Basic 2-channel EEG Training Protocols

Approaches, Methods, and Functional Block Diagrams

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Rationale for 2-channel training

- 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
Approaches

• Single-channel Bipolar Training
• Sum-channel Training
• Separate Protocol Training
• Coherence Training
• Phase Training
• Asymmetry Training
2-channel vs. bipolar training

- Bipolar takes difference between two sites to produce 1 channel of EEG
- E.g. F7 – O1 measures across left hemisphere
- Any difference in EEG produces measurable signal
- Cannot (generally) train direction, only difference
Single-Channel Bipolar Training

- Always training difference in instantaneous signal amplitudes
- When signals are alike, output is low
- When signals are different, output is high
- Downtraining -> signals more similar
- Can encourage synchrony, similarity
  - Typically occipital alpha, O1 vs. O2
- Can also cause both to decrease
Two-Channel Sum and Difference Training
Sum-Channel Training

- Chan1 = sum, Chan2 = difference
- Can train sum or difference of channels, or both
- Sum trains synchrony, similarity
- Difference looks for differences
- Can uptrain sum, downtrain difference
- Ratio of sum to difference important indicator
- Phase-sensitive, and amplitude sensitive
- All amplitude-based training outputs work, e.g. bargraphs, games, etc.
Two-channel Training - Separate Protocol Method
Separate Protocols

• Each channel has own training criteria
• Reward presented when either channel meets criteria – MIDI notes
• OR – Reward presented with both channels meet criteria – Reward Sounds
• Can use complex protocols, up to 16 go’s and stops
• Brain “sorts it out”
• All amplitude-based screens, games work
Separate Protocols Example I

- Built-in protocol “peak2”
- C3 / A1 / GND / A2 / C4
- Left: beta up, theta & hibeta down
- Right: SMR up, theta & hibeta down
- Performs “alert” on right, “focus” on left
- Also “slows down right brain”
- General mental fitness, improved affect
- Single reward sound sufficient for feedback
Separate Protocols Example II

• Built-in protocol “deep2”
• Trains up alpha on both left and right
• Trains up theta on both left and right
• Can use stops on delta, hibeta
• Can hear when either channel meets criteria with MIDI sounds – STEREO sound
• Can hear when all criteria met with Reward Sounds – more useful for alpha only
Coherence Training

(one component shown, 8 are possible)
Coherence Training

- Built-in protocol “peak”
- Use computed coherence as training variable
- Trains similarity between sites
- Used to “bind” or “connect” sites
- Increase amount of shared information / communication between sites
- Can also downtrain coherence -> “break up” dependencies between brain locations
Phase Training

• Typically Downtrain Phase
• Reduces delay between sites
• Increased speed of information transfer
• Can also synchronize to a third location, e.g. thalamic pacemaker
Asymmetry Training - Amplitude Based Method

- F3
  - Cz
  - 7-13 Hz Filter / Envelope Detection
  - Autothreshold 75% Time over threshold
  - Below Threshold?
  - Both Criteria Met?
  - Visual & Auditory Feedback

- F4
  - Cz
  - 7-13 Hz Filter / Envelope Detection
  - Autothreshold 25% Time over Threshold
  - Above Threshold?
  - Both Criteria Met?
  - Visual & Auditory Feedback
Asymmetry Training

• Used to train asymmetrically
• Make e.g. right side larger, left side smaller
• Associated with mood, affect
• Typically done frontally, e.g. F3 & F4 with Cz reference
• Cannot be done with 1 channel