frequency, which could range from 4 to 8 breaths per minute.

- **Heart Rate and Heart Rate Variability:** Heart rate is simply the number of beats per minute (BPM). The average is from 60 to 85 BPM. People who are more athletic and aerobically fit will tend to have a lower rate. Lowering baseline heart rate has been shown to reduce risk of cardiovascular disease and the overall message of stress to the body. One regulates heart rate through the breath. As described above, a smooth and rhythmic breath pattern is optimal. When this is achieved, the heart follows; this is known as coherence of the two values. Since breathing is a very tangible process, it is often used to access less-tangible processes, such as heart rate. The sensation of heart rate and breathing coherence is one of calm, yet fully alert (not drowsy).

  A sensor known as a photoplethmograph is Velcro-strapped onto the left middle finger. This device emits an infrared signal. It then registers when that signal is returned – in milliseconds. If quickly, then there is blood flow because it bounces off of its density. If less quick, then there is less blood flow, and thus less density. The constant pulse of the flow informs the heart rate as well as oximetric value and the variability of the heart rate (which we will further discuss below). This can also be measured on the ear lobe with a clip, which can be better since there is less chance of movement artifact.

Heart rate variability (HRV) is measured as the distance in the number of beats from the average (and standard deviations) of the BPM during inhale and BPM during exhale (Gevirtz, Schwartz & Lehrer, 2016). There is a natural and healthy need for there to be a difference. The heart pumps faster when, during the inhale, fresh oxygen is delivered and needs to be pumped to the vascular system. And, it naturally slows down during exhale. A healthy difference is about 15 BPM. So, if one has a heart rate of 70, it usually means during inhale it's about 78, and during exhale about 62. When training HRV, the BPM measure is monitored from the photoplethmograph, and the person is taught to slow their breath to a level that brings the HRV into coherence with it, as measured by a power spectrum that tracks electrical output of the cardiac muscles and is a good indicator of the fluctuations in heart rate during the breath cycle.

- **Neurofeedback:** Neurofeedback is by far the most complicated biofeedback modality. One needs to understand brain anatomy and function at least minimally, or be supervised by someone who does. Like all biofeedback, the neurofeedback modality utilizes the operant conditioning learning model. This involves rewarding the physiological behavior when it meets the expectations the clinician designs within the biofeedback equipment. The most common and well-investigated disorders include ADHD (Monastra & Lubar, 2016; Thatcher, 2012), seizure, depression, anxiety, stroke, mild traumatic brain injury, dementia, and PTSD (Martins-Mourao & Kerson, 2017). While each disorder has recognized brain EEG (electroencephalic) profiles, EEG patterns are like fingerprints — extremely unique to the person (Urlich, 2013). Therefore, be wary of systems that have default protocols for dysregulation without performing an assessment. The assessment for neurofeedback is called a multi-channel EEG. This usually entails doing a "brain map" of 19 channels that are universally designated. The clinician will observe the patterns and connection grids of the EEG, and can then compare it to a normative database to discover the standard deviations from normal populations. The individual patterns are as important as the comparison to the normative database.

  Once the brain map is assessed and the client conveys their goals, the clinician develops a training program. Generally, about 30 sessions are needed. Clinicians will train anywhere from 20 to 60 minutes per session. During my years in clinical practice, I trained for 30 minutes, usually using 5-minute rounds and small breaks in between. The training protocol is designed to teach the client to regulate brain waves by programming the software to offer a reward, which was usually a soothing sound, a puzzle filling in, bars extending above or below the threshold (depending on whether the specific brain wave frequency should be rewarded or inhibited), etc.

The brain is eager to please and learns quite quickly what it needs to do in order to get that reward. Original studies of brain wave operant conditioning were done with cats, rats, pigeons, and monkeys. Because humans have further-developed frontal lobes that incorporate and complicate emotional content very differently than other species, neurofeedback takes much longer than the original animal studies. This is also why neurofeedback can be considered an adjunct to other somatic modalities (or vice versa), and should not stand alone.

A typical neurofeedback session starts with the client getting hooked up. Let's imagine a client with anxiety using a protocol designed to be calming. The clinician hooks up a few sensors to the scalp (active sensors) and ear lobes (references and ground), and settles the client. The environment is a quiet space, with dimmed incandescent lighting and a comfortable reclining chair. The software is programmed to provide the appropriate feedback, and the session begins. The client is instructed to intend for the positive reward to happen. It really is that simple; let the reward happen. The instructions should include removal of thinking and over-strategizing and to allow the process. This first step can be very complicated for the client, but once learned, the process accelerates. (For some, this could take many sessions that are interspersed with other modalities to incorporate the learning of letting go.)

Integrating Biofeedback and Body Psychology

Of importance, the American Psychological Association (APA) has recently granted proficiency for biofeedback (APA, 2019). This is significant because first, it recognizes biofeedback as a reliable adjunct modality for psychologists, and second, with proper training and mentoring, psychologists can practice biofeedback for many of the physiological indications commonly seen by body psychologists (of whom, many are licensed by APA).

The many body psychology modalities that are used to alleviate anxiety, trauma, pain and other real physiological ramifications of emotional imbalance, such as Somatic Experiencing®, healing touch, and neuro-effective modeling, are an excellent match with the practice of biofeedback because biofeedback can illuminate body experiences in a tangible way. In the case of pain, one learns to recognize and regulate differing levels of pain while working through the etiological emotional context. In addition, assessing and regulating brain wave profiles, which become dysregulated as one braces and/or dissociates from pain, can support the energetic work of body modalities. Camfferman and colleagues (2019) found that pain intensity, coupled with sleep issues, which are commonly comorbid to pain issues, dysregulates the alpha bandwidth. The clinician can teach self-regulation of the brain wave profile in conjunction with body therapy, which crafts a dialog between brain and body not previously accessible.

Authentic movement is another modality that could benefit from biofeedback – specifically EMG or skin conductance. Since authentic movement is a process in which the experience of the body is from within, having the muscle patterns recorded could illuminate differences in subjective and objective experiences. For example, when one is moving, one could learn of muscle groups that "hold" when not needed, which could be connected to unhealthy body patterns. As well, the skin conductance can measure changes in perspiration that can determine when certain body postures become more emotionally activating. The former could be useful in determining when there is residual or idiopathic pain when certain movements are made, and the latter could be useful in cases of trauma associated with sexual abuse, for example.

Catastrophizing can derail a somatic treatment because the practitioner is helping work through issues that are emotionally severe, but project to differing systems than the client reports or recognizes. Using most (or all) of the biofeedback modalities explained in this paper during an initial assessment will elucidate actual body system behaviors while asking the client to describe their body experience. Often, body experience and actual level of body strain are incongruent, and the clinician can use this discrepancy to guide the body therapy. One example is when one conducts bioenergetic analyses, in which measuring actual physiological systems can support or challenge observations from an energetic perspective.

Family and couples therapy can be enhanced with biofeedback, which may expose physiological trends that are not otherwise evident during any therapy in which these dynamics are aided. For example, during a couple's talk therapy session, the skin conductance and video recording, can reveal individual reactions to the deliberations of the other participants. The client may not have cognitively recognized how physiologically toxic a comment or event was. During the session, these responses likely will have been noticed by the clinician, yet they are much more implanted in the client's self-understanding by the physiological evidence of, for example, the subtle change in skin conductance, or the review of their body and facial reactions via video.

Pain assessment of cognitively impaired individuals, whether youth or elders, can be complicated as they cannot verbally express their experience of the pain in the same way a cognitively stable person can (Strand, Gundrosen, Lein, Laekeman, Lobbezoo, et at, 2019). Biofeedback can assist with this, because it can support or disprove facial and other responses to testing. These portrayed responses, coupled with the actual objective behaviors, speak to the real need for either physiological or emotional intervention.

In the PTSD population, the levels of depression and suicide are staggering, and our returning warriors are greatly in need of modalities that resolve traumatic stress (US Dep't Veterans Affairs, 2019). The first-line treatment is currently medications, likely SSRIs, which are a class of anti-depressants that focus on altering the chemical properties of between-cell affinities, specifically serotonin, which is the neurotransmitter most associated with pleasure and contentment. Other first-line treatments include cognitive behavioral therapy (CBT) and exposure therapy (Reisman, 2016).

Recent research on trauma-based treatments has reported on many of the biofeedback modalities — in particular, EEG and heart rate modalities (Lake, 2017; Van der Kolk, 2014). Many books and articles focus on these modalities for PTSD, whether for returning veterans, in which case it is event-based, or for developmental PTSD, which is based on long-term trauma during childhood (van der Kolk, Hodgen, Gapen, Musicaro, Suvak, et al, 2016; Gerin, Fichtenholtz, Roy, Walsh, Krystal, et al, 2016)). They discuss the importance of integrating mind (or psychology, emotional balance, and motivational systems) and body (or physiology). The effectiveness of these protocols is currently observed as no larger than 30% (see Reger, Hollloway, Candy, Rothbaum, Difede, et al, 2011; Reisman, 2016). Further investigation would be warranted to validate the use of biofeedback in conjunction with CBT or other body modalities, however, this author can anecdotally report many cases in which the presence of objective physiological feedback improved outcomes.

Case Presentation

A 36-year-old veteran (PS) presents with diagnosed PTSD and self-reported sleep disorder. He describes sleep onset and duration issues; it takes him at least 2 hours to fall asleep, and then he complains that he does not feel rested after a continuous sleep period of about 6 hours. He is highly reactive to daily stressors. He is on a prescribed SSRI (1 year) and reports it has not helped as much as he'd hoped. He recounts conflict with his wife and undue frustration with his 5 (f) and 7 (m) year-old children.

PS reports for a biofeedback assessment in which he is given an EEG (brain wave) recording and a psychophysiological stress profile (PPSP). During the EEG assessment, a spandex cap is placed over his head, and electroconductive gel is inserted into the sensors. He is asked to remain perfectly still for 5 minutes with his eyes open, and then again with his eyes closed. This records how his brain functions during both resting states, as well as how it differs between the eyes open and closed states.

The PPSP is administered in which he cycles through baseline, a stressor (Stroop test), recovery/relax stage, a math stressor (series 7), recovery/relax stage, talk stressor, and final recovery/relax stage.

The EEG recording takes about an hour, and the PPSP about 20 minutes. The total intake session, including interview, is about 2 hours. The EEG reveals typical patterns of "hypervigilance," which is common to PTSD. This means that of the brain wave frequencies recorded, the faster frequencies show the highest power. This presents as a "rev," and an inability to slow the brain down in order to evaluate moments for reaction.

The PPSP shows poor recovery from stress. We are measuring breath rate, heart rate, electrodermal activity, muscle tension (usually in the upper back: trapezius, and frontalis, and the upper facial muscles, which are where stress is mostly held). This means that once the stressor is completed, there is little or no recovery to baseline measures, which in this case were elevated at the outset. So, in the end, the high baseline measure wasn't sustained, and the PPSP left PS in a higher level of arousal. This is not uncommon in the presentation of PTSD The combination of a hypervigilant EEG profile and high physiological baseline in which stressors are difficult to recover from is indicative of PTSD, and PS served as a typical patient.

We started with breathing and heart rate training in which we practiced breathing at a slower pace than the recorded baseline (16 BPM). We started at 12, then 10, and then 7 BPM. This enabled a more functional and healthful heart rate (starting at 90 beats per minute and finally at 72 BPM). Once PS succeeded in breathing at 7 breaths per minute for 5 minutes, and his heart rate slowed to the low 70s, he began to experience what he called "How I felt before my deployment." In addition, his skin temperature raised from 76* to 82* (which is not optimal, but a meaningful start). And finally, his skin conductance (SC) measure shifted from 3.4 to 2.7 uSiemens. A large change in SC was not expected since he was taking an SSRI, which is a regulator of skin conductance.

After 3 sessions of breath work, we proceeded to neurofeedback training, in which we started with a protocol known as SMR, or sensory motor rhythm training (Sterman & Egner, 2006). This training is used to calm the motor cortex. Once PS reported response to daily stressors with much less agitation, we continued to do another neurofeedback protocol known as the alpha theta protocol for 12 sessions (Martins-Mourao, Kerson, 2017). This protocol takes patients to a deeper state, similar to mindfulness meditation, and guides them through suggestion to access memories and thoughts that are normally difficult to process. The combination of relaxation, as learned from the biofeedback protocols, and the SMR neurofeedback protocol (19 sessions) allowed PS to access suppressed experiences while in the calmest state and environment, and allowed him to process these experiences without a reaction of vigilance. Consequently, he learned to process these reactions in his life, and with regular at-home biofeedback training, recalibrated his harsh reactions to everyday stressors to a more healthful level.

In Conclusion

No matter the biofeedback modality (or modalities) used in conjunction with body therapies, once a few sessions have been done, usually the client experiences behavioral changes that act as secondary gain and support further self-regulation. For some, the shifts are life-changing; for others, they are very subtle. Essentially, with the help of physiological information to back up their intuition and expertise, the clinician remains a catalyst for the process, supporting any changes and reminding clients of their specific goals as they advance through the procedure.

The many modalities of biofeedback are diverse, and should be individual to the presentation and goals of the client as described above. Their strategies are symbiotic to the process and specific to their outcome, and should be considered seriously by the clinician. With some training, and possibly certification, the clinician specializing in somatic modalities can add these skills and greatly improve outcomes. Biofeedback can be thought of as an "East meets West" paradigm in which somatic movement (Eastern objectivity) is enhanced by psychophysiological mastery (Western objectivity).

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