

Principles of Multichannel Neurofeedback

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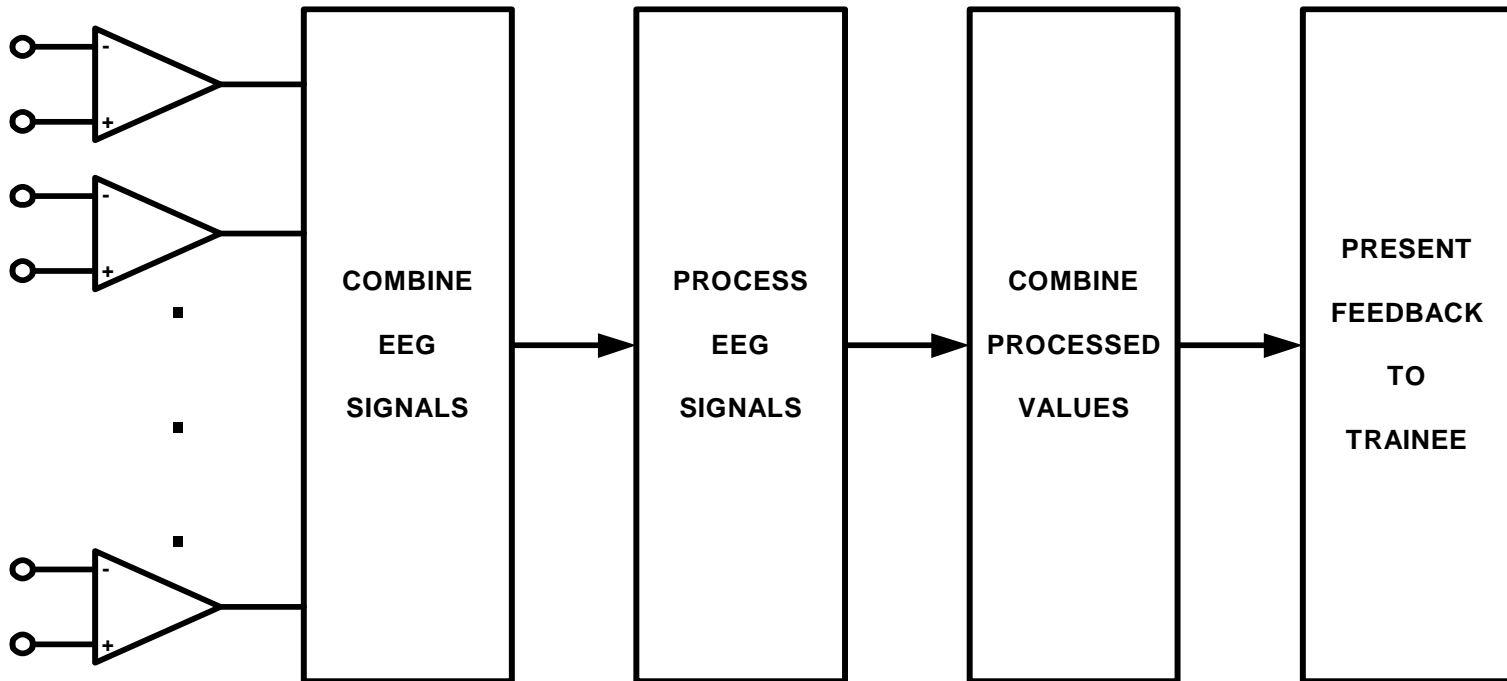
Multichannel Neurofeedback

- Goals
- Methods
- General Approaches
- Specific Approaches

Multichannel NF Goals

- Address L & R Brain, A & P Brain, or Whole Brain
- Train 2+ locations at one time
- Increase/reduce intersite coupling
- Increase/reduce intersite communication
- Achieve brain balance
- Achieve brain asymmetry

Multichannel EEG - General Approach



Two-channel vs. Bipolar I

- Bipolar takes difference between two sites
- E.g. F7 – O1 measures across left hemisphere
- Any difference in EEG produces measurable signal
- Cannot (generally) train direction, only difference

Two-channel vs. Bipolar II

- Two-channel allows specific relationships to be measured, fed back, trained
- E.g. specific states or events in each channel
- Can train asymmetry specifically
- Can train coherence, phase between sites

Multichannel NF - Examples

- Channel Summation
- Two-channel protocol
- Multi-channel feedback
- Coherence Training
- Synchrony Training
- Asymmetry Training

Channel Summation

- Adds raw EEG signals in time domain
- Analog or Digital implementation
- Peaks and valleys reinforce or cancel
- Synchrony produces larger signals
- Sensitive to phase relationships
- Process as a new EEG signal

Values vs. raw EEG

- Combining raw eeg combines waveforms
- Combining values combines numerical results of filtering or spectral analysis
- Values typically always “positive”
- Can set thresholds independently
- Can set for specific asymmetries

Two-channel protocol

- Extend protocol processor to 2+ channels
- Define criteria separately for each channel
- Reward using either or both sets
- E.g. C3 beta high AND C4 smr high
- Can provide simple feedback signal
- Brain learns multiple tasks at one time

Multi-channel feedback

- Each channel has own feedback method(s)
- Feedbacks are combined (audio or video)
- Provides multiplicity of information
- Stereo sounds, multiple boxes, etc.
- Brain discerns multiple states or events
- Secondary benefits: coherence, symmetry, etc.

Coherence Training

- Process 2 channels to measure coherence
- Sensitive to spectral similarity
- Reflects amount of common frequency
- Reduced by presence of incoherent “noise”
- Can provide a simple feedback signal
- Encourages amount of common signal
- Downtraining encourages independence

Coherence Training – Bipolar I

- E.g. F7-F8 versus P5-P6
- Large signal in either channel implies L-R asymmetry in brain (either direction)
- Large coherence implies coordination front-to-back
- Single task engenders complex brain response

Coherence Training – Bipolar II

- E.g. FPz-Oz versus T3-T4
- Large signals imply difference front-to-back or left-to-right
- Large Coherence implies coordination across and between hemispheres
- Can alternate uptraining and downtraining for flexibility, awareness

Synchrony Training

- Process 2 channels to measure synchrony
- Sensitive to phase (signals lined up)
- Reflects amount of common timing
- Reduced by phase “jitter”
- Absolute or relative phase possible
- Encourages speed of information transfer

Asymmetry Training

- Use processed values in an equation or algorithm
- Can train ratios, differences, combinations
- Can provide a simple feedback signal
- Results similar to two-channel protocol with uptraining vs. downtraining
- Benefit of simplicity and directness

Summary

- Various ways to combine channel information
- Various ways to present information
- Combining complex brain state/event information into comprehensible form
- Can train inter- and intra-hemispheric properties, some simultaneously