Real-life Neurofeedback

Part II: an introduction to neurofeedback

Neurofeedback

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Neurofeedback is a technique of self-regulation by means of EEG-based biofeedback

In this technique, some parameters of EEG recorded from a subject's scalp (such as an EEG amplitude in a given frequency band) are presented to the subject through visual, auditory or tactile modality

The task for the subject is to voluntarily alter these parameters in a desired direction (leading to a more efficient mode of brain functioning)

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Setting

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Principles

The brain state (including any dysfunction or dys-regulation) is reflected in parameters of EEG recorded from the scalp.

EEG ⇔ brain state

The human brain has plasticity to memorize the desired (rewarded) state.

Operant conditioning

Classical conditioning

A process of behavior modification by which a subject comes to respond in a desired manner to a previously neutral stimulus that has been repeatedly presented along with an unconditioned stimulus that elicits the desired response

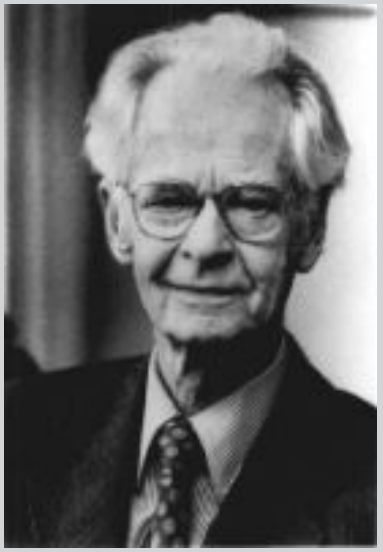
Pavlov:

Food => Salivation	**(US => UR)**
Bell + Food => Salivation	**(CS => UR)**
Bell => Salivation	**(CS => CR)**

Operant conditioning

A process of behavior modification in which the likelihood of a specific behavior is increased or decreased through positive or negative reinforcement each time the behavior is exhibited, so that the subject comes to associate the pleasure or displeasure of the reinforcement with the behavior

Skinner:
Skinner box…



History

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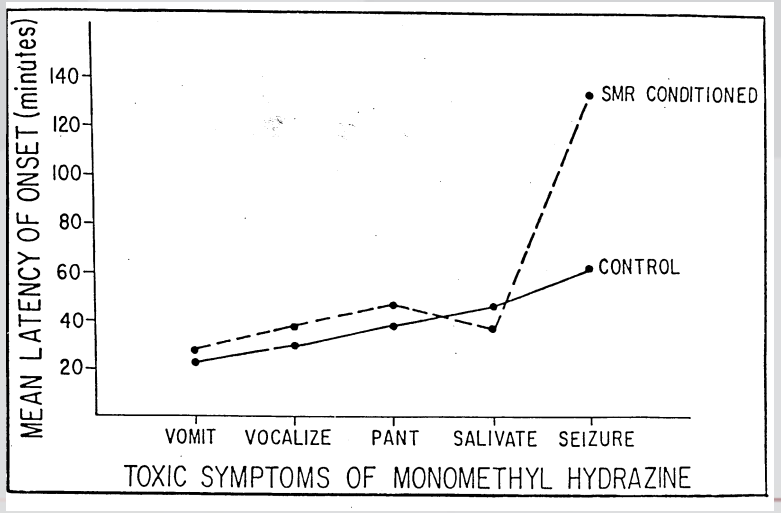
In 1967, sleep researcher Barry Sterman, Ph.D. trained cats to increase the newly discovered SMR through operant conditioning

The trained cats were used in a Nasa investigation of the seizure-inducing effects of rocket fuel hydrazine

Sterman's EEG trained cats took longer to go into seizure after exposure to rocket fuel then normal cats



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Epilepsy

In 1972, Sterman applied the principle of EEG (SMR) biofeedback to epileptic patients

What he found was a remarkable seizure reduction

Method

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EEG amplifier is connected to the individual by two sensors placed on the scalp. The sensors are safe and painless; they do not prick the skin

The individual performs a task (which is not defined to him/her and which he/she has to assess) while receiving instant visual and auditory feedback on his/her *theta*, *beta, SMR* or other brainwave activity

The information is used to help individuals learn to change brainwaves to desired levels

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Duration

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Neurofeedback is a training process where improvements take place over time. The effective treatment requires 20-40 one-hour sessions

Learning to change brainwaves is similar to learning how to ride a bicycle. It takes a while to learn, but once it is learned it is never forgotten

Improvements in behavior are usually durable. A small percentage of individuals may need booster sessions

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Protocol

Evidence-based

QEEG guided choiche of protocol

Assumption-based

standard protocols based on the complaints of the patient

Clinical use

The function of Neurotherapy is self-regulation of brain wave activity as a means of modifying psychological symptoms.

- Relieving the symptoms ADD/ADHD, conduct disorders, learning disabilities
- Relieving anxiety, depression, chronic fatigue syndrome
- Reduction of seizures
- Treatment for autism and Tourette's syndrome
- Treatment for addiction (alcoholism, drug abuse)
- Rehabilitation after stroke, traumatic brain injury
- Enhancement of cognitive functions in aging

Non-clinical use

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- Improvement of attention, concentration, and focus - peak performance
- Improvement of relaxation
- Assistance with meditation
- Improvement of personal awareness
- Improvement of mental fitness

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Efficacy

The assessment of the change in EEG is necessary to determine if self-regulation of neuronal activity is altered by bio-feedback. However, altered brain wave activity is an insufficient index of treatment efficacy for the various psychological disorders to which it might be applied.

Target symptoms for those disorders must also be assessed with additional standardized and validated measures

Timing

- *The speed with which the system can respond to changes in the EEG.* This is a function of the sampling rate and the type of filtering used. Most systems use digital filters as opposed to FFT's. Most useful EEG biofeedback filters have a width of 2 to 5 Hz, and can have a time constant between 20 and 100 milliseconds.
- *The desired EEG signal must be sustained for an appreciable time before feedback rewards are produced.* This prevents the system from responding to transient signals due to noise or brief EEG events that are not sufficient to warrant rewards

Beta training

Beta training is a common method used for a variety of purposes. It energizes the trainee, and provides a very uplifting experience. There may be a significant "aha" experience when the trainee discovers the exact type of mental state that is associated with the beta production. Beta is often trained on the left side (C3). Possible negative side effects may include agitation, irritability, or a sense of being "hyper". Therefore, sessions may be as short as 5 or 10 minutes. Often, a short period of beta training is used at the end of an EEG session, to bring the trainee into a state of energy and alertness.

Alpha/Theta training

Alpha/Theta training is often used to produce a state of relaxation. When theta is reinforced, it can lead to increasingly deep states of consciousnes, including contact with deep-seated thoughts and feelings. Alpha/Theta sessions can be quite long, extending to an hour or longer. As the session progresses, there is often a transition from a dominance of alpha to a dominance of theta ("crossover"). When the trainee spends some time in the theta state, they may be extremely relaxed, even stuporous or languid. It is often necessary to coach or counsel the trainee afterwards, to ensure that they do not leave in an excessively sensitive or internally directed state of mind.

SMR (low beta) training

SMR or low-beta training is a very common plan, and it is often used in the treatment of ADD/ADHD, seizures, or other disorders that indicate that the brain has trouble organizing its activity. It is usually done on the right side (C4), and sessions may last from 15 to 30 minutes. After an SMR training session, the trainee may feel relaxed yet energized, uplifted, organized, and efficient.

Squash protocols

- Squash protocols seek to benefit the brain by teaching it to suppress the production of brain rhythms. By training the brain to suppress EEG energy, we are reinforcing the independent behavior of the cortical neurons, as opposed to their synchronized, group behavior. It actually reflects some work when the brain stops producing EEG energy, and this reflects a desynchronized, hence active, state of affairs.
- A squash protocol may be done on any part of the brain. However, certain practitioners prefer specific locations, such as the frontal areas, or the central area.

Mind-mirror type training

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It refers to any training that uses a complete EEG spectrum as the display, and whose goal is self-awareness. It is often done with a counselor or coach who helps the user to understand and interpret the spectral display. Most EEG systems provide some form of complete spectrum in the display, and by learning to recognize the contours and shapes of the display, the trainee can gain an awareness of their mental states, style of thinking, and response to tasks or input.

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End of part II