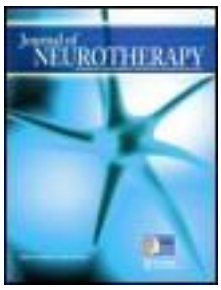

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Case Study of Trigeminal Neuralgia Using Neurofeedback and Peripheral Biofeedback

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Case Study of Trigeminal Neuralgia Using Neurofeedback and Peripheral Biofeedback

Andrea Sime, LCSW

ABSTRACT. *Introduction*. Trigeminal neuralgia is characterized by brief episodes of extremely intense facial pain often radiating down the jaw. These episodes can occur spontaneously or be triggered by light touch, chewing or changes in temperature. The pain can be so intense as to be completely disabling. This case study concerns a 46 year-old nurse with a 15-month history of trigeminal neuralgia. She had been maintained poorly on propoxyphene napsylate/apap100/650 mg (Darvocet-N100) over the previous year. Her neurologist's next planned intervention was to sever the trigeminal nerve.

Method. Over a period of nine months, this client had 10 peripheral biofeedback training sessions (including dynamic EMG biofeedback) and diaphragmatic breathing in conjunction with a program of stress management and counseling. She also received 29 sessions of neurofeedback (including T4, C3, C4, C3-C4 and T3-T4). C3 seemed to be the most effective placement for sleep maintenance issues, and T3-T4 seemed to be the most effective placement for pain issues.

Results. The client experienced a substantial reduction in pain and bruxism as well as improvement in sleep quality. Symptom reduction fluctuated with life stress issues and with adjustment in both peripheral and neurofeedback protocols. The success of this treatment allowed the client to avoid radical surgery (severing of the trigeminal nerve) and to discontinue use of propoxyphene napsylate/apap 100/650 mg. In a 13-month follow-up, the client reports having an active life style and

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managing her pain quite well on 20 mg of tramadol (Ultram) every 12 hours as long as she uses her self-regulation techniques.

Conclusion. This case study suggests that a multi-modal approach of neurofeedback, peripheral biofeedback, stress management and counseling was clinically efficacious in treating the symptoms of this difficult and painful condition.

KEYWORDS. Trigeminal neuralgia, neurofeedback, peripheral biofeedback

INTRODUCTION

Trigeminal neuralgia (TN) or tic douloureux is one of the most painful conditions known. Characterized by brief episodes of intense, stabbing, electrical shock type pain in the face, the pain (which can be temporarily disabling) comes on spontaneously or may be triggered by light touch, talking, eating, drinking, chewing, tooth brushing, hair combing, water from a shower, kissing or changes in temperature (i.e., cold; Tatter, 2002). The estimated prevalence of TN is 100 to 200 per 100,000 individuals. There are approximately 14,000 new sufferers of TN diagnosed each year in the United States (Brisman, 2002). The average age of onset is between 50 and 60 years of age. TN onset is more common in the later stages of life (50-70 years) but can occur in young adults and in children as well. Women are twice as likely to develop TN as men. TN is frequently a comorbidity in multiple sclerosis (Love & Coakham, 2001).

Individuals with TN often have endured years of suffering and unsuccessful treatments before being accurately diagnosed. The variety of conditions frequently mistaken for TN include migraine headache, myofascial pain, idiopathic facial pain, temporal arteritis, ophthalmic pain syndromes, paranasal sinus infections, various dental disorders, and temporomandibular joint dysfunction (Kaufmann, 2002).

When an attack occurs, most TN sufferers seek complete stillness and quiet in the hope of averting more pain. Because of the pain, sufferers often exhibit a painful wince. Years ago, TN was confused with sudden attacks of seizures which led to the term tic douloureux or neuralgia epileptiforme. Attacks usually do not occur during sleep; however, the

pain may be either exacerbated or decreased by being in a specific position, leaning or lying. The pain usually does not move to the opposite side of the face. Bilateral TN (pain occurring on the both sides of the face) occurs in only two percent of the TN population (Kaufman & Patel, 2002).

Common physician-ordered treatments fall into two categories: medications and surgery. Anti-convulsants such as carbamazepine (Tegretol), phenytoin (Dilantin) and gabapentin (Neurontin) are primary choices for initial treatment (Das & Saha, 2001). Lioresal (Baclofen) may not be as effective as Tegretol or Dilantin but is frequently used in combination with these medications. After the outset of treatment, the dose is usually increased as needed and tolerated. Medication is usually effective. If not, combinations of these medications are tried. Approximately 50% of sufferers become dissatisfied with the medication due to negative side effects or ineffective pain control. The next consideration is surgery consisting of the following choices: microvascular decompression (Tyler-Kabara et al., 2002; Barker, Jannetta, Bissonette, Larkins, & Jho, 1996), nerve injury/destructive procedures (rhizotomies) including percutaneous glycerol rhizotomy, percutaneous balloon compression rhizotomy (Skirving & Dan, 2001), radiofrequency rhizotomy, stereotactic radiosurgery–gamma knife (Pollock et al., 2000; Kao, 2002), peripheral trigeminal nerve blocks, sectioning and avulsions and microsurgical rhizotomy. These choices carry the following risks: (a) general and frequent occurrence of facial numbness, sometimes permanent, (b) loss of sensation to the cornea that can lead to blindness (Egan, Pless, & Shults, 2001), (c) loss of hearing (Strauss, Naraghi, Bischoff, Huk, & Romstock, 2000), (d) loss of chewing strength on the side of treatment (Yoon, Wiles, Miles, & Nurmikko, 1999), and (e) the general risks of surgery, post-operative infection, stroke, bleeding and swelling (Kaufmann & Patel, 2001; Brisman, 2002). Alternative treatments such as acupuncture have had mixed results across the spectrum of TN sufferers, but it has resulted in pain relief for some (Beppu, Sato, Amemiya, & Tode, 1992).

Subject. A 46-year-old nurse heard of biofeedback for pain control and presented herself for peripheral biofeedback training seeking relief from symptoms of trigeminal neuralgia of 15 months duration. Related symptoms included fatigue from restless sleep and poor sleep maintenance (i.e., waking after five to six hours of restless sleep) and bruxism. When her pain symptoms began, she thought she had a sinus or ear infection. When treatment did not resolve the pain, she had a root canal which did not relieve the pain either. Initially, she had good results with

acupuncture, but later it became ineffective. She had also tried massage and healing touch with only marginal symptom improvement. When the pharmaceutical intervention was initiated, the anti-seizure medications made her feel "awful" (nauseated and fuzzy). At times she appeared as if she were drunk and the medications did not provide substantial pain relief. Initially, her pain was more localized but as time progressed, the lightning-type intense pain became more diffuse. When she presented for biofeedback training, she had been taking the following medications: levothyroxine sodium (Synthroid), ethinyl estradiol/levonorgestrel (Trivora), amitriptyline (Elavil) and propoxyphene napsylate/apap 100/650 mg (Darvocet-N100) for the past year. Her neurologist's next planned intervention was to sever the trigeminal nerve.

At the outset of biofeedback treatment, the client was a divorced mother with three children. (She is now married.) She has a master's degree, is employed full-time in a professional position. Pertinent history includes being frequently slapped on the left side of her face as a child by her right-handed, physically and emotionally abusive mother. She also remembers being slapped by the nuns at Catholic school. She has had trauma to the left side of her head resulting from a motor vehicle accident. Additionally, as a child, she had lost consciousness and required stitches as a result of someone throwing a brick which struck her on the forehead. The client describes herself as having very high expectations of herself and indicates that she drives herself in her work and in her personal life.

METHOD

The client initially received six sessions of peripheral biofeedback (J & J, I-330 EMG and respiration only) with diaphragmatic breathing training and stress management included. At the end of the assessment session, the client was given an audio cassette tape containing instructions for "Deep Muscle Progressive Awareness Training." In her second session, she reported her back hurt from using the tape and she offered that she believed it was because "I am so tense." Her massage therapist had commented in the past that it was difficult to massage her because her "back was very tight." The therapist's standard muscle relaxation and EMG biofeedback protocol was used in this second session to address clenching, grinding and other unnecessary muscle tension in the masseter and facial muscles. After reading several educational articles on stress management given to her in her first session, the client

commented that she recognized the importance of getting "balance in her life." She acknowledged the need to "get off the fast track and slow down." She reported that her sleep was slightly better and that she had used less pain medication during that week.

In the third session, the client reported increased awareness of frequent tension/clenching in her masseter muscles during the day and biting the inside of her cheeks. When asked about this in the previous session, she denied daytime clenching. However, she acknowledged that she has worn a dental splint at night since childhood because of bruxism.

In the subsequent sessions, biofeedback enhanced relaxation techniques were taught that addressed tension in the cervical, upper and mid-trapezius and back muscles. As she became more aware of the tension in her body and then relaxed, she initially reported a new burning sensation in the left cervical and upper trapezius muscles. With continued relaxation and awareness training, this new pain gradually dissipated. Diaphragmatic breathing was taught. Problem solving counseling was used throughout her treatment focusing on her family of origin issues, failure of her first marriage, her parenting and discipline techniques and issues in her relationship with her fiancée.

By her fourth session, the client had become quite proficient in reducing the tension in her cervical and upper trapezius muscles. Though she responded well to muscle awareness and relaxation training, it was still difficult for her to slow down from her hurried and pressured lifestyle. In her sixth session, she reported having had TN pain on right side of her face in the previous week. This frightened her since previously she had pain only on the left side. (Recall that only two percent of TN sufferers experience pain on the opposite side.)

Neurofeedback was begun at the seventh session with the Neuro-Cybernetics system (manufactured by EEG Spectrum International in Canoga Park, CA). The pain had returned to the left side only. However, in later sessions she did report brief flare-ups of pain on the right side when her stress and tension levels were high. In accordance with the Othmer protocol recommendations for TN, a T4 placement referenced to A2 with the ground at A1 was used (referred to as T4-A2; Othmer, Othmer, & Kaiser, 1999). The standard Othmer protocols involve reinforcement of EEG spectral amplitudes on the sensorimotor strip. Typically 3 Hz wide bands are reinforced, with simultaneous inhibits of excessive high and low frequency signals. Reinforcement is typically at a higher frequency on the left hemisphere than the right (usually 3 Hz). Reward frequencies are titrated on the basis of the client's experience both dur-

ing the session and post-session with regard to alertness, mood and sense of calmness or tension. Inhibit filters of 2-7 Hz and 22-30 Hz were chosen based on the therapist's past experience with pain clients. Reviewing the spectral display after the session suggested the 2-7 Hz filter was an appropriate inhibit choice. Even though the Othmer protocol suggested starting at 12-15 Hz, a low reward frequency of 7.5-10.5 Hz was chosen instead in an attempt to relieve pain, or at the least, not exacerbate the pain. This lower frequency was chosen due to the therapist's past experience with pain clients. The concern was that a higher frequency might increase the pain. Reinforcement was initially given by playing "Pacman," a video game which "beeps" when the training criteria have been met. (In later sessions, a variety of non-competitive computer games were utilized.) At the end of twelve minutes in the first neurofeedback session, the client said the feeling changed from intense pressure on her left mastoid and burning pain on the left side of her face and ear to a feeling as if novocain was wearing off in that area. She reported that the pain levels decreased from "4" to "1" (on a scale of "1" to "7" with "7" being severe pain). She stated, "I know something is happening."

Unfortunately, in the eighth (second neurofeedback) session the client reported that the pain had returned and that she had difficulty staying asleep. Per the Othmer protocols for sleep maintenance, a C3 placement referenced to A1 with the ground at A2 was added for three minutes (i.e., C3-A1). Inhibit frequencies were 2-7 Hz and 22-30 Hz. Again, because the therapist was concerned about possible increased pain when training at a higher frequency (Othmer recommends an initial trial of 15-18 Hz at C3), the reward frequency chosen was 12-15 Hz. The T4-A2 placement previously mentioned was also used for 12 minutes which again resulted in a reduction of pain pre- and post-session. In the next session, the client reported that her sleep was deeper and she was more rested in the morning although she still awoke frequently during the night which she attributed to years of being a single mother, getting up and checking on her children in the middle of the night. Because she was sleeping better, she had voluntarily discontinued the amitriptyline. She had less of the jolting pain and no sensations of her skin crawling, so she reduced her use of propoxyphene napsylate/apap. During this session while doing the T4-A2 placement with 7-10 Hz reward, 2-7 Hz and 22-30 Hz inhibit, she began to have an itchy feeling in her face (but not in proximity to where the electrodes, prep or paste were).

This protocol was used in the next six neurofeedback sessions resulting in less pain and feeling more relaxation. She continued to have the

itchiness on her face during and at the end of training. She also reported the pain became more localized (less diffuse), usually in her left cheekbone, teeth and gums (where she had first noticed the pain) and that the pain was less intense at the end of each training session.

The client reported sleeping better during the next few sessions even though she was having significant difficulty with her family life. Spending a holiday with her emotionally abusive mother resulted in recurrence of increased pain and sleep symptoms. Stress management and counseling were incorporated into her sessions to address work and family issues. Setting better boundaries in her life was important to her continued progress. Only the T4-A2 neurofeedback placement was used in the next four sessions due to a lack of time with a portion of each session devoted to the problem solving counseling. During the next four sessions, the reward frequency was gradually increased in an attempt to increase the benefits of training. Initial attempts to increase the frequency resulted in increased pain and anxiety. However, by the twelfth session, she was getting better results with the reward frequency at T4-A2, 11-14 Hz (versus 7-10 Hz), 2-7 Hz and 22-30 Hz inhibit.

In an attempt to achieve longer and improved pain relief, the updated Othmer bipolar inter-hemispheric training protocol for TN was initiated (Othmer & Othmer, 2002). This involves training of the interaction between homologous sites of C3 and C4 or T3 and T4. The rationale for this approach is given in the Appendix. In this protocol, one usually begins with a reward frequency of 12-15 Hz. The optimum frequency is discovered by increasing or decreasing the frequency by 1 Hz according to the client's positive response. Additional fine tuning sometimes requires .5 Hz adjustment. In the following session, T3-T4 was used with the same inhibit filters (2-7 Hz and 22-30 Hz). As the frequency was gradually reduced to 7.5-10.5 Hz, the client reported a dramatic decrease in pain after fifteen minutes of training in the first trial of this placement. By the end of the session, her pain level was "1." In this session, the client reported a reversal in the progression of pain and other symptoms such as itching and tingling. It seemed to her that the symptoms were regressing in reverse order of their original onset. By the fourteenth session, over-all pain levels and nausea from the pain had lessened substantially in between sessions. Once again she reduced her propoxyphene napsylate/apap use. T3-T4 was used predominantly thereafter and almost always resulted in a dramatic reduction in pain in each of the remaining neurofeedback sessions and between sessions.

Around the time of the fifteenth session, the client had gotten a terrible chest cold. The TN pain was "3," but one propoxyphene napsylate/apap

modulated it quite well. However, sleep onset and staying asleep had become an issue again and she had a "4" headache. After again reviewing the new Othmer protocols, C3-C4 12-15 Hz reward, 2-7 Hz and 22-30 Hz inhibit was tried for six minutes after T3-T4 7.5-10.5 Hz reward, 2-7 Hz and 22-30 Hz inhibit for 12 minutes. Her headache was gone by the end of that session. Later, her cold turned into bronchitis and she did not respond well to the prescribed antibiotic. This complicated the treatment process. In the following sessions, the C3-C4 placement resulted in less positive effects of training and was abandoned. After recovery from her illness, using C3-A1 14-17 Hz reward, 2-7 and 22-30 Hz inhibit for six minutes and T3-T4, 8.5-11.5 Hz reward, 2-7 Hz and 22-30 Hz inhibit for 15 minutes again resulted in reduction of pain from "3" to "0" pre- to post-session and good sleep results.

By her twentieth neurofeedback session, she was voluntarily withdrawing from propoxyphene napsylate/apap. Altering the montage to C3-A1 and using the reinforcement contingencies of inhibition of 2-7 Hz and 22-30 Hz and reward of 13-16 Hz increase for six minutes, C4-A2 with 10-13 Hz reward and 2-7 Hz and 22-30 Hz inhibits, six minutes and T3-T4 with 8.5-11.5 Hz reward, 2-7 Hz and 22-30 Hz inhibit for six minutes jointly resulted in better sleep onset and maintenance as well as pain control. The reward frequency was increased and/or decreased for maximum positive effects during the session per the Othmer training protocols and the therapist's past experience.

At this point, the therapist observed cervical and upper trapezius muscle bracing. The dynamic EMG training program was resumed. One active electrode was placed on the superior ridge of the trapezius half-way between the acromion and the spinus process of the seventh cervical vertebra. A second active electrode was placed on the cervical paraspinal at approximately C4. The ground was equidistant between them. The dynamic EMG biofeedback program involves monitoring activities of daily living with EMG biofeedback, in contrast to traditional EMG biofeedback which is usually conducted while sitting in a recliner at rest. The goal was minimal but effective and efficient recruitment of muscles for each task and more importantly, quick recovery or shut off of the muscles after task completion. This protocol includes monitoring separately the left and right cervical and upper trapezius muscles while simulating activities such as working at a desk and computer, using a telephone, driving a vehicle, standing, etc. Instruction was also given in postural alignment techniques while relaxing non-essential postural muscles (Middaugh, 1998). Also, a technique to strengthen the muscles of the middle trapezius while maintaining relaxation in the upper

trapezius was taught (Taylor, 1999). There is documentation that this technique can assist in alleviating pain associated with trigger points in the intrascapular and mid-trapezius region. The client had several trigger points under the left scapula that might have played a part in triggering her trigeminal pain.

After four dynamic EMG sessions, the client's TN pain symptoms were lessened in concert with the absence of muscle bracing. She was also taught hand-warming techniques. Frequently neurofeedback was done while also giving EMG biofeedback to her about the muscle activity on the left and right cervical and upper trapezius muscles with an EMG (J & J M-53 with light bar and integrator set on a two-second integration period) sitting next to the neurofeedback monitor. As she resumed setting better limits in her work and family life while continuing with the neurofeedback program (T3-T4, 9-12 Hz reward, 2-7 Hz and 22-30 Hz inhibit), her pain was better controlled.

Pre-treatment EMG readings on the upper trapezius and cervical muscles averaged 4.4 microvolts (μv) on the left and 8.5 μv on the right. At the end of treatment, average readings on the left were 2.46 μv and 2.66 μv on the right. Relevant pre- and post-EEG microvolt values are presented in Table 1. These values are the measured averages for the first and last sessions. Low frequency refers to the low frequency inhibit filter (2-7 Hz) and the high frequency to the high frequency inhibit filter (22-30 Hz). The C3-A1 reward filter was 12-15 Hz and for T3-T4 it was

TABLE 1. EEG Microvolt Values Pre- and Post-Training.

	Pre	**Post**
C3-A1		
Low Frequency	18.0	18.2
Reward Frequency	7.9	9.0
High Frequency	5.5	5.2
T3-T4		
Low Frequency	23.2	11.9
Reward Frequency	14.8	9.6
High Frequency	5.3	9.4

9-12 Hz. The criteria for inhibition were based on review of the spectral display. Threshold settings were set at an average of about 10% time over threshold in the 2-7 Hz region and about 5% time over threshold in the high-frequency region. The criteria for reward were based on positive response from the client on the basis of both in-session reporting and response between sessions. The reward threshold was set to yield a training success of 85 to 90% of time above threshold. Both reward and inhibit thresholds were adjusted as necessary to maintain these criteria.

After 23 neurofeedback sessions and 10 sessions of peripheral biofeedback, the client had withdrawn from propoxyphene napsylate/apap 100/650 mg and was using only tramadol (Ultram) 50 mg for the pain. By the 29th neurofeedback session, she was using only one-half tramadol (25 mg) per day.

Follow-up at six- and thirteen-month intervals. In a six-month follow-up, the client reported temporary episodes of increased pain in certain situations. Coughing induced by respiratory illness, dealing with her abusive mother, a cool breeze, touch and dysponesis (muscle bracing) in the neck and shoulder muscles can still initiate or aggravate the pain. However, she reported much better ability to manage her pain. The client emphasized her strong feeling that incorporating the peripheral biofeedback techniques into the neurofeedback program were an integral part of her success in managing this very painful condition. She was using one-half (25 mg) to one (50 mg) tramadol per day as needed. Most importantly in her view, she has been able to avoid the facial surgery which she dreaded and which involved a certain degree of risk as noted earlier.

In a thirteen-month follow-up, the client reported continued use of tramadol 25 mg every 12 hours. She manages the pain quite well as long as she maintains her program of stress management and relaxation techniques and is able to avoid cold temperatures. She reports that sleep and bruxism are no longer a problem. In the two weeks prior to the therapist's follow-up call, she had opted for physical therapy at her hospital work site for convenience because she had resumed her hectic life style and her pain levels had increased. She reported that stretching out her neck muscles was the most helpful aspect of the physical therapy and that she intends to return for occasional neurofeedback training for pain relief maintenance.

DISCUSSION AND CONCLUSIONS

The client's trigeminal neuralgia pain dramatically diminished over the course of 37 weeks. Neurofeedback training (29 sessions) was apparently a key component of this success, especially the T3-T4 placement. Bruxism was also positively impacted. Sleep maintenance improved after the initiation of C3-A1 neurofeedback. The client significantly improved her self-regulation skills through peripheral biofeedback training (10 sessions).

This therapist (based on her training and experience with other pain clients) was initially reluctant to begin neurofeedback training on the left side (C3 or T3) out of concern for the risk of increasing her pain. However, this case suggests that C3 training (for sleep maintenance) in conjunction with T3-T4 (for pain) was more helpful in resolving symptoms than just using T4-A2. For the future, the recommendation is to begin with T3-T4 and add in C3 or other placements as symptoms warrant. Also, frequencies need to be tailored not only to each individual, but as this case study suggests, they need to be adjusted incrementally up or down throughout the neurofeedback process based on the client's response to training. The amount of time training during each session should also be tailored to the client.

The issue of itching of the face during neurofeedback training was most likely not due to electrode prep or paste. It was probably due to increased blood flow into the facial area.

This case study suggests that a multi-modal approach of neurofeedback, peripheral biofeedback, stress management and counseling was clinically efficacious in treating this difficult and painful condition. If confirmed by further research, these results collectively may offer a worthy complement to anti-seizure and pain medications, as well as represent an alternative that should be tried before resorting to surgery in the treatment of trigeminal neuralgia.

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APPENDIX

In a personal communication with Siegfried Othmer (April 5, 2003), he provided a rationale for using the T3-T4 protocol as well as for the increased amplitude of some of the inhibited frequencies and the decreased amplitude of some of the reward frequencies which would not be the anticipated result of the training.

"In inter-hemispheric training using bipolar montage on homologous sites, the reward waveform is most strongly driven by the phase relationship between the two sites at the center frequency of the reward band. It is also driven by the instantaneous amplitudes at the two sites. With respect to phase, the in-phase condition is effectively discouraged, and an opposite-phase condition is relatively favored. With respect to amplitude, the training rewards a decrease in the comodulation of the two sites. (Comodulation here refers to the covariance of the spectral amplitudes.) Taking both the amplitude and phase information together, it is most economical to say that the training favors the reduction in coherence between the two sites. The coherence is determined over the bandpass of the reward filter. In this instance, the reward waveform is derived from an Infinite Impulse Response (IIR) elliptical filter with 3 Hz bandwidth and two poles.

The theoretical underpinnings for this approach are modest at this time. The most obvious rationale is that deviations in the EEG tend to be such as to drive the system toward higher coherence. In these instances, down-training of excess coherence would be an obvious point of departure. However, the particular protocol appears to be effective even in cases where we are not confronting an obvious EEG deviation. The rationale, therefore, has to be more comprehensive.

It can be argued parsimoniously that the brain must organize timing at the relevant frequencies even between the hemispheres, and that this particular neurofeedback protocol presents a direct challenge to all the mechanisms that govern such timing. One may see the neurofeedback simply as a challenge that moves the cortex out of the intended state to a slightly different state. That may initiate active responses by the brain to restore the intended state. In this view, neurofeedback is seen as a very subtle, benign, targeted brain challenge that evokes the brain's response in two senses–first, in the direction of the reward and second, in response to the resulting change in state. The repetition of that action-reaction dynamic may serve to strengthen the underlying brain networks that govern cortical timing relationships.

It has been found empirically that the inter-hemispheric bipolar training is particularly relevant to cases in which the brain appears to be relatively unstable. An extremely rapid response to the neurofeedback intervention can usually be taken as an indicator of such instability. The pain patient discussed herein is a case in point, and a resort to the inter-hemispheric training was indeed found to be worthwhile" (Siegfried Othmer).