A Neurofeedback Approach to Improving at Golf and Other Sports

Considerations for the use of neurofeedback protocols and techniques
in the improvement of golf and similar sports performance

Thomas F. Collura, Ph.D., P.E., BCN

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Introduction

This report describes some basic considerations and operational details for using a series of neurofeedback techniques in the pursuit of personal improvement in golf or related sports. Generally, the neurofeedback will be used in order to acquaint trainees with desirable mental states, and to help them to learn to achieve and recognize these states. Our approach to training these states is based upon the concepts of *flexibility* and *appropriateness*, and does not appeal to the notion of good vs. bad brainwaves or brain states. No particular brain state is good or bad, in its own context. What matters is being able to achieve an appropriate state at the appropriate time, and to be able to recognize it. Indeed, if we try to specifically enhance or inhibit any particular brainwaves in general, we will surely lose some of the capacity for change and flexibility that is at the very essence of being able to be a peak performer.

This report is intended to provide information for the neurotherapist, the coach, and the trainee. It does not provide details on how to organize a training program, or exactly how or when to administer neurofeedback treatments. Rather, it provides a brief description of the basic protocols and techniques, with a short explanation of the manner of use, and the anticipated benefits. The neurotherapist, coach, and trainee should be able to work together to provide a simple sequence of trainings, progressing from simple to more complex, and to suit the needs at hand. At a minimum, trainees will likely do simple alpha training, HEG, and a basic type of "squash" protocol. There is sufficient flexibility and expandability in the available neurofeedback systems to accommodate a growing and advancing personal plan, that can easily extend to many months, and years, as training progresses and the trainee learns more depth and sophistication.

What are the mental tasks associated with good golf? There are many. There is the need to take in the overall layout of the course, and to plan the shots to be used. There is the need to calibrate oneself to each shot, and to relate the distance and direction to one's personal position at the outset. Then, there is the need to stand before the ball and be still, and prepare for a brief moment of highly precise action. But this action must be undertaken in a relaxed, automatic fashion, free of the encumbrances of overt thought. The mind cannot process a golf swing as it happens, it must be automatic, practiced, and sure. Finally, after each shot, the individual must again relax, process the activity, and prepare for the next. The golfer must be able to carry out repeated, precise, difficult maneuvers without tiring or becoming frustrated or angry. The successful and satisfying completion of this complex series of tasks is facilitated by being able to achieve the relevant brain state at the relevant time, and being able to move gracefully and freely from state to state. This is at the core of golf, or of any sport or activity, for that matter.

As a result, what we describe here are basic techniques, tools, for personal fitness, awareness, and improvement. In the context of golf, this becomes neurofeedback for peak performance. But what we are really teaching here is neurofeedback for better living. Golf is simply a phase of life that presents its own unique challenges, measures, and rewards. But in the sense that, as an activity, it asks us to be relaxed, focused, directed, composed, and efficient, it is merely a special case of regular life, and nothing more. In other words, get better at mental fitness, and you become better at golf. Become better at golf, and you (might) become better at life.

Rather than providing a prescription or plan for golf improvement, this report shall present a compendium of techniques, their characteristics, and their possible use. From this collection, the trainer and trainee can pick and choose those that seem most appropriate, and incorporate them into the program. It is expected that training plans will evolve and grow along with the experiences of the trainers and trainees who use them, and that continued progress will lead to a variety of approaches and plans, designed to suit individuals and groups at all stages along the various roads to personal progress and improvement.

Basic Considerations

It is important to understand that the brain is a dynamic entity, much like the body, and that it has a variety of tasks and ways to achieve them, and it needs to be able to shift quickly and effectively between particular states, in the interest of good performance, satisfaction, health, and sustainability. So we will not try to identify certain frequencies as “good” and others as “bad”, or try to eliminate some and enhance others for this type of reasoning. We will look to train the flexibility to enter and leave identifiable brain states at appropriate times, and to be able to recognize when this happens.

We do not, for example, train a basketball player to run around the court with an arm in the air at all times, just because the basket is up there. We must train the player to have the arm in the appropriate place at the appropriate time, and to be ready to move it there quickly. We need to train flexibility and appropriateness, not a fixed set of brain frequencies.

Previous work (Chartier et. Al. 1997) has identified effective neurofeedback training of elite golfers, as well as helping them to achieve what is called an “Iceberg Profile” on the Profile of Mood States (POMS). In this report, 14 out of 15 participants reported significant improvement in their game as measured by pre- and post-training scores. Improvements were also reported in the Sympton Checklist 90, particularly in the obsessive-compulsive scale. This demonstrated the value of neurofeedback training in a peak-performance context, when used in a golfing situation.

What follows is a series of brief descriptions of specific protocols and methods, with an indication of how these could be applied as part of a comprensive sports improvement plan. This is intended to be a “shopping list”, or a starting point for the discussion and planning of a specific program or programs for golf improvement. It is hoped that trainers and administrators will be able to extract from these descriptions sufficient information to create the basic plan for training, and to begin to explore neurofeedback training and its benefits, as part of a comprehensive plan of performance improvement.

Note that all neurofeedback training is, at its heart, relaxation training. Whatever the location and the frequencies trained, there is an element of relaxation, in that cortical brain cells produce measurable voltages only when they act in unison, and in order to act in synchrony, they must relax, allowing postsynaptic potential to build up. By allowing the brain to relax and produce endogenous rhythms in various combinations, it is possible to train specific changes in brain state

in particular locations, and in particular ways. But what is always happening is that the brain is finding its own way. Neurofeedback never forces anything to happen. It shows the brain when the desired state is present. Training mostly consists of relaxing, letting go, and allowing the equipment and the brain to work together. In this way, there is a naturalness to the learning, and what is thus learned is generally retained. Having learned to relax and achieve particular states, the trainee is thus prepared to undertake golf (or any task) with a sense of confidence, automaticity, and simplicity. It is truly learning, in the best meaning of the term.

One of the lessons of golf is that it is not supposed to be hard. We learn to think and act smartly, not harder. Neurofeedback complements this concept, by providing additional mental and brain tools, allowing the player to proceed in a more natural, effortless manner, toward performance that has fewer errors, fewer distractions, and more productivity.

Alpha Relaxation

This is the basic soothing, 1-channel or 2-channel alpha feedback (8-12 Hz) using relaxing MIDI sounds with real-time amplitude feedback. Eyes-closed. This will be done with theta inhibition, using the standard *"relax"* protocol. The trainee closes eyes, relaxes, and allows the tones to come. Voices may be flutes, cello, viola, seashore, "spacey" sounds, etc. This will achieve a state of general relaxation, while avoiding the lower frequencies and theta activity associated with deeper, inner connectedness. Generally, O1/O2, P3/P4, or C3/C4 will be used. 2 or 3 minute segments, optionally separated by a pause.

This protocol will allow trainees to learn to relax in general, and achieve a state that is generally healthy. For example, when walking the course, when planning shots, when working with scoring, it is generally a good thing to be relaxed, yet alert. Achieving and maintaining this state is helpful for generally reducing stress and its associated effects, and will also help to minimize the effects of any anxieties, anger, disappointment, or other negative emotions that may arise in the course of play.

Alpha Coherence

This is a more specific type of alpha training, achieving a coherent state between the left and right hemispheres, in the alpha (8-12 Hz) band. Eyes-closed. Uses *"peak"* protocol. Generally, O1/O2, P3/P4, or C3/C4 can be used. Trainee should uptrain coherence in 1 or 2 minute segments, optionally separated by a pause.

This coherent alpha state is a state of well-poised readiness, and deep relaxation It is associated with improved creativity, sense of well-being, and ability to perform effectively. It has been seen in zen monks and similar meditative and contemplative individuals, particularly among the most experienced and recognized leaders.

14 Hz ("SMR")

Uses *"focus"* protocol. This will provide enhancement training of the 12-15 Hz ("Lobeta") range, from C4 (single channel) Eyes-open. Includes theta inhibition. May precede this training with Low-Frequency Inhibition ("Squash") simply by setting the Lobeta threshold to zero (or set target percent to 100%) so that the theta inhibit becomes the primary task. Then can raise Lobeta threshold, to introduce the element of concentration, hence achieving a focused, relaxed state of concentration. Usually, a simple "click" or "ding" sound ("morse" is good) is used as a reward.

The trainee relaxes, again "allowing the sounds to come", and gains a little learning and appreciation with each point. Typically, 600 to 800 points are achieved in a 20 minute session.

Overall, this is a good "relaxed, focused concentration" protocol. It is used extensively (Lubar, Sterman, etc) in work with those with difficulty paying attention, and those who are hyperactive. Specifically, the centrally generated SMR (sensorimotor rhythm) has been shown to be associated with the brain's "intent to remain still". It can be trained in cats and other mammals, and is a basic relaxation rhythm of the motor system. For example, it is extinguished when a contralateral limb is moved, shaking, etc. Training this rhythm teaches a deep relaxation of the sensorimotor system, and thus involves stillness of the body. This typically leaves the trainee in a relaxed and still, yet focused, alert, and ready state. This is one example of a state that may be regarded as "the zone". When the trainee is able to achieve and sustain good performance in this task, they may experience a sense of "cruising" or "getting into it" which is automatic, yet responds to the direction of the trainee's will, to find and hold it.

Associated as it is with stillness, plus having theta reduction, this training protocol is often associated with training to help people function in a structured, academic, or attention-demanding environment. For example, it is commonly used with school children, businesspeople, etc. In a sports application, it helps to achieve a still, focused state for appropriate times. For example, in any seminar or workshop setting, when discussing concepts, or when studying specific shots, planning and reasoning, this state of relaxed yet alert, focused concentration enhances the ability to think, reason, and reach good conclusions.

Low Frequency Inhibition ("Squash")

Focuses on learning the task of reducing the low frequency EEG in the theta (4-7 Hz) band, as the primary task. Eyes-open. Trainees experience the feel of moments of low theta, observing a bar graph and hearing a sound when this is sustained. Can be done with *"focus"* protocol by setting the Lobeta threshold to zero. Reducing theta is associated with decreased distractibility, and the ability to focus on one thing at a time.

At any time that a trainee is faced with the need to limit concentration to a single item, this training is helpful. It is associated with a decrease in distractability, less tendency for the mind to run in all directions, and with an increase in the ability to have a single thing in mind, and to keep it there without changing. It is also associated with stillness and rest, because the theta wave also serves to detect eye movements, head movements, and other types of activity. Thus, theta inhibition encourages the head, neck, eyes, etc. to be still and quiet, while the brain also settles down and stops shifting around.

This protocol is generally used with simple discrete sounds (clicks, etc) and is done eyes open. The trainee should try to experience the "body feel" of when the theta is reduced. It is an indescribable, yet pleasant and still feeling. It may be associated with focusing of thought, and a sense of distractions fading away. May be thought of as a "pushup" for the brain (actually a push-down), and should be practiced for a minute or two, with brief pauses if desired.

Broadband "Squash"

This extends the low-frequency squash technique to a broader band (4-20 Hz). This can be done with the *"sharp"* protocol. This helps trainees to achieve a state of overall EEG quietude, which is physiologically associated with a neuronal state of readiness, acuity of response, and being poised for action. Can be done anywhere, particularly centrally, or frontally. Skilled archers and

pilots, for example, have been shown to have a state of overall EEG quieting, (and a shift to beta frequencies) during the moments before well-executed skilled actions. This training emphasizes entering that state of optimal readiness for a difficult task, such as a golf swing, and learning to maintain that state, in preparation for the execution of skilled actions.

This is best viewed as a special task, to be done for a brief (30 second or 1 minute) trial, followed by a pause. It is a form of "bench pressing" for the mind. During the pause, the brain may produce alpha, and this is in fact beneficial. The brain will learn to focus and squash when asked, then to relax and produce alpha (a form of "post-reward synchronization) in the relaxation phase. The important point is to learn the concentration/relaxation cycle, not to achieve a permanent state of low EEG.

When a performer learns to achieve the concentration/relaxation cycle in an automatic and habitual manner, they become capable of executing difficult tasks with much more confidence, repeatability, and stamina. (This was shown by Sterman in extensive EEG studies of Air Force Pilots).

Alpha/Theta Training

This will only be done in particular situations, under specific supervision of a clinician managing the trainee. Uses *"deep"* or *"deep2"* protocol. Eyes closed, extended times (30 or more minutes) Feedback sounds are deep, soothing instruments using unusual voices such as "echo drops" or "bowed glass" to enhance the ethereal aspect of the experience. This may be in conjunction with psychotheraputic, experiential, or related work involving the access to deeper, inner states, subsequent processing, and changes in awareness, etc. Should be used with caution, and with attention to possible abreaction.

Alpha/Theta training will be used in cases where a trainee desired to pursue specific issues, which may center around internal thoughts, feelings, memories, or other issues. This experience continues the basic relaxation achieved in alpha training, and allows the brain to slow down in frequency, and to produce diffuse theta waves. Normally associated with distractability, daydreaming, and creativity, when theta waves are trained for a continued period, the trainee achieves internal connectedness that may also be associated with feelings of dreamlike states, imagery, free association, and intuitive thoughts. Alpha/theta training is generally followed by a period of re-activation, discussion, experiential work, or other processes that incorporate the new information into the trainee's continued processing, allowing the benefits of the new awareness to be achieved. Possible abreaction may include a sense of disconnectedness, anxiety, or similar negative affect. Drowsiness may persist after the training, if sufficient re-activation is not achieved afterward.

General-purpose Photic Stimulators ("mind machines")

Any type of photic or auditory stimulator ("mind machine") may be considered for use, as a augment to the neurofeedback training. This may have a desired "entrainment" effect on the EEG, although such effects may be temporary. These are probably most useful to acquaint the brain with particular types of states, and to provide a brain "massage" which may be stimulating or relaxing. However, after some time, the effects tend to go away, since no true learning (operant conditioning) is occurring. For more effective photic-assisted neurofeedback training and for more lasting learning, and EEG-controlled system should be considered.

Basically, these function as a type of ("brain gym") and provide temporary stimulation or relaxation, and should be used under the supervision of an experienced trainer. They may include built-in "protocols" that control the timing and frequency of the flashing. These should be used according to the manufacturer's recommendations, with attention to outcomes.

MIDI-Stim Photic Stimulator

The MIDI-Stim is a more sophisticated type of photic stimulator, designed for use in EEG neurofeedback protocols. It is capable of delivering controlled photic stimulation, under EEG control. In the use for theta reduction, the glasses can be programmed to flash at an appropriate rate (12-15 Hz, typically) when the theta activity exceeds threshold. This has an automatic effect of reducing theta in the trainee, and helping them to learn to enter and recognize the state of reduced theta. It is an assist that helps the trainee to enter the state, by a "nonvolitional" method, hence independent of the trainee's effort or volition. After a short period of such training, one of the conventional neurofeedback protocols can be used to reinforce the learning, and allow the training to progress from the assisted state, into further learned states.

This approach provides special clues for enhancing or inhibiting rhythms, and adds a direct manipulation of the EEG, in what is closer to "classical conditioning" than "operant conditioning". Thus, as a very basic reward or inhibit mechanism, the brain can be coaxed into particular states without the trainee's conscious effort, providing a rapid and efficient way to either start training ("training wheels"), or to accelerate the progress of training ("personal coach").

Note: These types of devices are for investigational use only. Photic stimulators should not be used by persons with epilepsy or any seizure disorder. Use should be discontinued if headaches, nausea, or other discomfort are experienced.

HEG

HEG (Hemoencephalography) is a biofeedback method that uses a photo-optical measurement of the amount of blood in the trainee's brain. This is generally done with a headband and measuring the frontal lobe. This training responds directly to level of mental effort, and motivation. This is typically done in short trials (1-2 minutes), separated by pauses. Whenever the trainee exerts sufficient effort to increase the cerebral blood flow by about 0.1%, the system provides positive feedback auditory and visual.

It is anticipated that trainees will use HEG somewhat especially in the early phases of training. It is a simple and direct form of biofeedback that is less complex to administer, learn, and understand than the more involved EEG methods. It provides an excellent introduction to biofeedback, and brain biofeedback, while emphasizing the basic attributes of motivation and effort. It further rewards improvements in efficiency of concentration and effort, and the ability to "rally" the brain to get to work, upon demand and with a minimum of energy expended.

This is used with a melodic, percussive feedback sound (xylophone, piano, etc) and can be enhanced with the TrendView display, or the AVI animations. Animations typically advance slowly, and respond to the effort of the trainee. Thus, animations such as growing plants, spreading roots, or other "emerging" displays are well suited to this use.

This type of training will enhance the trainee's sense of being in control, and being able to sustain the will to win. Responding as it does to volition, it can help to foster the "killer instinct" that

comes when the individual combines strong desire with confidence, and has the sense that "nothing can stop me now."

"Interactor" Vibrotactile Cushion

This auxiliary feedback device will operate with all of the above protocols and techniques. It provides a kinesthetic feedback, delivered with a strong vibrotactile stimulator. Feedback is felt, not seen or heard, and can be delivered to the hand, arm, leg, back, or any other suitable body surface. It provides feedback which is pleasant and easy to sense, and also does not depend on the brain's auditory or visual processing system, in order to process the information. In other words, it provides direct body feedback, so that the body participates more fully in the feedback learning process.

Any continuous or discrete tone feedback can be used with the Interactor. The sound may be faintly heard, but it will be primarily felt. In addition, with expansion software, it is possible to make the cushion respond to its own protocol. For example, during typical 14 Hz training, it is possible to have the cushion vibrate to encourage alpha (8-12) Hz. This "out of band" signaling, provides the body with its own relaxation training based on alpha, in addition to the simultaneous SMR-based focus/concentration training for the brain.

It is important to recognize that this type of feedback provides the opportunity for the trainee to work with eyes closed, and in an essentially silent environment. The mind is truly stilled, and the visual and auditory senses are not active. This provides a very peaceful, focused type of training, and allows the trainee to focus on inner awareness, without the distractions of having to view, listen to, or process some sensory input. This is a direct "brain to body" link, and has qualities and benefits all its own.

We also look at this type of feedback as a "pat on the back." The trainee obtains a rapid, pleasant, and re-inforcing feedback that directly appeals the physical sense of having done the right thing. Very little (or no) instruction is necessary, as everyone knows the inner reward sense that is achieved with reassuring and well-deserved tactile feedback, especially when it is so closely coupled to the task being reinforced. Depending on the protocol and type of feedback used, the trainee may given a "pat" whether they focus and reduce theta, achieve a state of bodily stillness and relaxation, succeed in achieving a state of coherence, or whatever the protocol is doing. There is also a natural continuity with physical guidance, coaching, and reinforcement that may be given by the coach themselves, in which the body is an essential element in the learning.

References

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