Electromygraphy

Why Record EMG?

- Facial Musculature rich; emotional expressions; a “leaky channel of expression”
- Startle blink as a probe for affective valence
- Muscle tension in disorders and stress
- Record “pre-behavioral” motor output
  - Facial Expressions
  - Human Performance (e.g incorrect channel EMG in forced-choice RT task)

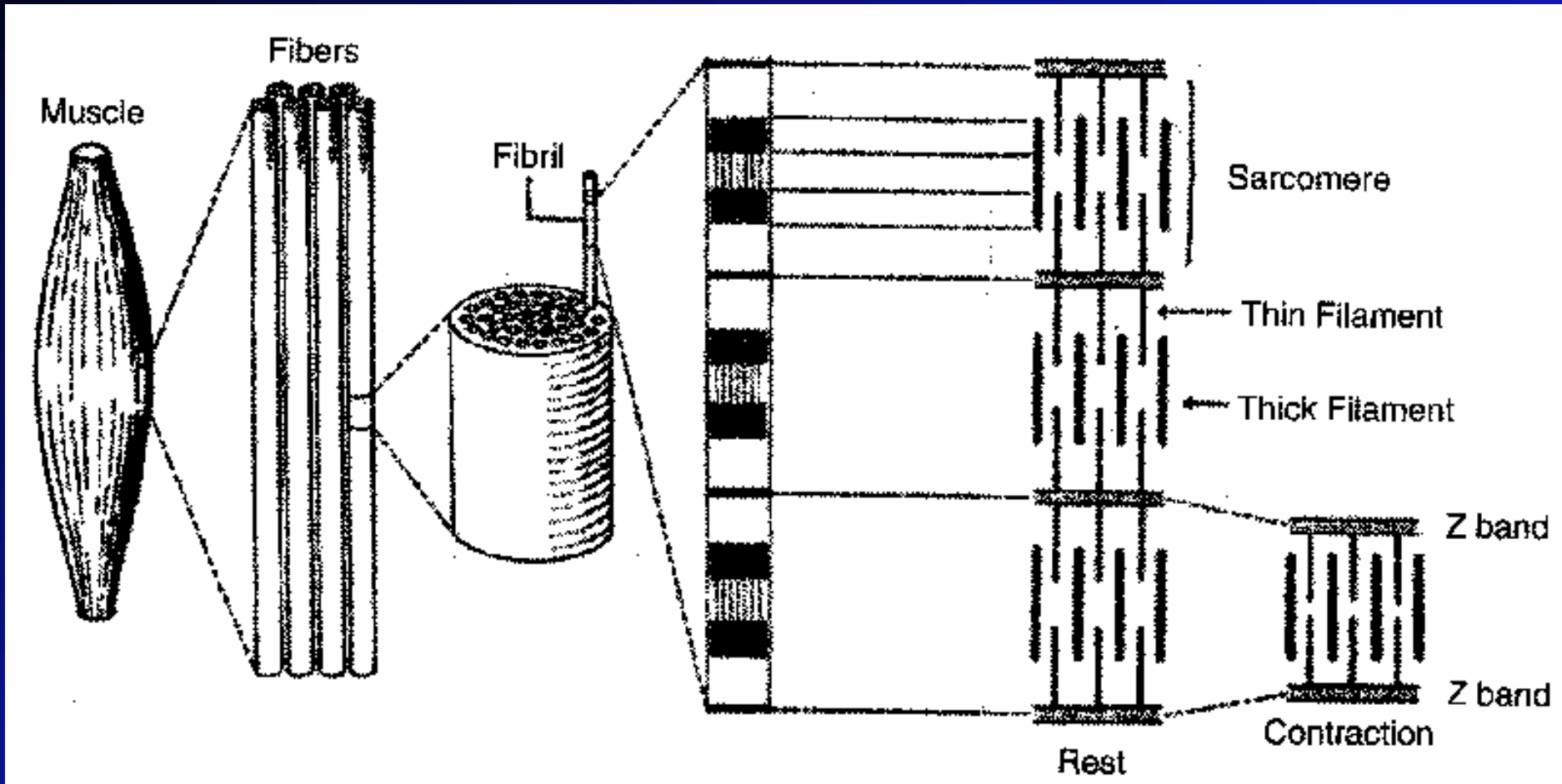
The Expressive Face

- Clip 1
- Clip 2

Striated Muscle

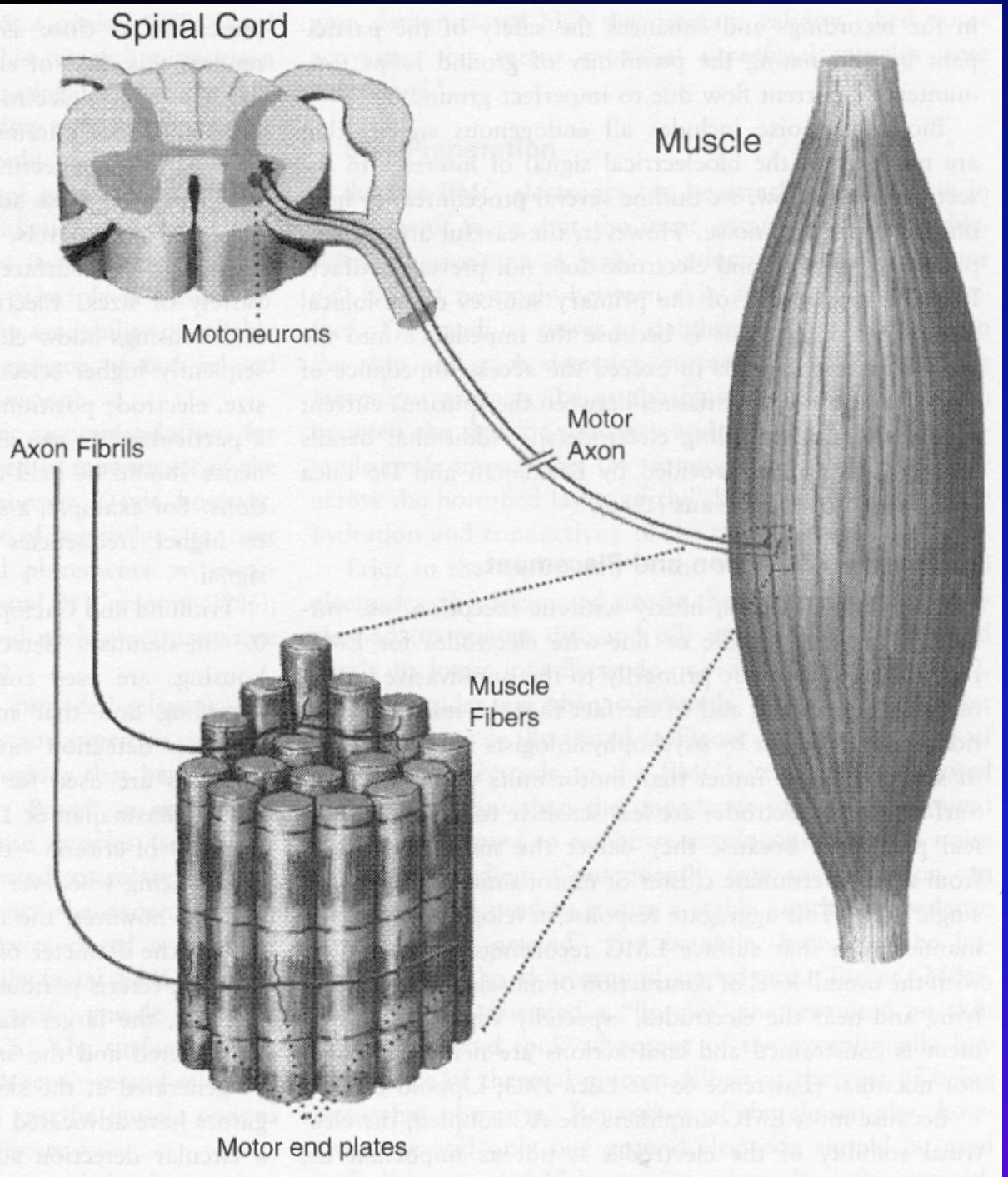
- Large number of muscle fibers arranged in parallel
- "Striated" reflects that these fibers are actually comprised of smaller fibrils
  - Fibrils have repeating cross striations (Z-lines)
  - Fibrils plus tissue between = Sarcomeres
- During contraction:
  - Small changes in length of filaments
  - But result in big changes in the distance between the Z-bands as the thick filaments slide between the thin

The Muscle

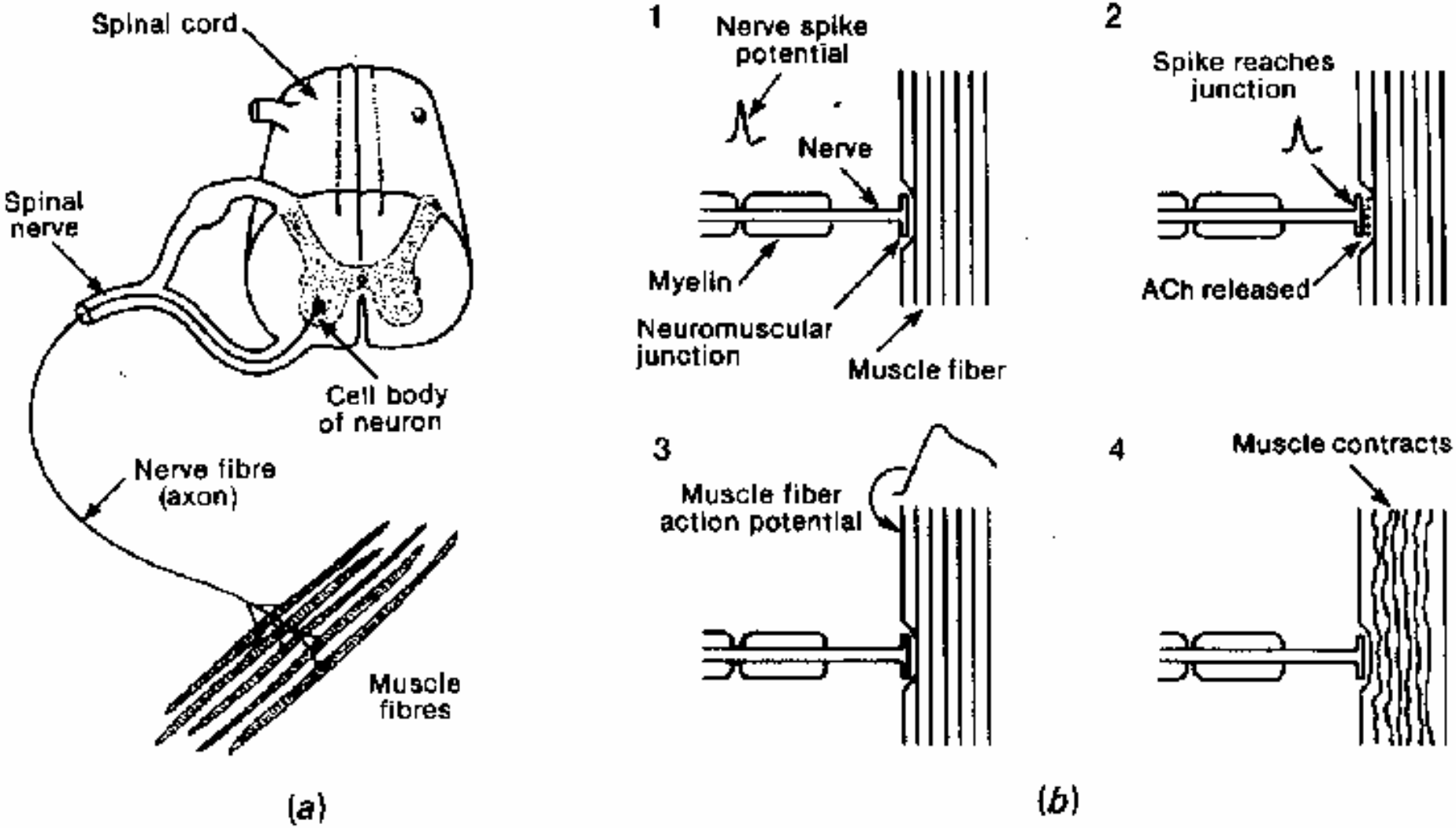

Muscle
Fibers
Fibril
Sarcomere
Thin Filament
Thick Filament
Z band
Z band
Contraction
Rest

Innervation

- Muscle needs stimulation to contract
- The motor nerve
  - Contains many motoneurons
  - Each motoneuron branches into several axon fibrils
- At end of each axon fibril is a junction with the muscle fiber
  - Known as the motor endplate
- Each motoneuron innervates several muscles, but each muscle innervated by only one motoneuron
  - Therefore, muscle fibers fire simultaneously or in concert with one another


Spinal Cord
Muscle
Motoneurons
Motor
Axon
Axon Fibrils
Muscle
Fibers
Motor end plates

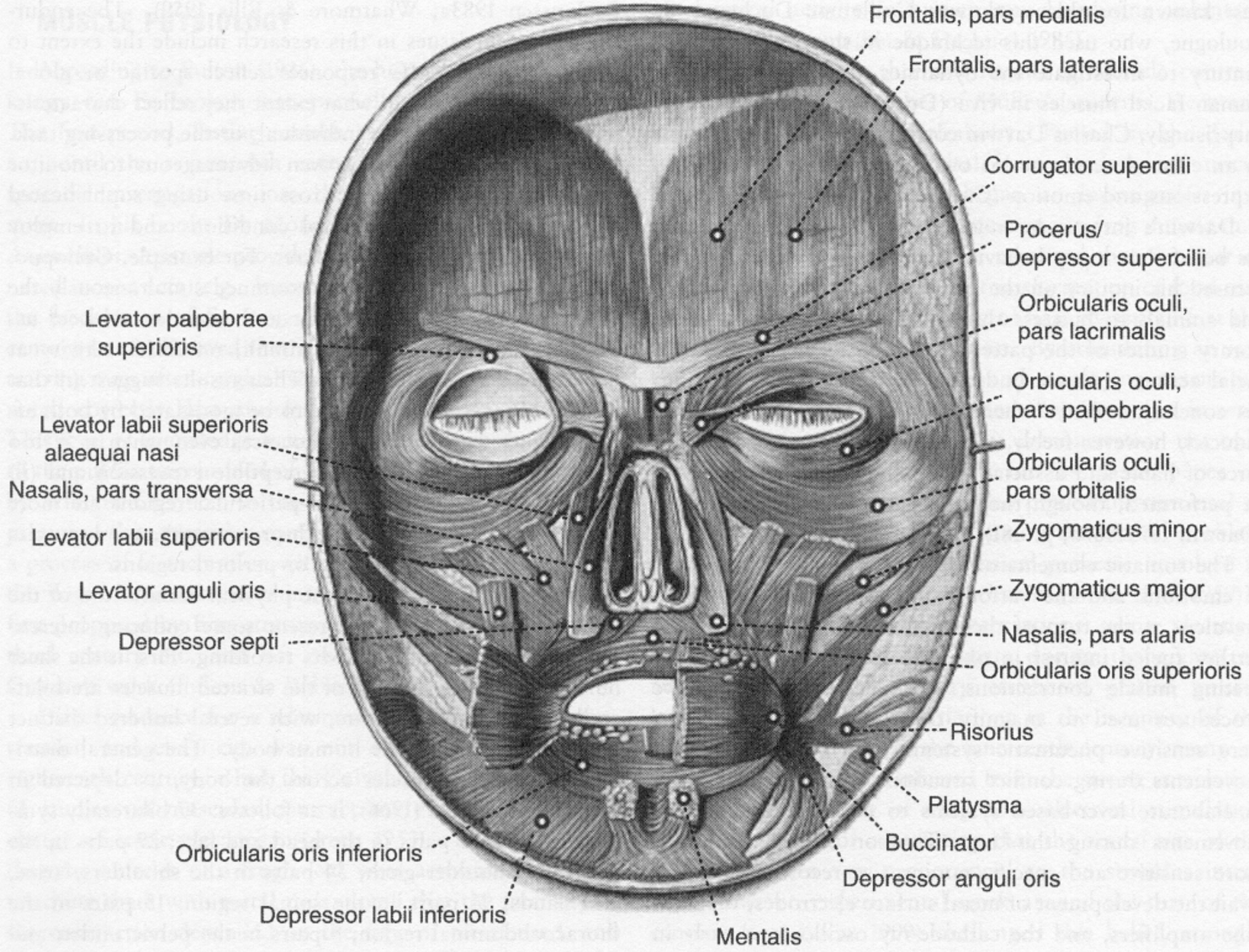
Cartoon of how it works

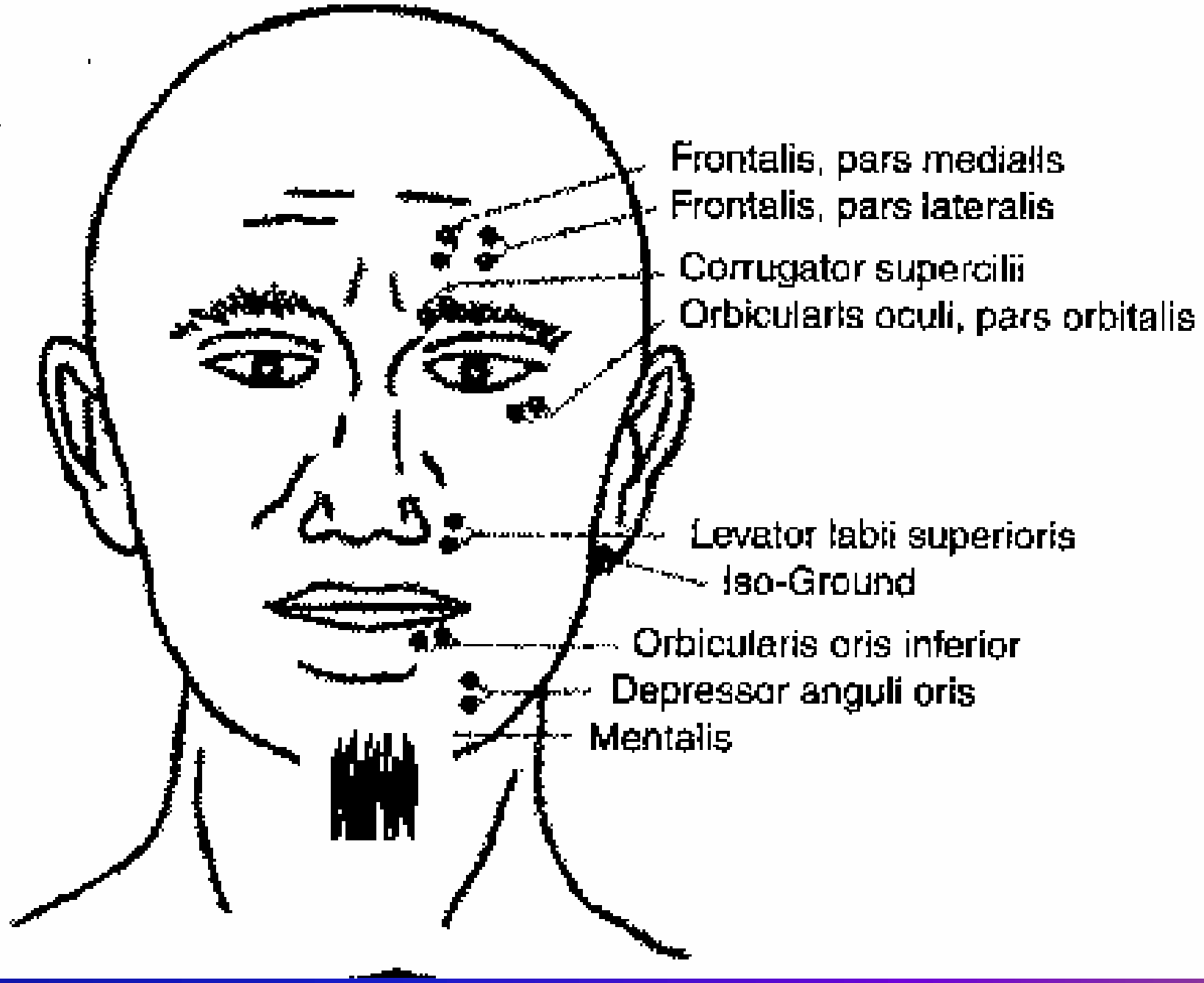


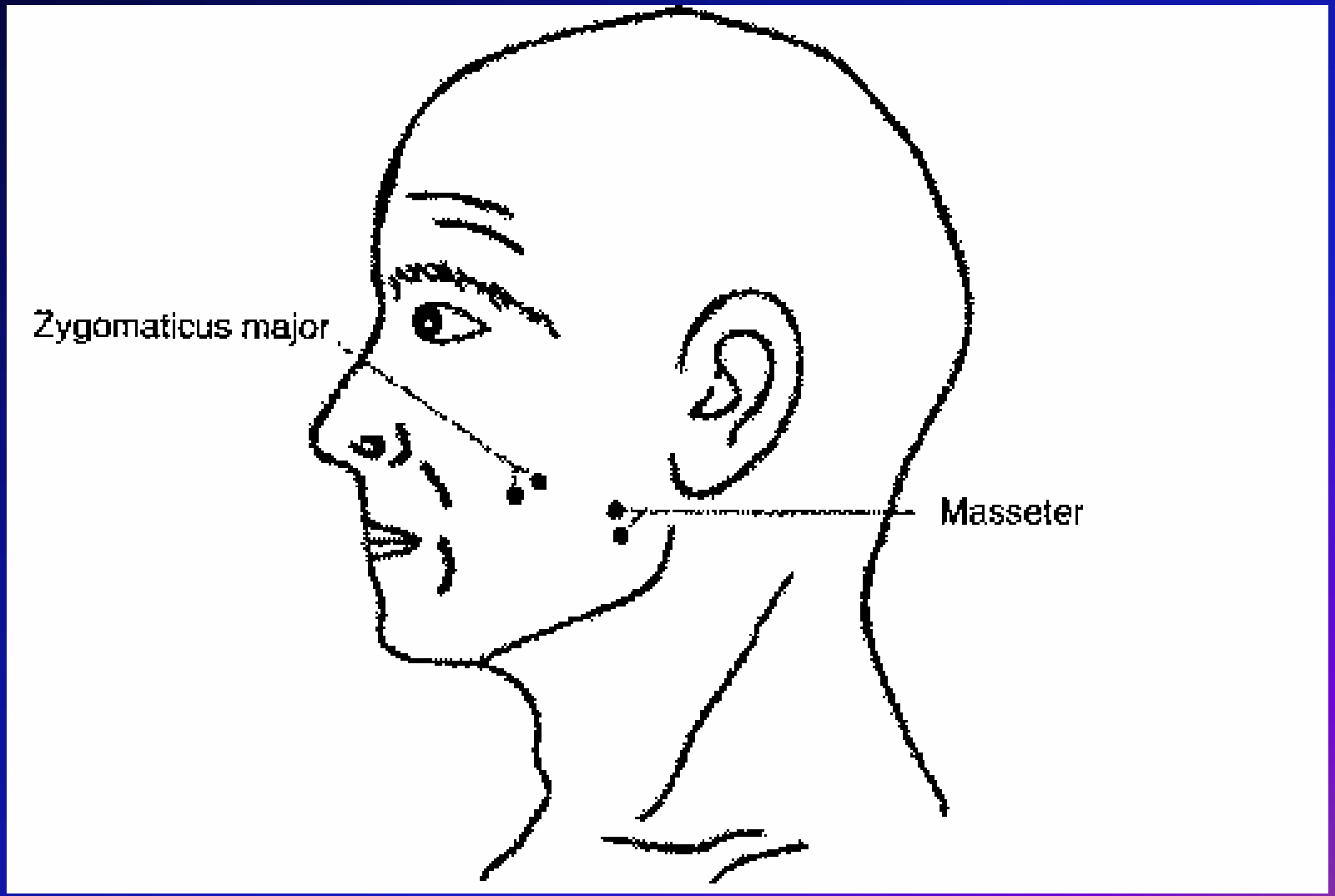
What is EMG signal?

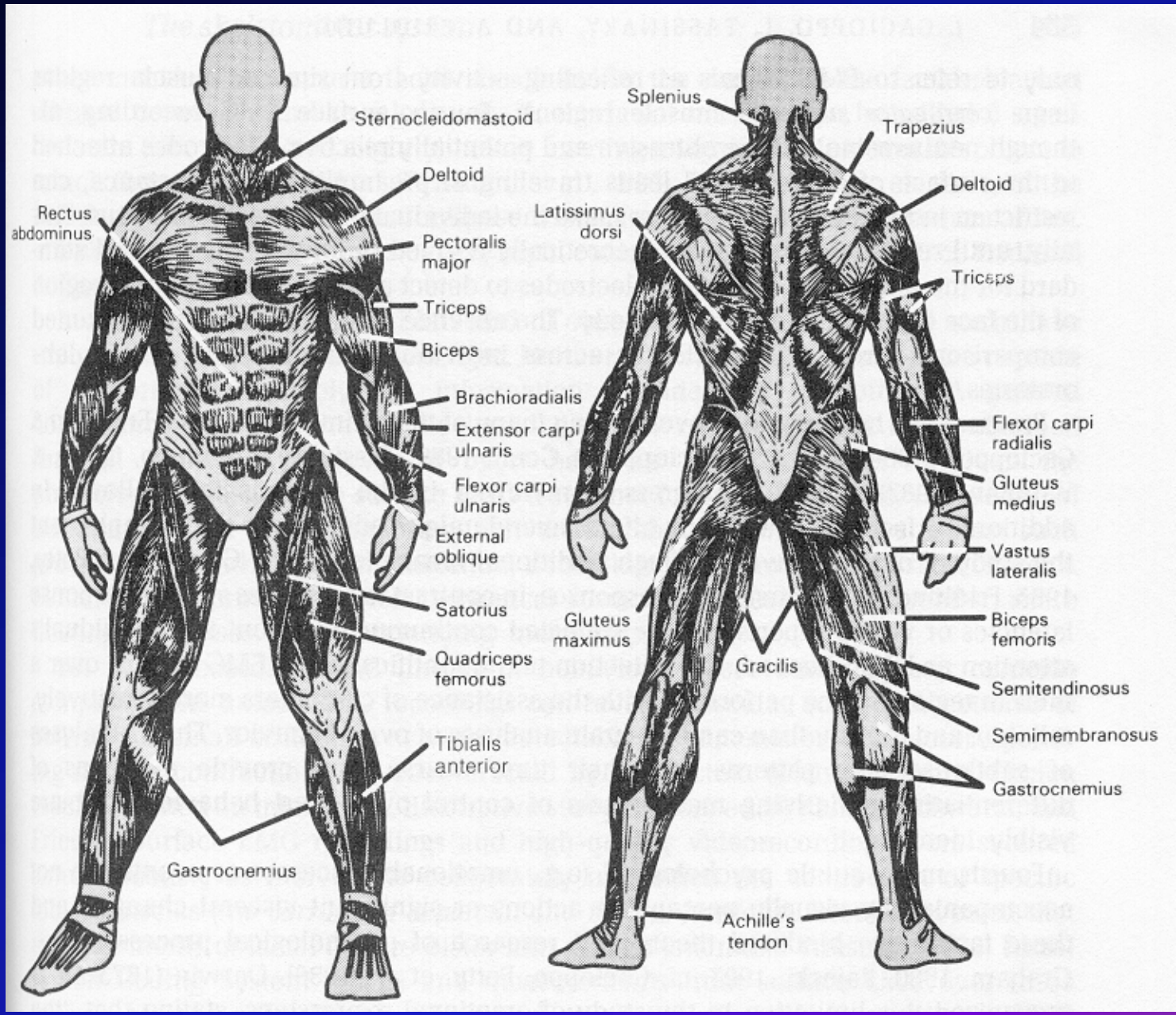
- Reflects electrical field generated by Muscle Action Potentials (MAPs)
- Small portion conveyed to surface via extracellular fluids to skin
- Can also record invasively with subcutaneous needle electrodes

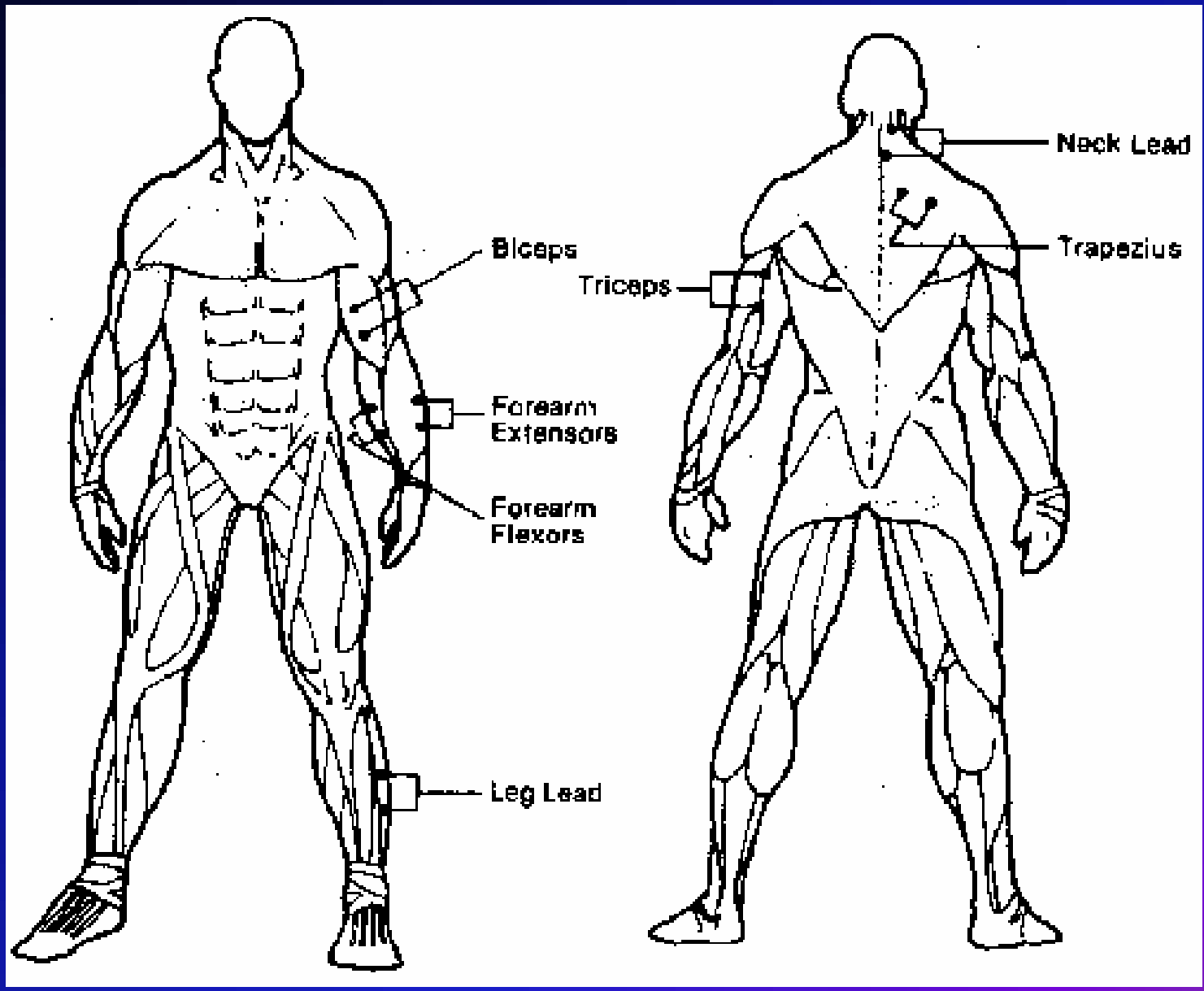
The Facial Muscles




Frontalis, pars medialis
Frontalis, pars lateralis
Corrugator supercilii
Orbicularis oculi, pars orbitalis
Levator labii superioris
Iso-Ground
Orbicularis oris inferior
Depressor anguli oris
Mentalis


Zygomaticus major
Masseter


Sternocleidomastoid
Deltoid
Rectus abdominus
Pectoralis major
Triceps
Biceps
Brachioradialis
Extensor carpi ulnaris
Flexor carpi ulnaris
External oblique
Satorius
Quadriceps femorus
Tibialis anterior
Gastrocnemius
Splenius
Trapezius
Deltoid
Latissimus dorsi
Triceps
Flexor carpi radialis
Gluteus medius
Vastus lateralis
Biceps femoris
Semitendinosus
Semimembranosus
Gastrocnemius
Gluteus maximus
Gracilis
Achille's tendon


Biceps
Forearm Extensors
Forearm Flexors
Leg Lead
Neck Lead
Trapezius
Triceps

Signal Recording

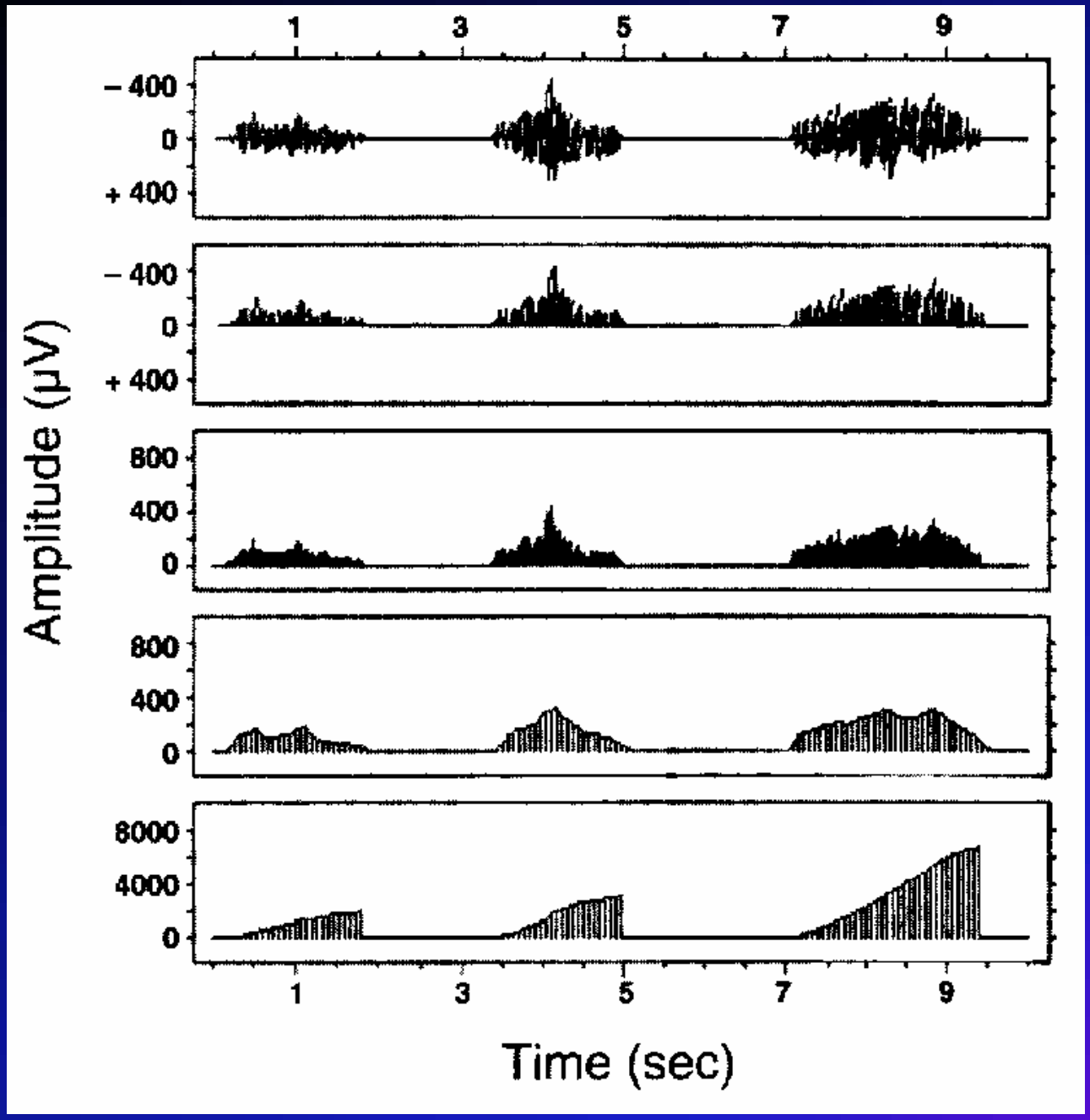
- MAPs summate in quasi-random fashion to produce resultant signal
  - Range of ~10-500 Hz
  - Amplitude of sub-microvolt to over 1000 microvolts
- Note overlap with 60 Hz range
  - Prepare ground site carefully; Differential amplifier will assist in removing 60 Hz
  - Prepare recording sites carefully to lower impedance
  - Shielded rooms and leads can help
  - Can also filter out this range, but may toss "baby with bathwater"

Signal Recording (cont')

- Can use wide variety of electrodes
  - Ag-AgCl still preferred
  - Small size increases specificity of recording
- Skin Prep
  - Abrade to reduce impedance to < 5K Ω
- Use Bipolar arrangements, in line with long direction of muscle of interest
- Use common ground for all sites
- Keep wires and such out of subject's visual field
- Describe placements precisely
  - Standard for location is Fridlund & Cacioppo (1986) for facial EMG placements

Signal Recording (cont')

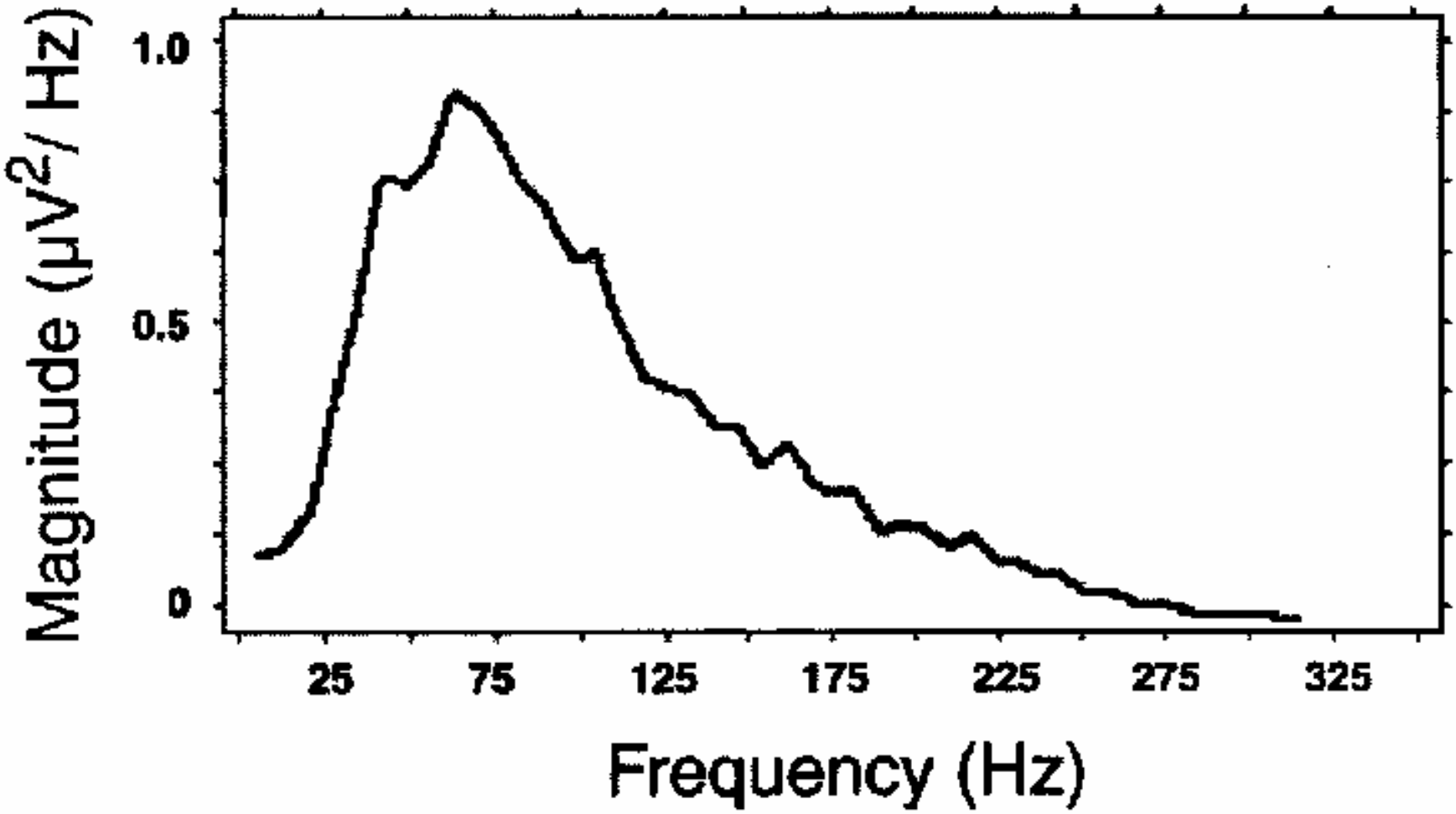
- Amplification
  - Differential amplifiers with common mode rejection
  - Actually double differential (ground)
- Amplify voltages 1000-20000 times
- May use on-line filter
  - Should pass 10-500 Hz
- Digitization (more in next lecture)
  - Fast, very fast
  - Or, slower, following on-line signal processing



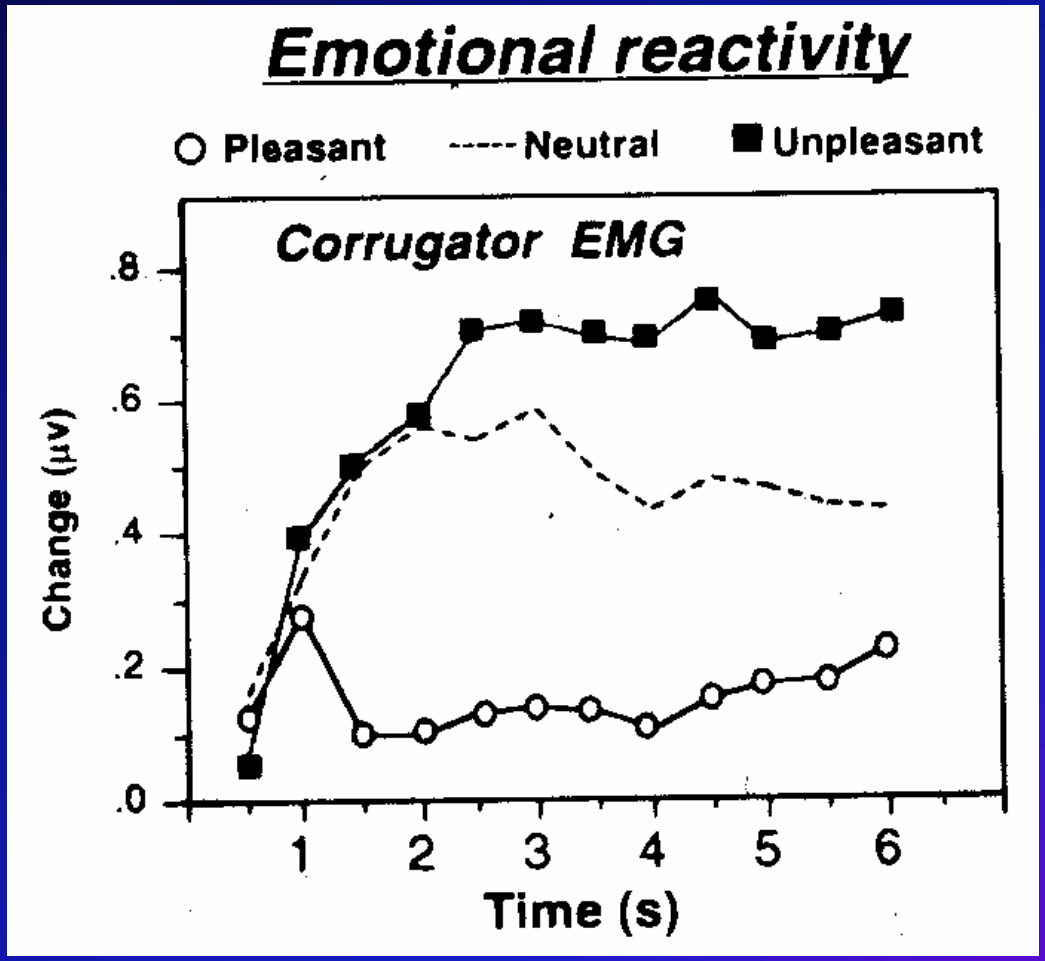
Signal Transformations

Demos

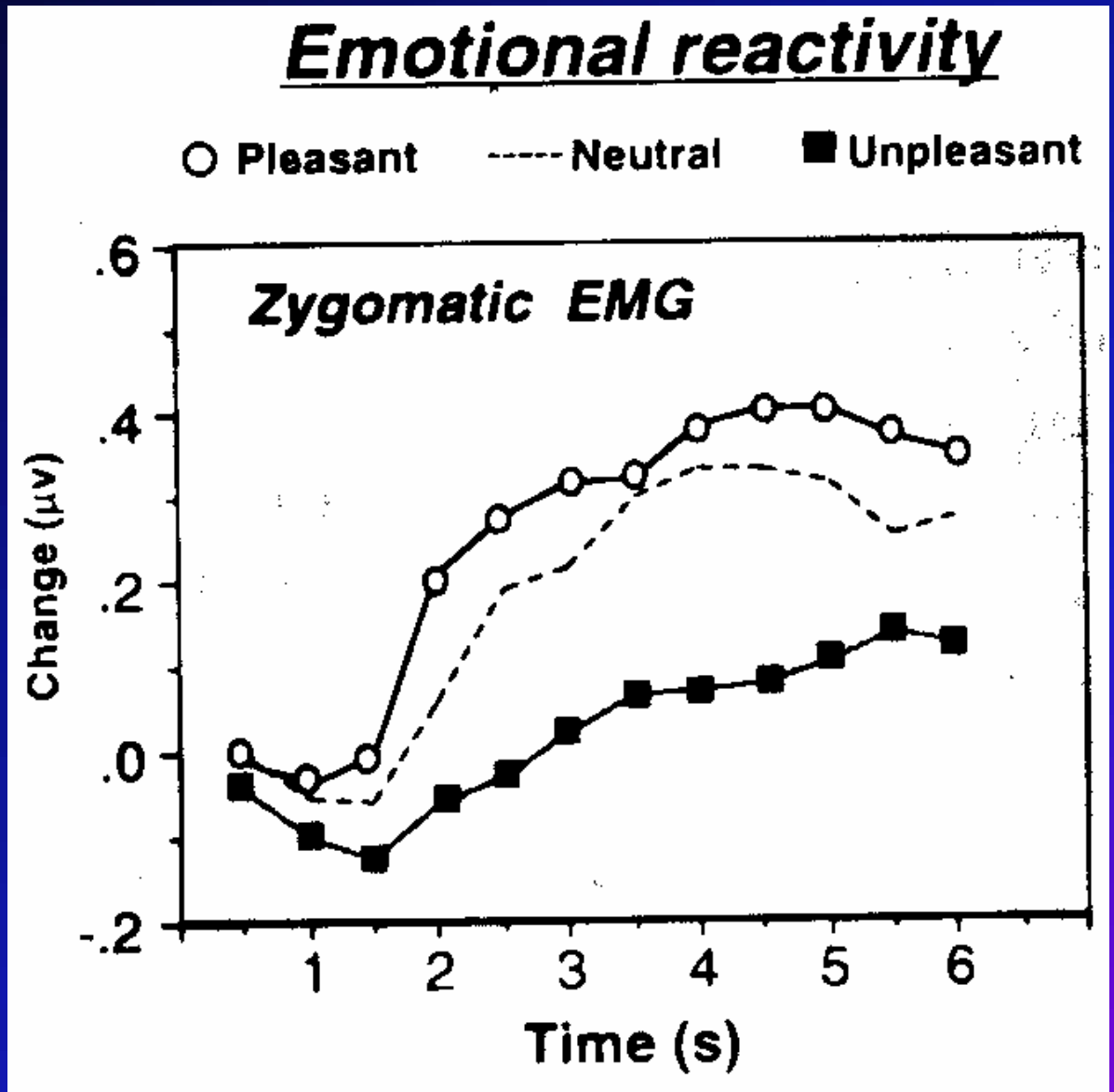
EMG Power



Corrugator “Frown”

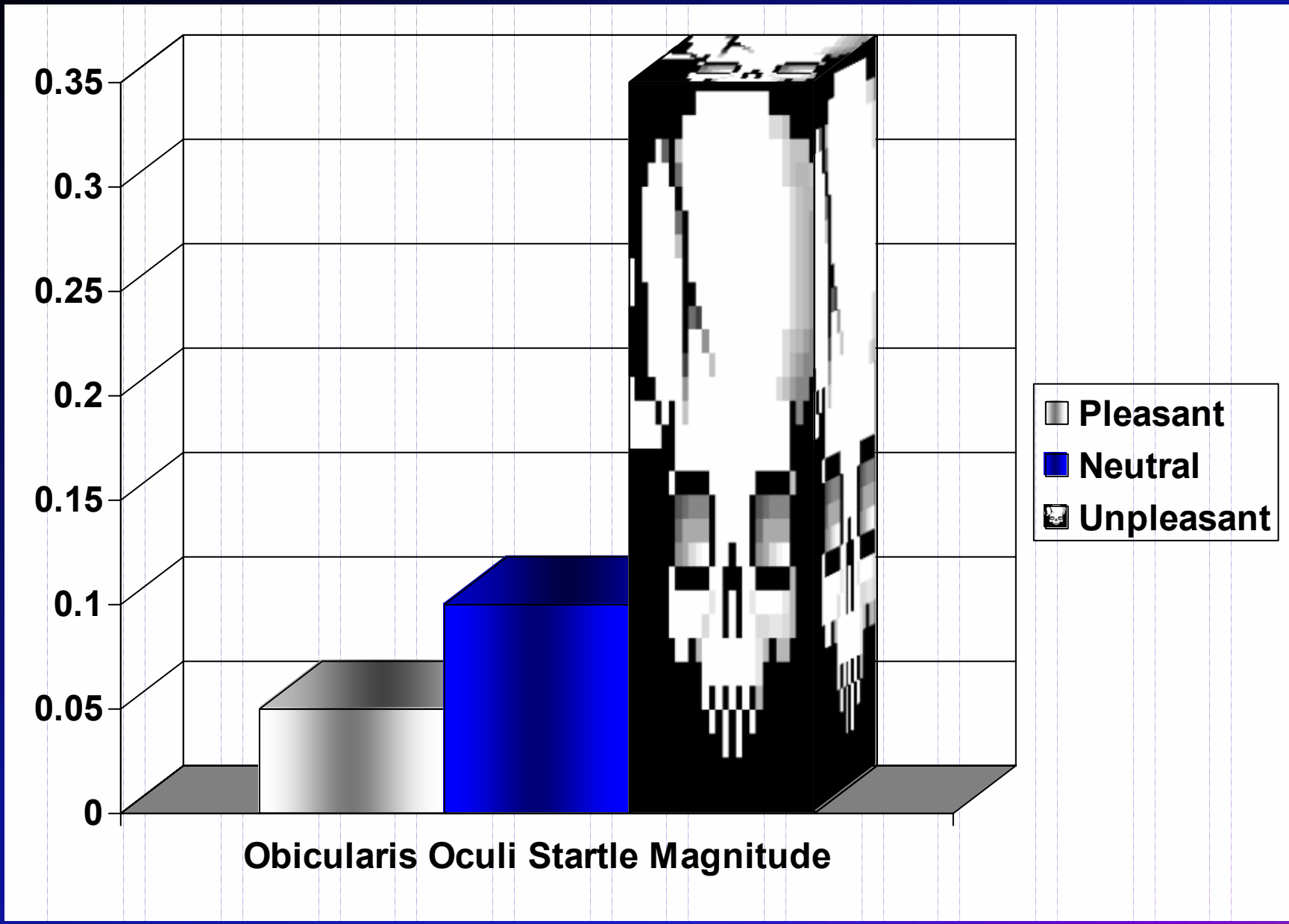


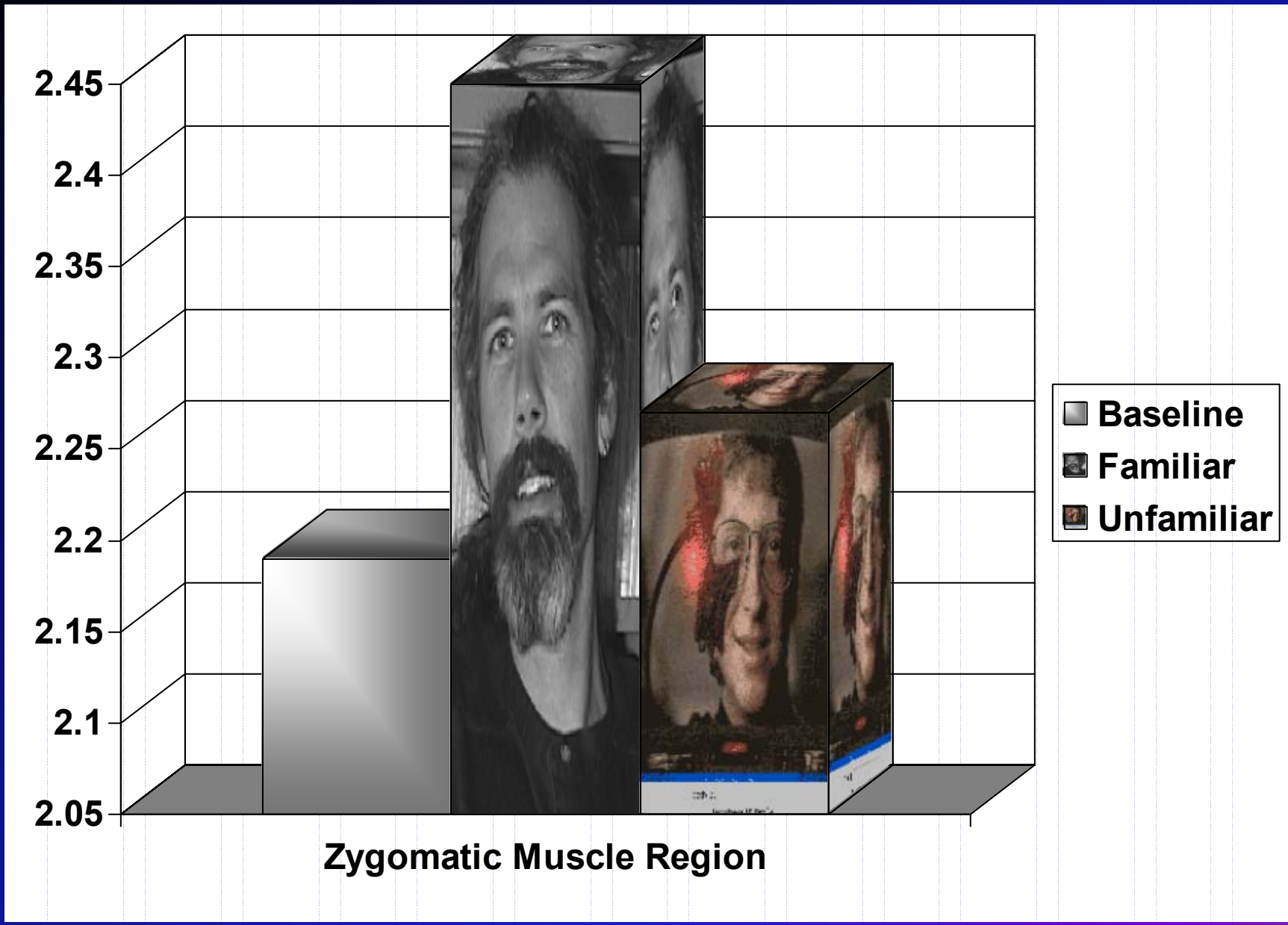
Zygomatic “Smile”



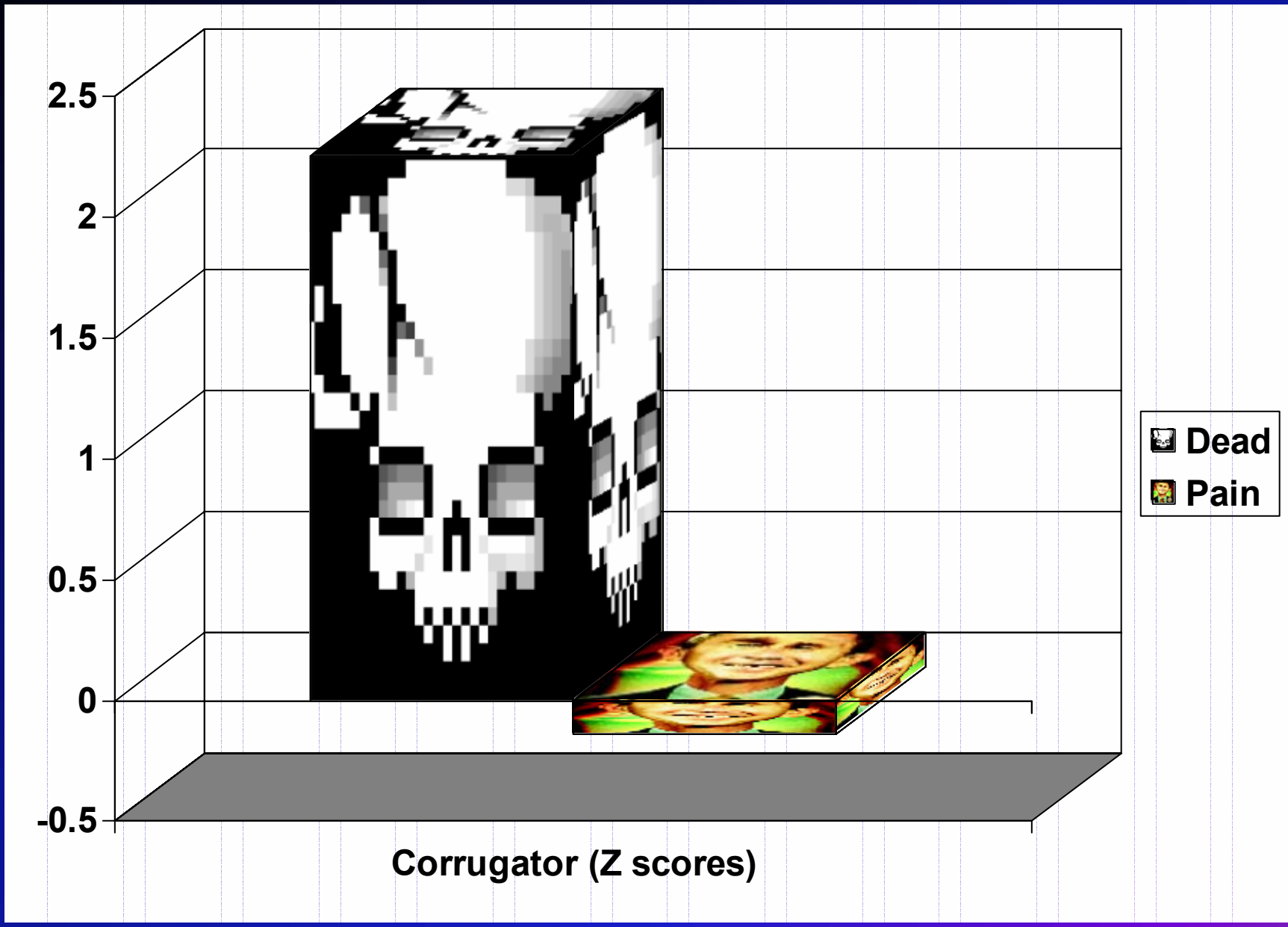
Applications

- Startle Probe
- Subtle affect
  - Mere Exposure
  - Mortality Salience
  - Biofeedback of EEG -- outcome measure

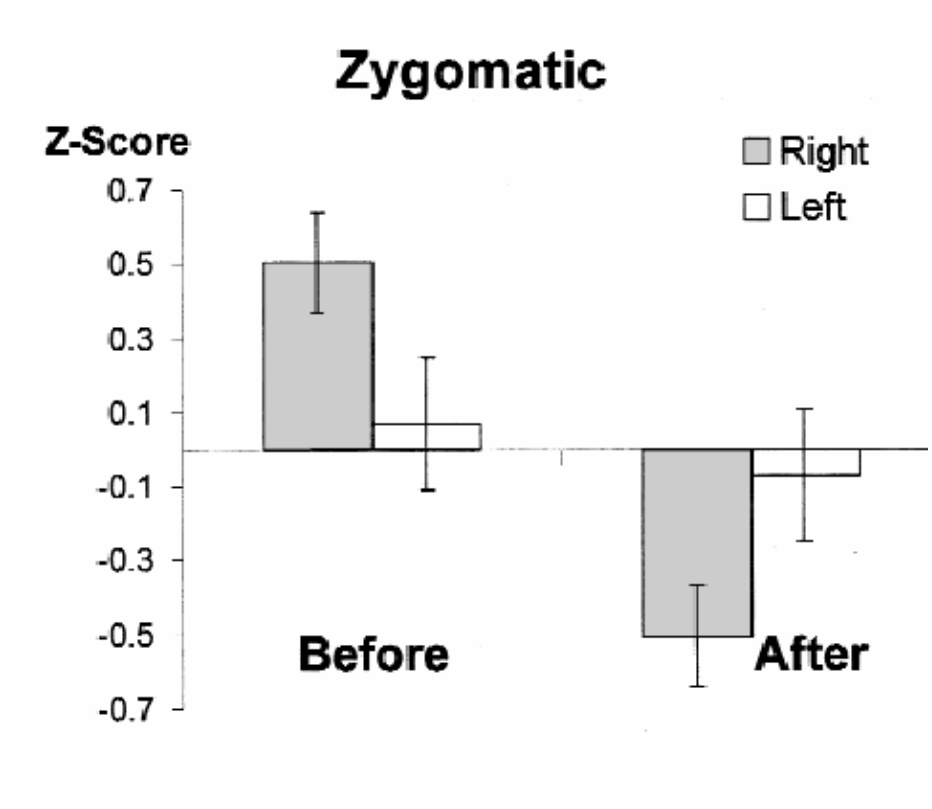

0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Pleasant
Neutral
Unpleasant
Obicularis Oculi Startle Magnitude

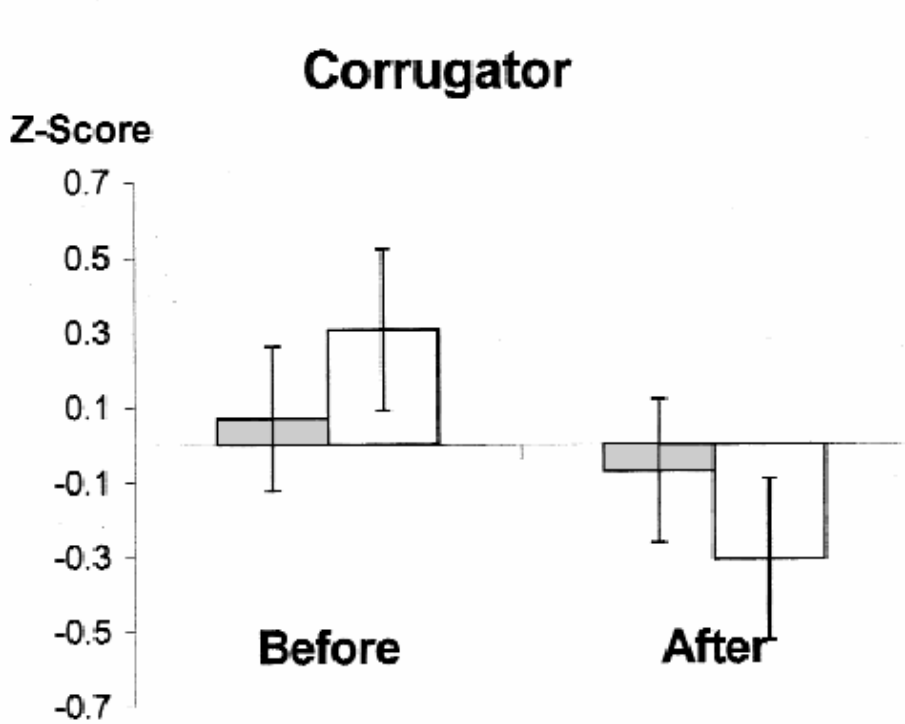


Loosely translated from Harmon-Jones & Allen, 2001



Another loose translation: Arndt, Allen, & Greenberg, in press





From Allen, Harmon-Jones, and Cavender (2001)