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Attention and Neurofeedback Synchrony Training: Clinical Results and Their Significance

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ABSTRACT.
Background. Previous research on information processing by the primate brain prompted further investigation of phase synchronized alpha brain wave activity at five loci in humans. The results of this investigation indicated that a particular form of attention was associated with production of whole brain synchrony.
Method. Patients were treated with a dual approach, a systematic program of attention training coupled with the regular practice of multi-channel alpha phase synchrony training. One hundred thirty-two clinical patients were treated for a variety of stress related symptom categories by six therapists in different locations. Patients were rated for symptom intensity, frequency and duration.
Results. It was found that learning to develop this particular form of attention, coupled with the regular practice of multi-channel alpha phase synchrony were effective in resolving many common stress related disorders. Analysis of 132 cases using this dual approach found that more than 90 percent of the patients reported an alleviation of symptoms. These positive results were found with stress-induced headache, joint pain, and gastrointestinal disease.
Conclusion. The authors propose that there exists a common mechanism operating in these widely different successful applications; to wit, attentional flexibility, which is achieved through systematic practice of audio taped attention exercises and neurofeedback phase synchrony training. Patients who participated in this program generally reported experiencing a release from their symptoms and from emotional conditioned responses in favor of more flexibility and more stable homeostasis. The significance of this "release experience" is discussed and attention-neurofeedback training is compared to other interventions, which rely exclusively on peripheral modalities of biofeedback training.

KEYWORDS. Attention, biofeedback, neurofeedback, EEG phase synchrony, headaches, hypertension, irritable bowel syndrome, dissolving pain

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INTRODUCTION

From its first clinical applications, certain types of biofeedback training were directly related to the patient's specific symptoms. To illustrate electromyographic (EMG) feedback was used to alleviate muscle spasm pain (Beaty & Haynes, 1979), while blood pressure feedback and bronchial resistance feedback were developed to combat hypertension and asthma (Blanchard & Ahles, 1979). In other cases, the modality or method of biofeedback training was not directly related to the symptoms that the patient sought to alleviate. For example, EMG and skin temperature biofeedback were often employed to alleviate gastrointestinal (GI) disease presumably by improving the central nervous system's (CNS) basic response to stress (Schwartz, 1977; Blanchard, 1991). Others argued that electroencephalographic (EEG) biofeedback was a more direct and, therefore, a more effective means of improving CNS reactions to stress (Kamiya, 1969; Fehmi & Selzer, 1980; Lubar, 1983). However, this concept was criticized by others (Blanchard & Young, 1974; Sternian, 1977; Basmajian, 1983). There is a continuing debate regarding which method of biofeedback training is the most effective clinical intervention (Winer, 1977; Frumkin, 1978; Blanchard & Ahles, 1979; Blanchard, 1991).

Since 1967 research and clinical observations have emphasized the importance of training the patients to change their CNS response to stress and its symptoms so as to permit rapid return to homeostasis (Fehmi & Selzer, 1980; Fehmi, in press). Learning a modified CNS response was observed to resolve and prevent both peripheral and CNS symptoms. A phase synchrony-training program was derived from observations made in the course of earlier primate research on the importance of synchronized neural activity for effective information processing by the CNS (Fehmi, Adkins & Lindsley, 1969; Adkins, Fehmi & Lindsley, 1969). Attention and neurofeedback studies of various forms of synchronized brain wave activity in humans (Fehmi & Selzer, 1980; Fehmi, in press) led to the following observations:

1. The capacity to generate alpha waves, phase synchronized among various lobes of the brain, could be learned through practice with the appropriate biofeedback instruments.
2. Production of synchronized brain wave activity is associated with a particular effortless form of attention and a unique set of attention training instructions.
3. The value of attention training is based upon the observation that rigidity of adhering to specific attention styles determines the magnitude of the stress related symptoms more than does the content nature of the situation itself. In other words, it is not only what happens, but also how one attends to it, that determines the level of stress response, and the associated sense of well or ill being.
4. Learning to integrate various attention modes and skills into daily life is an especially valuable aspect of the training program (Fehmi, 1978; Fehmi & Selzer, 1980).
5. Practice of increasing and decreasing control of attention and associated brain wave activity produced significant health benefits for both peripheral and CNS symptoms (Fehmi & Selzer, 1980; Fehmi, in press).

These discoveries were systematized (Fehmi, 1978; Fehmi & Selzer, 1980) to define a form of attention flexibility training for treatment of a wide range of stress induced chronic diseases. It should be noted here that the attentional processes resulting from verbally guided forms of attention training in combination with neurofeedback phase synchrony training, the combination hereafter called "attention-neurofeedback," appeared to be different from the attentional response to "relaxation" protocols known at that time. For example, Jacobsen's progressive muscle relaxation (Jacobson, 1938) or Autogenic phrases (Farhion, 1977; Luthe, 1969), or the "relaxation response" (Benson, 1974) involve different physiological effects than attention-neurofeedback training, and appear to produce different results, as discussed below.

There is an impression among some physicians that biofeedback therapy is only marginally and temporarily beneficial (Farhion, 1991) even though its clinical effectiveness and cost effectiveness has been confirmed in published research many times (Schneider, 1987; Shellenburger, Amar, Schneider & Stewart, 1994). However, the biofeedback literature (Schneider, 1987) does indicate that there can be wide variations in the effectiveness of short duration treatment when using peripheral modalities of biofeedback. Other reviews of biofeedback studies demonstrate that efficacy can vary from only marginal to a lasting resolution of most symptoms, even when apparently similar peripheral training programs were used (Hatch, 1987; Middaugh, 1990). Biofeedback training to criterion levels of performance has recently been related to long-term efficacy and success (Shellenburger et al., 1994).

The following study of clinical data evaluates the efficacy of a single standardized general CNS oriented attention and neurofeedback training program for a range of clinical applications. The relevance of the findings regarding the efficacy of both peripheral and central forms of biofeedback is discussed.

METHOD

During the period from 1977 to 1982 the attention-neurofeedback training protocol was used at a number of clinics in the New Jersey area. All patients diagnosed as appropriate for biofeedback therapy presented detailed medical histories and a list of all of their presenting symptoms. The criteria used for acceptance of patients for treatment included one or more of the following:

1. The patient's symptoms had failed to respond satisfactorily to standard medical treatment.
2. The patients wanted to discontinue an extended treatment with medications in many cases with concerns about undesirable side effects.
3. The patient's medical and personal histories indicated, to either their medical physician or to the biofeedback therapist, that their disease was aggravated by stress.

The retained records of 780 patients of all types from five clinics and seven therapists for a five-year period formed the base from which records were selected for inclusion in this analysis. Patient records were sorted from their alphabetical storage for acceptance into

this study strictly on the basis of meeting all of the following requirements:

1. There existed a statement of the initial symptoms and their aggravation by stress.
2. The patient participated in the program for one month or longer.
3. There was written indication showing the status of the symptoms over time
   (a) by learning voluntary control of symptoms,
   (b) records showing frequency, duration or severity of the symptoms,or
   (c) a final report to their medical primary care provider (PCP) describing the impact of the treatment upon specific presenting symptoms.

There were a total of 132 case records meeting these criteria, which fall into three symptom categories: common stress induced headache, back pain, and gastrointestinal disorders.

PROCEDURE

The benefits to the patients reported in the case histories were given a subjective rating from zero to ten based on the therapist's written records describing the patient's response to treatment. The rater was not a clinician and did not participate in treatment. Four variables were reviewed to develop ratings: frequency of symptoms, intensity of symptoms, duration of symptoms and ability to effect in part the dissolution of the intensity of symptoms. These were considered in the order presented above. When no change occurred in any of these variables, a zero rating was given. When frequency reduced some percent from presenting frequency, the rating was directly commensurate with percent frequency decrease. The zero to ten-scale rating process is further described below. When frequency did not change, then intensity was considered next. The percent reduction in intensity from presenting intensity yields a value directly related to the assigned rating. When frequency and intensity did not change, duration was considered. Again, the percent reduction of symptom duration yields a value directly related to the assigned scale rating. Finally, when the intensity of the symptoms responded to symptom dissolving techniques in the clinic or at home, without general reduction in symptoms over time, a rating of "one" was given. A rating of "one" was given when there was some evidence that the patient was learning to control something beneficial in relation to his or her symptoms, or if there was some sufficiently detailed evidence of symptom reduction of five percent or less. A rating of "two" was given if evidence of symptom reduction was between 5 to 25 percent, but most of the patient's symptoms still remained. A rating of "three" or "four" was given if there was evidence of symptom reduction of 25 to 50 percent, although the patient still retained 50 percent or more of his symptoms. A rating of "five," "six," or "seven" was given if increasing degrees of symptom reduction were reported, 50, 60, 70 percent, respectively. A rating of "eight" or "nine" was given if 80 or 90 percent of the patient's symptoms were alleviated. A rating of "ten" was given if all, 100 percent, of the symptoms were resolved.

None of the therapists knew that the results of their therapy would be rated. The ratings were made ten years after treatment. The distribution of results developed by this rating procedure was compared to determine whether there were statistically significant

differences between different therapists or between different disease categories.

The same training approach was used for all patients. However, seven different therapists at six different clinics provided the therapy. Attention-neurofeedback training began with listening to a series of audio attention training tapes while being informed by sound and light feedback from a multi-channel brain wave training instrument as to the presence and amplitude of their own phase synchronous alpha wave activity. They were instructed to listen to the audio attention training tapes in such a way as to maintain the presence of the feedback signals at maximum levels. The center frequency of alpha activity was approximately 10 Hz with a band pass of 0.5 Hz. Phase synchrony was determined by electronically summing the analog brain activity from five scalp locations (Fehmi & Sundor, 1989; Fehmi, 1976, 1977). When the brain waves are in synchrony, the amplitude of their sum is larger. Thus, when the summed waves exceed the set threshold, the feedback (beeps and flashes) signals increased brain wave synchrony. Brain wave synchrony was measured using sensors at FPZ, at CZ, at OZ, T3, and T4 sites of the International 10120 System (Jasper, 1958; Valdez, 1985 a & b; Valdez, 1988).

The initial training goal was to learn how to listen to the tape-recorded exercises in such a way that the most light and tone feedback was produced. The presence of light flashes and beeps indicated above threshold levels of five channels of phase synchronous alpha brain waves. This combined approach of audio attention training and neurofeedback training orients the patient to listen effortlessly, at middle levels of arousal, by maintaining and gradually increasing the desired synchronous brain wave activity. Patients were also asked to listen to these audiotapes at home, at least twice daily, with the same attention that produced maximum levels of light and sound feedback in the clinic. A series of four taped attention exercises were presented over a four-week period, one exercise per week, culminating with an exercise called “dissolving pain” (Fehmi, 1978; Fehmi & Selzer, 1980). These tapes and discussion of the patient’s progress during clinic sessions de-emphasize the content of the patient’s experience and rather address directly the way they pay attention to the contents of their consciousness. The audiotapes are designed to impact four dimensions of attention: narrow, difuse, objective and immersed attention (Fehmi, in press). Clinical relevance and other associations to personal situational variables are seldom discussed after a one-hour “intake” session, unless the patient stated that the contents of consciousness (e.g., thoughts, feelings and emotions) interfered with home practice with audiotapes and could not be dissolved using the attention methods practiced.

In all cases the audiotape instructions included exercises in which patients learned to dissolve pain, a personal skill, which had been very important for many patients before the present study was undertaken. For others, as the home and office practice continued, the symptoms did not return and this pain dissolution skill was rarely needed. Further descriptions of the audio attention and neurofeedback procedures used are reported elsewhere (Fehmi, 1978; Fehmi & Selzer, 1980; Fehmi, in press; Fehmi & Sundor, 1989; Valdez 1985 a, 1985 b; Valdez 1988).

Subsequently, depending on progress and remaining symptoms, patients would be given attention instructions while practicing with thermal or other standard biofeedback instruments, such as galvanic skin response (GSR) or EMG. Patients would practice and return to neurofeedback training as soon as it was apparent to them that the same attention and CNS skills they learned, which produced brain wave phase synchrony and

associated feedback signals, also warmed their hands, and reduced their muscle tension and perspiration levels. After attention control of these peripheral processes was learned to criterion, the patient was encouraged, with neurofeedback, to alternately increase and decrease brain phase synchrony, voluntarily upon request. The training objective was to teach the patient attentional flexibility, how to achieve and maintain, for gradually extended periods, each of a variety of styles of attention (Fehmi, in press; Fehmi, 1978; Fehmi & Selzer, 1980). A long-term goal of training was for the development of an attention process in which all four styles of attention are simultaneously represented, and for this to become a habitual and effortless way of paying attention, as it gradually transfers to daily life activity.

Those patients using medications were encouraged to continue to follow their physician's treatment recommendations. Discussions regarding withdrawal from medication with their physician were deferred until symptom relief allowed medication reduction because it was perceived as unnecessary by the patient and physician.

RESULTS

The results showing the overall efficacy of treatment are presented in Table 1. Table 1 indicates that more than 75 percent of the patients received some health benefits. Table 2 compares the results obtained by different therapists by examining the incidence of failure (i.e., a rating of zero) and the incidences of outstanding success (i.e., a rating of 8, 9, or 10) since these outcomes are the most clear. There were no significant differences in effectiveness between the therapists even though the training experience of the therapists varied widely.

The entire rating distributions of the listed therapists, shown in Figure 1 and Figure 2, illustrate the same result. That is, these rating distributions are not significantly different across therapists. The lowest probability for a significant difference between the complete distributions was for "A" versus others. This probability was 0.093 using the Mann-Whitney U test ($p = 0.05$ or less is required for statistical significance). The Mann-Whitney U Test was used for the complete distributions and the Chi-square Test for grouped results. Non-parametric analysis was employed since the data are not composed of equal intervals and the distributions are not normally distributed.

TABLE 1. Distribution of Efficacy Ratings for 132 Patients Receiving OPEN FOCUS-Neurofeedback Training

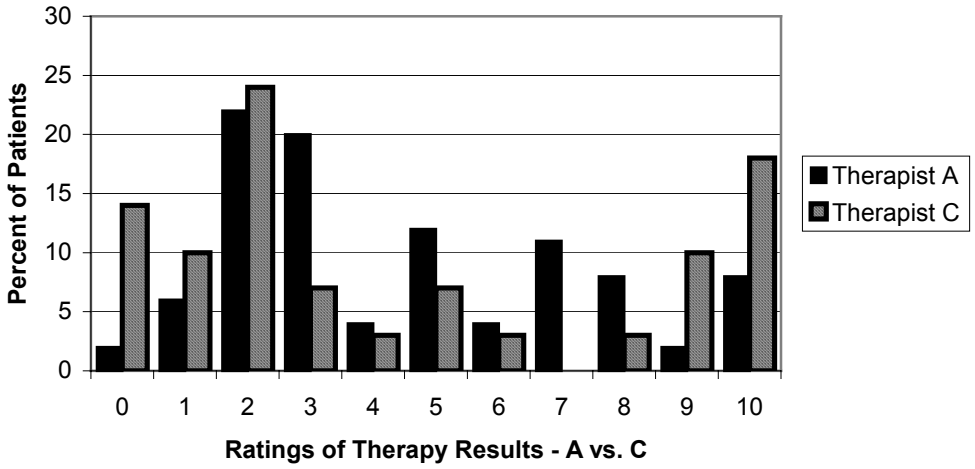
Rating	Efficacy
0	9%
1	14%
2	18%
3 or 4	17%
5, 6 or 7	17%
8, 9 or 10	25%

TABLE 2. Outcomes Comparison of Efficacy Results as a Function of Therapist

		0 Rating		8, 9 or 10 Rating	
Therapist	Total No. of Cases	No. of Cases	%	No. of Cases	
A	46	1	2	9	20
B	31	2	6	9	29
C	30	4	13	9	30
Others	25	5	20	6	24

FIGURE 1. Comparison of the Distributions of the Ratings of Therapy Results- Those Obtained by Therapist A vs. Therapist C

The vertical axis reflects the percentage of all patients treated by a given therapist who received a particular result rating as shown on the horizontal axis



The abbreviated distribution of results as a function of disease category, shown in Table 3, do not differ significantly whether the disorder is experienced in the gastrointestinal system, muscle joints or the head. For example, comparing the complete disease category distributions using the Mann-Whitney U test (see Figures 3 and 4), $p = 0.056$ for headaches vs. joint pain and 0.085 for headaches vs. GI disease.

When analyzed in the same way, the complete distributions of poor to excellent ratings were shown to be independent of the length of time the patients continued their office visits (see Figure 5). As one might expect, there were very few patients who continued for eight months or more who received no benefits by our rating system. In most instances these patients continued until they concluded that further office visits would not provide significant additional benefit. Patients are quite variable in the rate at

which they can acquire these skills, and are quite persistent in seeking further benefits. Of greater importance is the fact that 69 percent of the 78 patients achieving good to excellent results required more than three months of weekly office practice sessions to achieve these results. The remaining 31 percent of these patients required eight months or more. In no case was it reported that the program was terminated because, after some initial success, the patient's original symptoms returned. This was verified for 47 of these patients who were followed for seven months or more.

FIGURE 2. Comparison of the Distributions of the Ratings of Therapy Results-Therapists A vs. Others

The vertical axis reflects the percentage of all patients treated by a given therapist who received a particular result rating as shown on the horizontal axis

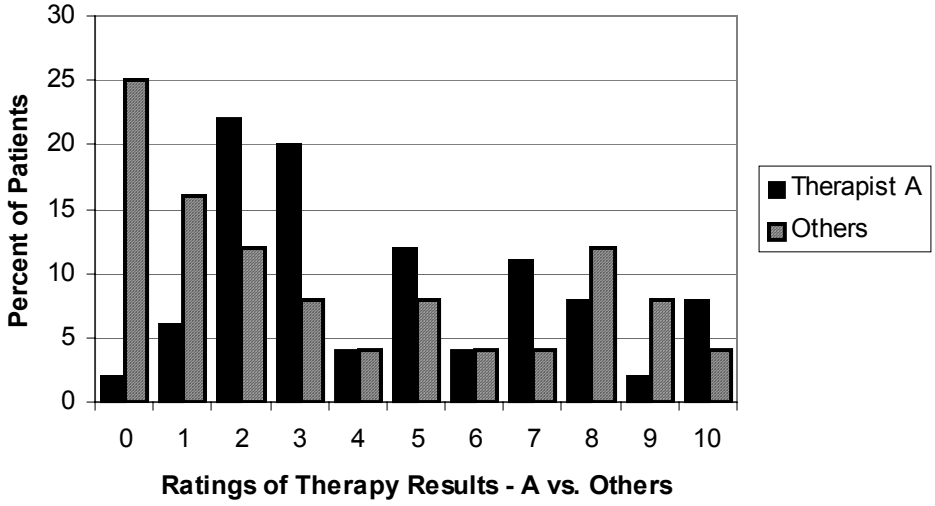


TABLE 3. Outcomes – Comparison of Efficacy Results as a Function of Disease Category

		0 Rating		8, 9 or 10 Rating	
Therapist	Total No. of Cases	No. of Cases	%	No. of Cases	
Headaches	44	1	2	19	43
Muscle/Joint Pain	32	2	6	6	19
GI Disease	23	3	13	6	26

FIGURE 3. Comparison of the Distributions of the Ratings of Therapy Results – Results with Headache Patients (HA) vs. Those with GI Disease

The vertical axis is the percent of all patients with a specified disease who achieved the results ratings shown on the horizontal axis

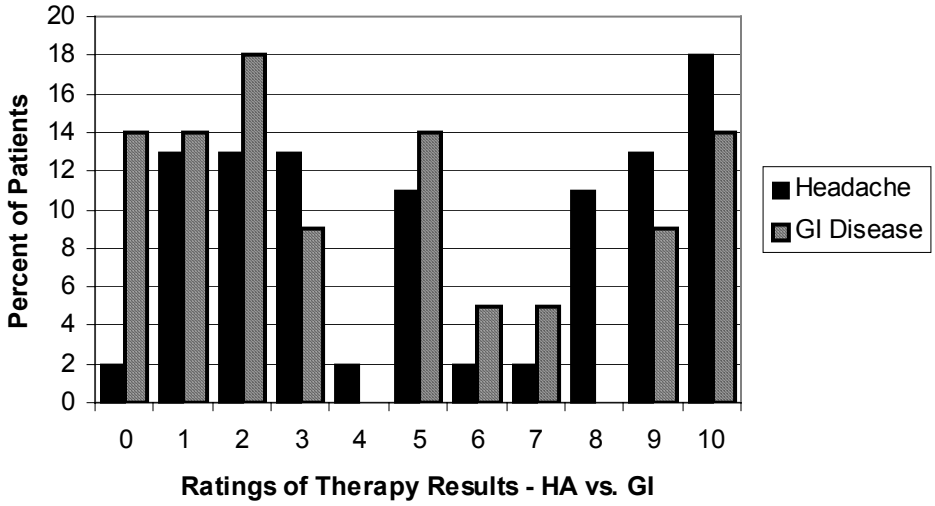


FIGURE 4. Comparison of the Distributions of the Ratings of Therapy Results – Results with Headache Patients (HA) vs. Those with Joint Pain (JP)

The vertical axis is the percent of all patients with a specified disease who achieved the results ratings shown on the horizontal axis.

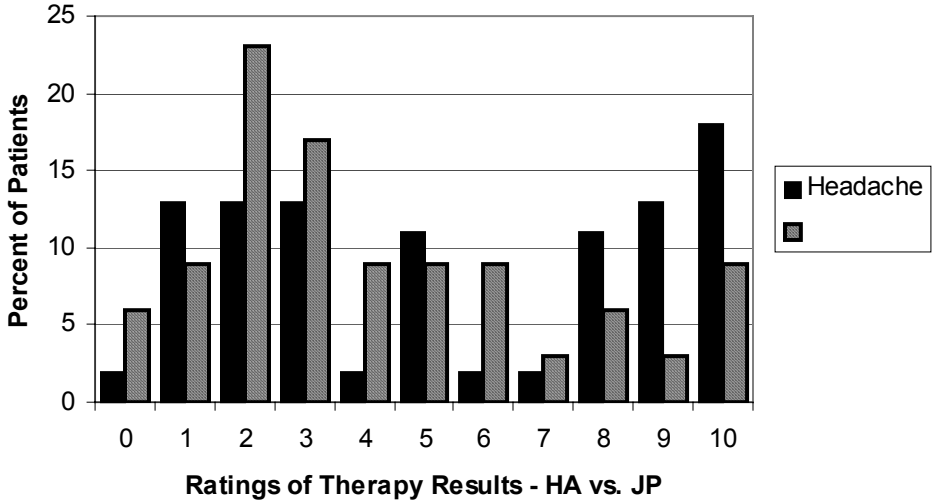
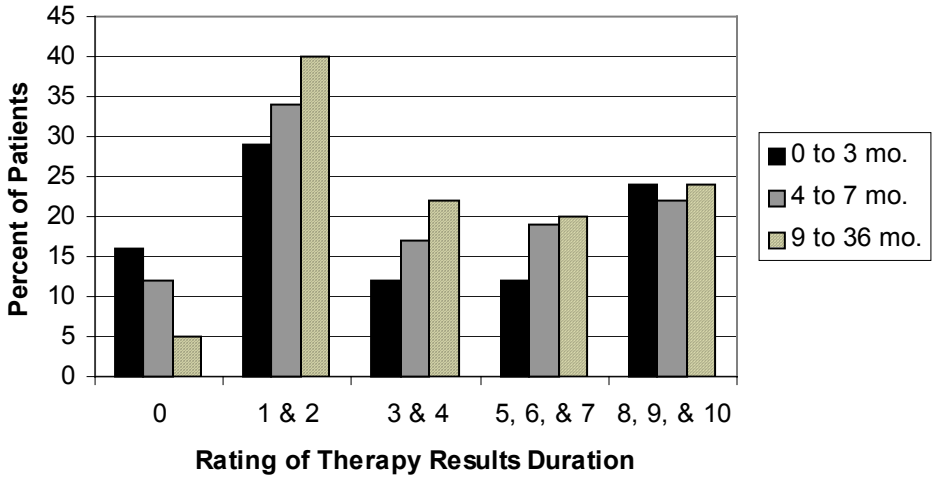


FIGURE 5. Comparison of the Distributions of the Ratings of Therapy Results- Those for Patients Receiving 1 to 3 Months of Therapy with Those Receiving 4 to 7 Months, and Those Receiving 8 to 36 Months

The vertical axis is the percent of all patients receiving treatment for a given duration who had the results ratings shown on the horizontal axis. '



DISCUSSION

Of the original 780 case histories, 648 did not meet all three of the criteria required for inclusion in this study. It is possible that this introduces some unintended bias into the results. For example, the short term (less than one month) patients were omitted and these undoubtedly included patients who decided, rightly or wrongly, that they were not going to be helped. It generally requires more than one month, four visits, for the training program to begin to be effective. In addition those records, which did not contain information concerning symptoms during the course of treatment, or at termination, were omitted. Undoubtedly some were cases where the treatment failed, even though there was no statement to that effect. This also may have introduced unintended bias in the results.

It has been noted that most of these patients had failed to respond satisfactorily to standard medical treatments. In most cases their symptoms had persisted for years, in spite of ongoing medical treatment. Thus, these patients may loosely be viewed as serving as their own control subjects. Furthermore, the skepticism, which resulted from the failure of previous treatments, mitigates against the forces of optimism associated with a placebo effect. In any case, the evidence presented may serve to motivate further controlled research.

The review of these clinical data from 132 patients and the experience derived from many hundreds of subsequent cases showed a somewhat typical sequence of patient responses. As a result of a change in attention toward broadening the scope of sensory awareness, and toward merging awareness with experience, while emphasizing body experience, patients experience a sensation of “letting go.” This can be an acute event or

a gradual realization that they no longer are as stressed, gripped, or as tense as they were before training. This "release" is not a directed goal. The goal of training is to address the source of accumulated tension, which we view to result from the unconscious effort to maintain habitual forms of focused attention. By reducing this largely unconscious bias toward focal attention and associated stress, which impacts all body systems and functions, a wide variety of stress-aggravated pathologies are benefited. This is supported by the results presented in Figures 3 and 4, and by the statistics reported in the results section, which indicates that headaches, joint pain and GI disease are similarly improved.

The release of general tension is rarely accompanied by a sudden emotional release, such as an abreaction (Marmor, 1980). When it occurs it is not induced by intentionally confronting past emotional trauma, or other resisted content, as in "one on one" or group psychotherapy.

Nor is it the result of a conscious decision to try to practice relaxing or "letting go" (Carrington, 1984). Similarly, only in very rare cases does understanding attention training on an exclusively intellectual or cognitive level lead to symptom resolution. Release is obtained through the systematic practice of attentional flexibility. This flexibility training supports the dissolution of gripping and other impediments to homeostatic processes. Successful outcomes are therefore, not surprisingly, directly related to the frequency of practice.

Many patients quickly observe that practice of non-habitual forms of attention leaves them feeling better in a variety of consistent ways. These "releases" become an on-going characteristic of attention flexibility training, which may be experienced also as a conscious broadening, and immersion of awareness. In contrast to many popular relaxation protocols, which emphasize focal, content-oriented cognitive procedures, attention flexibility training is a process-oriented approach which de-emphasizes focusing and the particular content of experience.

A controlled study using a variant of this attention-neurofeedback training protocol demonstrated enhanced academic performance of normal college students, along with a list of improved symptoms (Valdez, 1985, a, b; Valdez, 1988). Enhanced performance of job and social skills in adults is generally observed. Amateur, professional and Olympic athletes who have practiced this training program have observed improved performance of sports skills.

These reports, especially by highly ranked athletes, suggest that the process of attention has a significant effect even on intensely practiced, over-learned motor skills. The applications of this form of neurofeedback and attention training range from resolving stress induced or stress aggravated organic disease, to maintaining normal systemic health and to optimization of physical and mental function. The use of other forms of intensive neurofeedback training also yield a variety of clinically effective results, e.g., epilepsy (Sterman, 1982), attention deficit (Lubar & Lubar, 1984), treatment of addiction and posttraumatic stress syndrome (Peniston & Kulkosky, 1990).

The results listed in Table 1 show that most of the presenting symptoms of 57 out of 130 patients were completely eliminated and more than 75 percent of patients obtained some health benefits. These results are worthy of further research, particularly when they are compared to the available efficacy reports of many widely used pharmaceuticals for chronic headache (Schactel, 1990; Peters, 1983) and ulcers (Tagamet, 1993). These medications may be only 15 percent more effective than the placebo and they do not

prevent recurrence of these symptoms after they are discontinued. The majority of patients included in the study presented here had previously tried their physician's medication prescriptions, often for years, without satisfactory results, and often with negative side effects.

It was also found that learned attention skills and associated health benefits are independent of the skill or experience of the therapist (see Figures 1 and 2). This finding is consistent with the premise that the form of attention-neurofeedback training used here is not entirely the result of therapist-patient relationship variables. Rather it constitutes support for the efficacy of the training program itself. This is not to imply that better trained therapists would not excel at guiding patients to attentional flexibility. However, the capacity for return to attentional and physiological homeostasis through self-control of attention is something the patient learns and experiences for himself through his own practice. Self-control of brain synchrony is objectively demonstrated in the clinic to the patient by the voluntary practice of successful alternation of increasing and decreasing production of light and sound feedback.

Like locally acting drugs, peripheral biofeedback training in many cases, is only partially and temporarily effective, because it is not directed at affecting more fundamentally causative variables. When the patient only focuses on controlling a specific local or peripheral condition or symptom, he often reverts to his previous habitual maladaptive CNS response to stress. This is while at the same time continuing to maintain, for some period, the beneficial peripheral effects taught in his biofeedback training. For example, a patient might learn to reduce the tension in those muscles producing his back pain while reverting to his maladaptive general tensing response to his job situation. Continuing this example, since the patient received no training directed specifically to his generalized CNS response, his disease returns, perhaps evolving to a different peripheral form (e.g., tension headaches or TMJ). On this basis, the benefits of traditional peripheral biofeedback training could be limited and temporary in some cases, consistent with the reports cited previously. The present training protocol includes peripheral training with the goal of relating peripheral flexibility to control of attentional styles. Thus, within this protocol, peripheral training served as the occasion for additional central locus of control training.

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