Applied Psychophysiology for Daily Therapeutic Use: Healing a Shoulder Injury[1]

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Abstract: This case report describes an indirect approach incorporating diaphragmatic breathing, imagery, role rehearsal and surface electromyographic (SEMG) feedback to successfully reduce pain and increase left shoulder mobility in a 23 year old woman with a left pectoralis muscle injury from a skiing accident. It demonstrates how direct biofeedback or therapeutic interventions may be counterproductive and indirect approaches guided by SEMG activity may facilitate clinical success. Discussed are specific concepts, rationales and strategies employed that guided the successful therapeutic intervention. This article offers a case description with process and outcome comments from the client's and therapist's perspectives. It is offered as a model to increase therapeutic efficacy when an initial biofeedback intervention appears not to work.

"It has been an occurrence of the third dimension for me! How come my pain — that lasted for more than 10 days and was still so strong that I really had difficulties in breathing, couldn't laugh without pain nor move my arm not even to fulfil my daily routines such as dressing and eating — disappeared within one single session of 20 minutes? And not only that, I was able to freely rotate my arm as if it had never been injured before."

– (T.'s report of treatment outcome)

The client T., aged 23, was a psychology student who participated in an educational workshop for Healthy Computing. She volunteered to be a subject for a surface electromyographic (SEMG) monitoring and feedback demonstration. Ten days prior to this workshop, she had a severe skiing accident. She reported:

> I went skiing and may be I had too much snow in my ski-binding and while turning, I slipped out of my binding and fell head first down into the hill. As I fell, I landed on my ski pole which hit my left upper chest and breast area. Afterwards, my head was humming and I assumed that I had a light concussion. I stopped skiing and stayed in bed for a while. The next day it started hurting and I couldn't turn my head or put my shoulders back (they were rotated forward). Also, I couldn't ski as I was not able to look down to my feet—my muscles were too contracted and I felt searing pain whenever I moved. I hoped that it would go away however, the pain and left forward shoulder rotation stayed.
>
> —T

Assessment

Observation and Palpation

T.´s left shoulder was rolled forward (adducted and in internal rotation). She was not able to breathe or laugh without pain or move her arm freely. All movements in vertical and horizontal directions and rotations were restricted by at least 50% as compared to her right arm (limitations in shoulder extension, flexion and external rotation). Also, her hands were ice-cold and she breathed very shallowly and rapidly in her chest. She was not able to stand in an upright position or sit in a comfortable position without maintaining her left upper extremity in a protected position. Her left shoulder blade (scapula) was winging.

After visually observing her, the therapist placed his left hand on her left shoulder and pectoralis muscles and his right hand on the back of her shoulder. Using palpation and anchoring her back with his leg so that she could not rotate her trunk, he explored the existing range of shoulder movement. He also attempted to rotate the left shoulder outward and back—not by forcing or pulling—but by very gentle traction. No change in mobility was observed and the pectoralis muscle felt tight (SEMG monitoring is helpful to the therapist during such a diagnostic assessment by helping to identify the person's reactivity and avoiding to evoke and condition even more bracing). T. reported afterwards that she was very scared by this assessment because there was one point in the back which was highly reactive to touch. T. appeared to tighten automatically out of fear and trigger a general flexor contraction pattern—a process that commonly occurs if a person is guarding an area.

Often a traumatic injury first induces a general shock that triggers an automatic freeze and fear reaction. Therefore, an intervention needed to be developed that did not trigger vigilance or fear and thereby allowed the muscle to relax. If pain is experienced or increased, it is another negative reinforcement for generalizing guarding and bracing and tightening the muscles. This guarding decreases mobility – a common reaction that may occur when health profes-

sionals in the process of assessment increase the client's discomfort. T.'s vigilance was also "telegraphed" to the therapist by her ice-cold hands and very shallow chest breathing. Therefore, it was important to increase her comfort level and to not induce any further pain. We hypothesized that only if she felt safe it would be possible for her muscle tension to decrease and thereby increase her mobility.

Underlying concept: The very cold hands and shallow breathing probably indicated excessive vigilance and arousal—a possible indicator of a catabolic state that could limit regeneration. The chronic cold hands most likely implied that she was very sensitive to other people's emotions and continuously searches/scans the environment for threats. In addition, she indicated that she liked to do/perform her best which induced more anxiety and fear of judgement.

Single Channel Surface Electromyographic (SEMG) Assessment

The triode electrode with sensor was placed over the left pectoralis muscle area as shown in Figure 1. The equipment was a MyoTrac™ produced by Thought Technology Ltd. which is a small portable SEMG with the preamplifiers at the triode sensor to eliminate electrode lead and movement artefacts. Such a device is an inexpensive option for people who may use biofeedback for demonstrating and teaching awareness and control over muscle tension from a single electrode location.

The MyoTrac was placed on a table within view, so that the therapist and the subject could simultaneously see the visual feedback signal and observe what was going on as well as demonstrate expected changes. The feedback was used for T. as a tool to see if she could reduce her SEMG activity. It was also used by the therapist to guide his interventions: To keep the SEMG activity low and to stop any intervention that would increase the SEMG activity as this would prevent bracing as a possible reaction to, or anticipation of, pain.

1. Assessment of Muscle Reactivity. After the electrode was attached on her pectoralis muscle and with her arm resting on her lap, she was asked to roll her left shoulder slightly more forward, hold the tension for the count of 10 and then let go and relax. Even with feedback, the muscle activity stayed high and did not relax and return to a lower level of activity as shown in Figure 2. This lack of return to baseline is often a diagnostic indicator of muscle irritability or injury (Sella, 1998; Sella & Donaldson, 1998). If the muscle does not relax immediately after contraction, movement or exercise should not be prescribed, since it may aggravate the injury. Instead, the person first needs to learn to relax and then learn how to relax between activation and tensing of the muscle. The general observation of T. was that at the initiation of any movement (active or passive) muscle tension increased and did not return to baseline for more than two minutes.

2. Exploration. Self-exploration with feedback was encouraged. T. was instructed to let go of muscle tension in her left shoulder girdle. In addition the therapist tried to induce her letting go by gently and passively rocking her left arm. The increased SEMG activity and the protective bracing in her shoulder showed that she couldn't reduce the muscle tension. Each time her arm was moved, however slightly, she helped with the movement and kept control. In addition, T. was asked to reduce the muscle tension using the biofeedback signal; again she was not able to reduce her muscle tension with feedback.

3. Passive Stretch and Movements. The next step was to passively stretch the pectoralis muscle by holding the shoulder between both hands and very gently externally rotate the shoulder — a process derived from the Alexander technique (Barlow, 1990). Each time the therapist attempted to rotate the shoulder, the SEMG increased and T. reported an increased fear of pain. T.'s SEMG response most likely consisted of the following components:

a) Movement induced pain,
b) Increased splinting and guarding,
c) Increased arousal/vigilance to perform well.

These three assessment and self-regulation procedures were unsuccessful in reducing muscle tension or increasing shoulder movement. This suggested that another therapeutic intervention would need to be developed to allow the left pectoralis area to relax. The SEMG could be used as an indicator whether the intervention was successful as indicated by a reduction in SEMG activity. Finally, the inability to relax after tightening (bracing and splinting) probably aggravated her discomfort.

Multiple levels of injury: The obvious injury and discomfort was due to her left chest wall being hit by the ski pole. She then guarded the area by bracing the muscles to protect it which limited movement. The

Figure 1. Triode electrode placement on the left pectoralis muscle area (photo is from another subject)

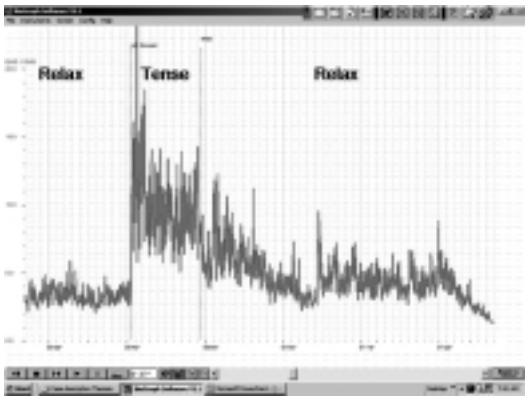

Figure 2. Recording of pectoralis sEMG. Note that after the muscle is contracted it takes a long time to return to baseline level (this is a recording from another subject showing a similar pattern as was visually observed with the Myotrac from T.)

guarding tightened the muscles and limited blood circulation and lymphatic flow which increased local ischemia, irritation and pain. This led to a self-perpetuating cycle: *Pain triggers guarding and guarding increases pain and impedes self-healing.*

As the SEMG and passive stretching assessment were performed, the therapist concurrently discussed the pain process. Namely, from this perspective, there were at least two types of pains:

- Pain caused by the physiological injury
- Pain as the result of guarding

The pain from the guarding is similar to having exercised for a long time after not having exercised. The next day you feel sore. However, if you feel sore, you know that it was due to the exercise therefore it is defined as a good pain. In T.'s case, the pain indicated that something was wrong and did not heal and therefore she would need to protect it. We discussed this process as a way to use cognitive reframing to change her attitude toward guarding and pain.

Rationale: The intention was to interrupt her negative image of pain that acted as a post hypnotic suggestion. The objective was to change her image and thoughts from "pain indicates the muscle is damaged" to "pain indicates the muscle has worked too hard and long and needs time to regenerate."

Treatment Intervention

The initial intervention focused upon shifting shallow thoracic breathing to diaphragmatic breathing. Generally, when people breathe rapidly and predominantly in their chest, they usually tighten their neck and shoulder muscles during inhalation. One of the reasons T. breathed in her chest was that her clothing—very tight jeans—constricted her waist (MacHose & Peper, 1991). This breathing pattern probably contributed to sub-clinical hyperventilation and was part of a fear or flexor response pattern. When she loosened the upper buttons of her jeans and allowed her stomach to expand her pectoralis muscle relaxed as she breathed as shown in Figure 3. As she began to breathe in this pattern, each time she exhaled her pectoralis muscle tension decreased.

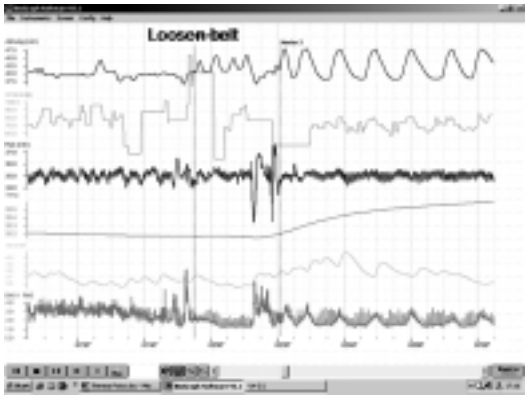

Figure 3. The effect of loosening tight waist constriction (eliminating designer's jean syndrome) on blood flow and pectoralis sEMG (this recording is from another subject whose physiological responses were similar to that was observed with the Myotrac from T.)

Following the demonstration that breathing significantly lowered her chest muscle tension, the discussion focussed on the importance of effortless diaphragmatic breathing for health and reduction of vigilance. Being awkward and uncomfortable at loosening her pants, she struggled with allowing her abdomen to expand and her pants to be looser because she thought that she looked much more attractive in tight clothing. Yet, she agreed that her boy friend would love her regardless whether she wore loose or tight clothing. To encourage an acceptance for wearing looser clothing and thereby permit diaphragmatic breathing during the day, an informal discussion focused on "designer jeans syndrome" (chest breathing induced by tight clothing) with humorous examples such as discussing the name of the room that is located on top of the stairs in the Victorian houses in San Francisco. It is called the fainting room—in the 19th century women who wore corsets and had to climb the stairs would have to breathe rapidly and then would faint when they reached the top of the stairs (Peper, 1990).

Rationale: Rapid shallow chest breathing can induce a catabolic state that inhibits healing while diaphragmatic breathing may induce an anabolic state that promotes regeneration. Moreover, effortless diaphragmatic breathing would increase respiratory sinus arhythmia (RSA)—heart rate variability linked to breathing— and thereby facilitate sympathetic-parasympathetic balance that would promote self-healing.

The discussion included the use of the YES set which means asking a person questions in such a way that she/he has to answer the question with YES. Often when a person answers YES at least three times in a row rapport is facilitated (Erikson, 1983, pp. 237-238). Questions were framed in such a way that the client would answer with YES. For example, if the therapist thought the person did not do their homework, a yes question could be framed as, "It must have been difficult to find time to do the homework this week?" In T.'s case, the therapist said, "I see, you would rather wear tight clothing than allow your shoulder to heal." She answered, "Yes." This was the expected answer, however, the question was framed in an intuitive guess on the therapist's part. Nevertheless, the strategy would have been successful either way because if she had answered "No," it would have broken the "Yes: set, but she would then be committed to change her clothing.

Throughout this discussion, the therapist placed his left hand on her abdomen over her belly button and overtly and covertly guided her breathing movement. As she exhaled, he pressed gently on her abdomen; as she inhaled he drew his hand away—as if her abdomen was like a balloon that inflated during inhalation and deflated during exhalation. To enhance learning diaphragmatic breathing and slower exhalation, the therapist covertly breathed at the same rhythm and gently exhaled as she exhaled while allowing the breathing movement to be mainly in his abdomen. In this process, learning occurred without demand for performance and T. could imitate the breathing process that was covertly modelled by the therapist.

The Change

The central observation was that each time she tried to relax or do something, she would anticipate and increase her pectoralis SEMG activity. The chronic tension from guarding probably induced localized ischemia, inhibited lymphatic flow and drainage, and reduced blood circulation

which would increase tissue irritation. Whenever the therapist began to move her arm, she would anticipate and try to help with the movement. Overall she was vigilant (also indicated by her very cold hands) and wanted to perform very well (a possible need for approval). Her muscle bracing and helping with movement was reframed as a combined activity that consisted of guarding to prevent further injury and as a compliment that she would like to perform well.

Labelling her activity as a "compliment" was part of a continuing YES set approach. The therapist was deliberately framing whatever happened as adaptive behaviour, with positive intent. Further, if one tries and does something with too much effort while being vigilant, the arousal would probably induce hand cooling. If the activity can be performed with passive attention, then increased blood flow and warmth may occur. The therapeutic challenge was how to reduce vigilance, perfectionism and guarding so that the muscles that were guarding the traumatized area would relax.

Therapeutic concept: If a direct approach does not work, an indirect approach needs to be employed. Through an indirect approach, the person experiences a change without trying to focus on doing or achieving it. Underlying this approach is the guideline: **If something does not work, try it once more and then if it does not work, do something completely different.** This is analogous to sexual arousal: If you demand from a male to have an erection: The more performance you demand the less likely will there be success. On the other hand, if you remove the demand for performance and allow the person to become interested and thereby feel an erotic experience an erection may occur without effort.

The shift to an indirect intervention was done through visualization. T. was encouraged to visualize and remember a positive image or memory from her past. She chose a memory of a time when she was in Paris with her grandmother. While T. visualized being with her grandmother, the therapist asked another older women participant to help and hold T's right hand in a grandmother-like way as if she was her grandmother. The "grandmother" then moved T.'s hand in a playful way as if dancing with T.'s right arm. Through this kinesthetic experience, T. became more and more absorbed in her memory experience. At the same time, T´s left hand was being held and gently rocked by the therapist. During this gentle rocking, the SEMG activity decreased completely in her left pectoralis area. The therapist used the SEMG feedback to guide him in the gentle rocking motion of T.'s left arm and very slowly increased the range of her arm and shoulder motion. Gentle movement was done only as long as the SEMG activity did not increase. It allowed the muscle to stay relaxed and facilitated the experience of trust.

> "Initially it was very difficult for me to let go of control because I found this idea somewhat strange and I was puzzled. I expected the therapist to intervene and I felt frightened. The therapist's soft and gentle touch and his very soft voice in this kind of meditation helped me to let go of control and I was surprised about my own courage to give myself into the process without knowing what would happen next."
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> (T.'s reflection of this process two days later)

Rationale: Every corresponding thought and emotion has an associated body response and every body response has an associated mental/emotional response. Therefore, an image and experience of a happy and safe past memory will allow the body to evoke the same state and vigilance can be abated. The intensity of the experience is increased when multi-sensory cues are included such as actual handholding. The more senses are involved, the more the experience can become real. In addition, the tactile sensation of feeling the grandmother's hand diverted her attention away from her shoulder into her hand and thereby reduced her active efforts of trying to relax the shoulder and pectoralis area. Doing something she did not expect to happen also helped her loose control – an implicit confusion approach.

SEMG feedback was used as the guide for controlling the movement. The therapist gently increased the range of the movements in abduction and external rotation directions while continuously rocking her arm until her injured arm was able to move unrestricted in full range of motion. The arm and shoulder relaxation and continuous subtle movement without evoking any SEMG activation facilitated blood flow and lymphatic drainage which probably reduced congestion. After a few minutes, the therapist gently dropped her arm on her lap. After her arm was resting on her lap, she reported that it felt very heavy and relaxed and that she didn't feel any pain. However, she initially didn't really realize that her mobility had increased dramatically.

Rationale: When previous movements that had been associated with pain are linked to an experience of pleasure, the movement is often easier. The conditioned muscle bracing patterns associated with anticipation of pain and/or concern for improvement/results are reduced.

To deepen and generalize the relaxation and breathing, she was asked to imagine breathing the air down and through her arms and legs—a strategy that she could then do at home with her boyfriend. We wanted to involve another person because it is often difficult to do homework practices without striving and concern for results and focussing on the area of discomfort. Her response to asking if her boyfriend would help was an automatic "naturally" (the continuation of the YES set). With her agreement, we role played how her boyfriend was to encourage diaphragmatic breathing. He was to gently stroke down her legs as she exhaled. She could then just focus on the sensations and allow the air to flow down her legs. Then, while she continued to breathe effortlessly, he would gently rock and move her arm.

To be sure that she knew how to give the instructions, the therapist role played her boyfriend and then asked her to rock his arm so that she would know how to teach her boy friend how to move her arm. The therapist sat on her left side, and, as she now held his right arm and gently rocked it with her left arm, the therapist gently moved backwards. This meant that she externally rotated her left arm and shoulder more and more. He moved in such a way that in the process of rocking his arm, she moved her "previously injured shoulder" in all directions (up, down, forward and backwards) and was unaware that she could move her arm and shoulder as she did not experience any discomfort. Afterwards, we shared our observations and she was asked

to move her arm and shoulder. She moved it without any restrictions or discomfort.

Rationale: By focusing outside herself and not being concerned about herself, she did not think of herself or of trying to move her arm and shoulder. Hence, she did not evoke the anticipatory guarding and thus significantly increased her flexibility.

Often after an injury, we are frustrated with our bodies. This frustration may interfere with healing. Therefore, the session concluded by asking her to be appreciative of her shoulder and arm. She was asked to think of all the positive things her shoulder, chest and arm have done for her in the past instead of the many limitations and pains caused by the injury. Instead of being angry at her shoulder that it had not healed or restricted her movement, we suggested that she should appreciate her shoulder and pectoralis area for all it had done without her awareness such as: How the shoulder moved her arm during love-making, how without complaining her shoulder moved during walking, writing, skiing, eating, etc., and how many times in the past she had abused her shoulder without giving it proper respect and appreciation. This process reframes the way one symbolically relates to the injured area. Every thought of discomfort or negative judgement becomes the trigger and is transformed into breathing lower and slower and evokes an appreciation of the positive nice things her shoulder has done for her in the past.

Rationale: When injured we often evoke negative mental and emotional images which become post- hypnotic suggestions. Those negative thoughts, images and emotions interfere with healing while positive thoughts, images and emotions tend to promote healing. A possible energetic process that occurs when injured is that we withdraw awareness/ consciousness from the injured area which reduces blood and lymph circulation. Caring and positive feelings about an area tends to increase blood flow and warmth (a heart-warming experience) and promotes healing.

Results

She left the initial session without any pain and with total range of motion. At the two week follow-up she reported continued pain relief and complete range of motion.

T.s reflection of the experience was:

> I really was not aware that I could move my arm freely like before the accident, I was just feeling a kind of trance and was happy to not feel any pain and to feel much more upright than before. Then I watched the faces of the two other therapists who sat there with big eyes and a grin on their face and then become aware of my own arms position which was rotated backwards and up, a movement that was impossible to do before. I remember this evening that I left with this feeling of trance and that I often tried to go back to my collapsed posture but this was not possible anymore and I felt very tall and straight. Now two weeks later I still feel like that and know that I had an amazing experience which I will store in my brain!
>
> My father who is an orthopedic surgeon tested me and found out, that I had hurt my rib. He said that I have a contusion and it will go away in a few weeks. Before this experience, I would say that he was not open to Biofeedback. However he was so captivated by my experiences that he spontaneously promised me to pay for my own biofeedback equipment and to support me with my educational program and even offered me a job in his practice to do this work!

Psychophysiological Follow-up: 3 Weeks Later

The physiological assessment included monitoring thoracic and abdominal breathing patterns, blood volume pulse, heart rate and SEMG from her left pectoralis muscle while she was asked to roll her left shoulder forward (adducted and internally rotated) for the count of 10 and then relax. The physiological recording showed that she breathed more diaphragmatically and that her pectoralis muscle relaxed and returned directly to baseline after rotation as shown in Fig. 4.

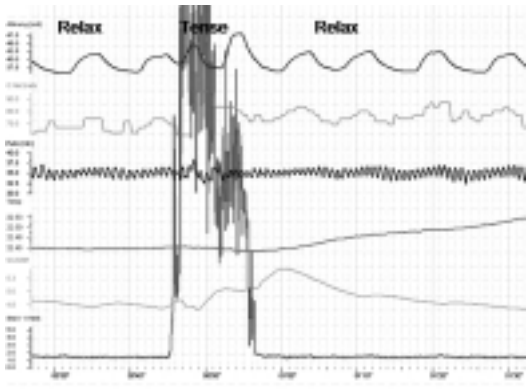

Figure 4. Physiological profile during the rolling left shoulder forward (tense) and relaxing at T.'s three week follow-up. Note that the pectoralis sEMG activity returned rapidly to baseline after contracting and her breathing pattern is slower.

Summary

This case example demonstrates the usefulness of a simple one-channel SEMG biofeedback device to guide the interventions during assessment and treatment. It suggests that the therapist and client can use the SEMG activity as an indicator of guarding—a visual representation of the subjective experience of fear, pain and range of mobility—that can be evoked during assessment and therapeutic interventions. The anticipation of increased pain commonly occurs during diagnosis and treatment and often becomes an obstacle for healing because increased pain may increase anticipation of pain and trigger even more bracing. To avoid triggering this vicious circle of guarding/fear, the feedback signal allows the therapist and the client to explore strategies that reduce muscle activity by indirect interventions.

By using an indirect approach that the client may not expect, the interventions shift the focus of attention and striving and may allow increased freedom and relaxation. The biofeedback signal may guide the therapeutic process to reduce the patterns of fear, panic, and bracing that are commonly associated with injury and illnesses. Once this excessive sympathetic activity is reduced, the actual pathophysiology may become obvious (in most cases is much less then before) and the healing process may be accelerated. This case description may offer an approach in diagnosis and treatment for many therapists and open a door for a gentle, painless and yet successful way of treatment and encourage therapists to be creative and use both experience/technique and intuition.

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Note

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Revised Ethical Guidelines for AAPB

The Ethical Guidelines for AAPB were revised and approved by the AAPB Board on March 27, 2003. Members may request a copy from AAPB or download a copy from the AAPB web site – *www.AAPB.org*

Biofeedback Treatment of Secondary Headache: A Case Study

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muscles due to his subjective feeling of pain and tension in that area. These readings ranged from 2 to 4mv initially and increased to much higher levels (10-20 mv) with stressful tasks (e.g., serial 7's, naming all animals starting with a certain letter). He was able to recover somewhat on his own after the stressors, but the readings ended at a higher level (range 4 to 6mv) than at the beginning.

These data indicated that he might benefit from training in biofeedback. Goals for treatment included hand warming (ideally to 90F), decreased levels of muscle tension, greater ability to lower pain and stress levels on his own, and greater awareness of physiological changes. After training in the clinic, he was asked to practice autogenics daily with the aid of an audiotape. With increased mastery of these skills, it was hoped that he would be able to lower his pain level and develop a greater sense of control over his head pain.

Treatment consisted of 6 biofeedback training sessions. Initially he was able to warm his hands with the aid of autogenics, but when it was suggested that he keep his head temperature cool, he had difficulty keeping his hands warm. He also reported difficulty staying focused on the suggestions of heaviness and warmth due to distracting thoughts. With the use of autogenics and guided imagery in the third session, he raised the temperature of the left hand from 73.8F to 75.5F and his right hand from 78F to 91.5F. His pain level also improved during this session. In the fourth session he was instructed in progressive muscle relaxation (PMR) and encouraged to practice PMR daily with a CD. He was encouraged to utilize diaphragmatic breathing for stress at work. Two weeks later he utilized PMR in session and was able to increase the temperature in both hands from 88F to 95F, although the left side was still slower to warm. He noted that he felt less pain and pressure when he was able to relax the muscles in his face and neck. His post-training EMG levels ranged from 1 to 2 mv bilaterally.

Outcome

With the combination of diaphragmatic breathing, autogenics, PMR, and biofeedback, his pain and stress levels were lower, and he felt more in control of his pain. He was able to work full-time and enjoy a higher quality of life than before treatment. Although the exact cause of his secondary headaches was hard to pin down, it was clear that he responded to biofeedback training in a positive manner.

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