A wee bit more
Cardiovascular Psychophysiology
…and then…

The Skeletomotor System

Announcements 3/3/25

- No Class Meeting March 10, Spring Break
- Electricity Exam retake if you scored < 16. Contact instructor
- Research Paper/Project: Never too soon to ponderD

Questions and Feedback

I actually don't remember if I submitted a question for last week's class. Sorry!

Hypertrophic Cardiomyopathy (HCM)	**Risk:** Worsened outflow obstruction
Severe Aortic Stenosis	**Risk**: Critical reduction in cardiac output
Ischemic Heart Disease (e.g., Coronary Artery Disease, Recent Myocardial Infarction)	**Risk**: Myocardial ischemia or arrhythmias
Heart Failure with Reduced Ejection Fraction (HFrEF)	**Risk**: Decompensation or syncope
Arrhythmias (e.g., Atrial Fibrillation, Ventricular Tachycardia, WPW Syndrome)	**Risk**: Induced or exacerbated arrhythmias
Severe Pulmonary Hypertension	**Risk**: Right heart failure or cardiovascular collapse

JOURNAL OF FORENSIC SCIENCES

Paper

Commode Cardia—Death by Valsalva Maneuver: A Case Series†

Amanda O. Fisher-Hubbard M.D., Kilak Kesha M.D., Francisco Diaz M.D., Chantel Njiwaji M.D., PaoLin Chi M.D., Carl J. Schmidt M.D.

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† Presented at the 66th Annual Meeting of the American Academy of Forensic Sciences, February 17–20, 2014, in Seattle, WA.

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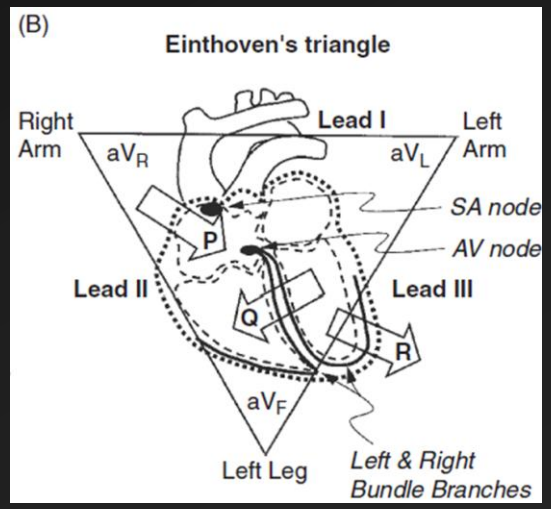
Abstract

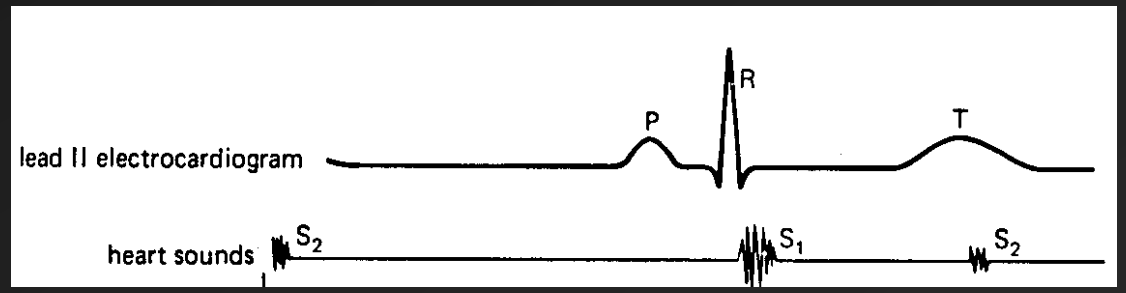
The Valsalva maneuver is used in clinical medicine for the diagnosis and/or treatment of various cardiovascular conditions. It can also be used in activities of daily living, such as defecation. Due to the cardiovascular effects produced during the Valsalva maneuver, it may be contraindicated in certain medical conditions and could be a trigger of sudden cardiac death. The incidence and prevalence of death following Valsalva maneuver in the presence of underlying cardiovascular disease, or "commode cardia," has not been examined. In 2012, the Wayne County Medical Examiner's Office (Detroit, MI) investigated 21 deaths that occurred on the toilet, fourteen of which were due to cardiovascular disease. In another 31 deaths in the bathroom due to cardiovascular disease, the possibility that the decedent defecated immediately prior to death could not be excluded. Hence, the incidence of commode cardia in this population ranges from 2.3 to 7.4% of all cardiovascular-related deaths.

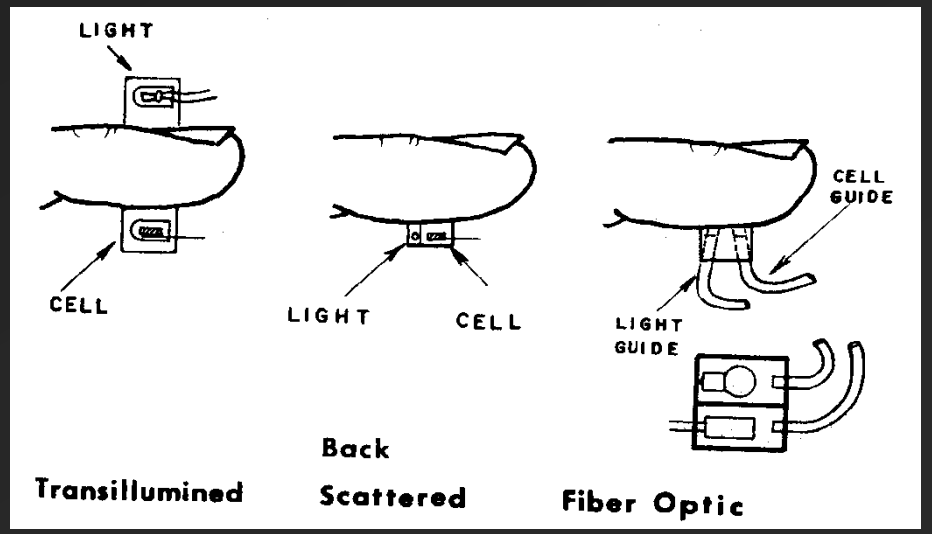
Returning to last time

Cardiovascular Measures

- Electrocardiogram (EKG)
- Phonocardiogram (PCG)
- Photoplethysmography
- Impedance cardiography
- Ballistocardiography
- Blood Pressure

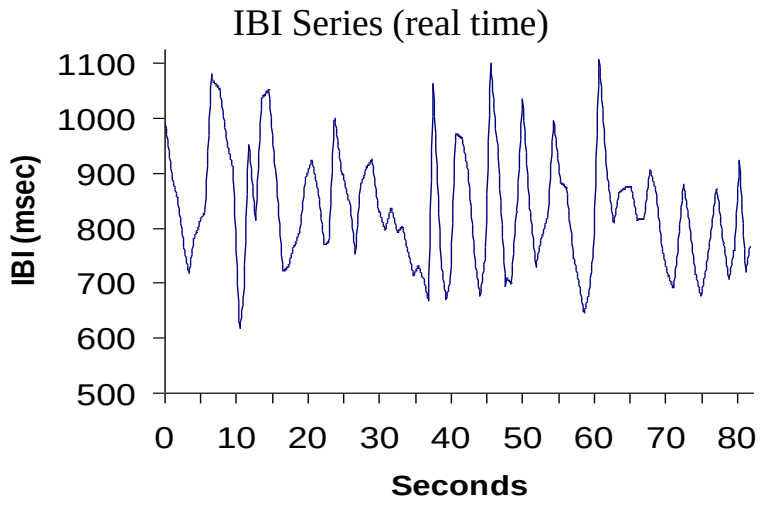






Measuring Vagal Influence

- Descending Vagal Influence slows HR
- Respiration interrupts this vagal influence
- The size of periodic oscillations due to respiration can therefore index the strength of the Vagal influence
  - Note, however, that under some circumstances, there can be dissociation between RSA and presumed central cardiac vagal efferent activity (cf., Grossman & Taylor, 2007)
  - Concerns over changes in rate, and to lesser extent depth
  - See special issue of *Biological Psychology*, 2007 for more in depth treatment of these issues and more!
- Demo with QRSTool


IBI Series (real time)
IBI (msec)
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700
600
500
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10
20
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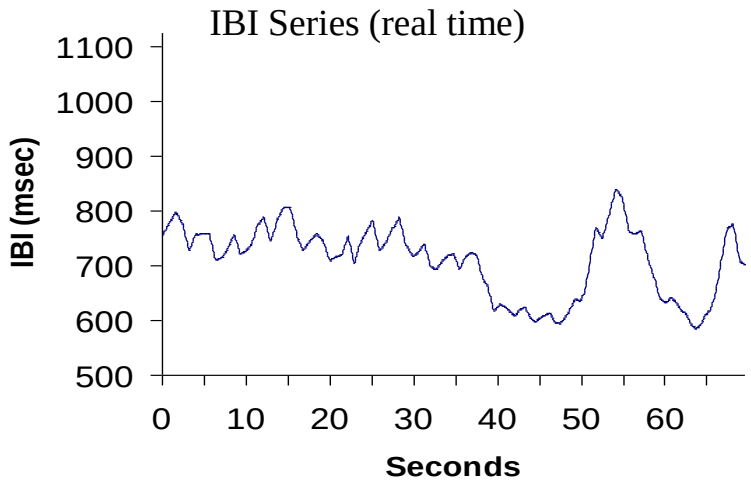
40
50
60
70
80
Seconds


IBI Series (real time)
IBI (msec)
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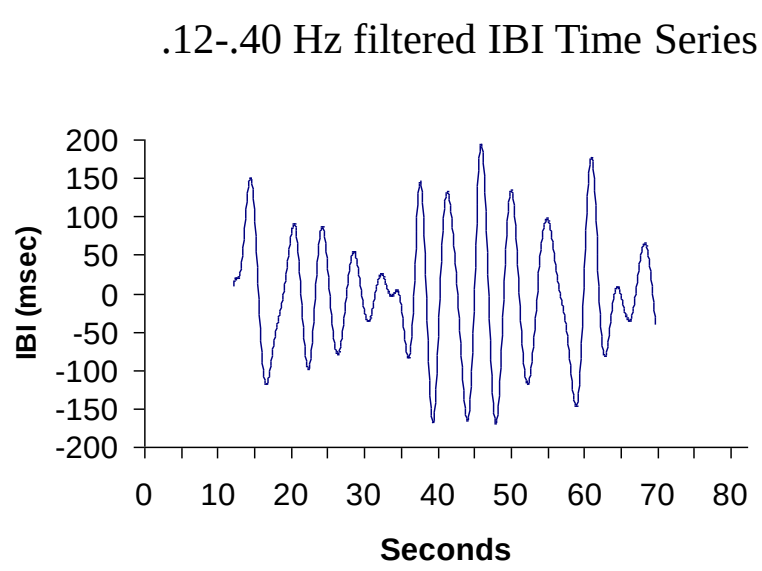
.12-.40 Hz filtered IBI Time Series
IBI (msec)
200
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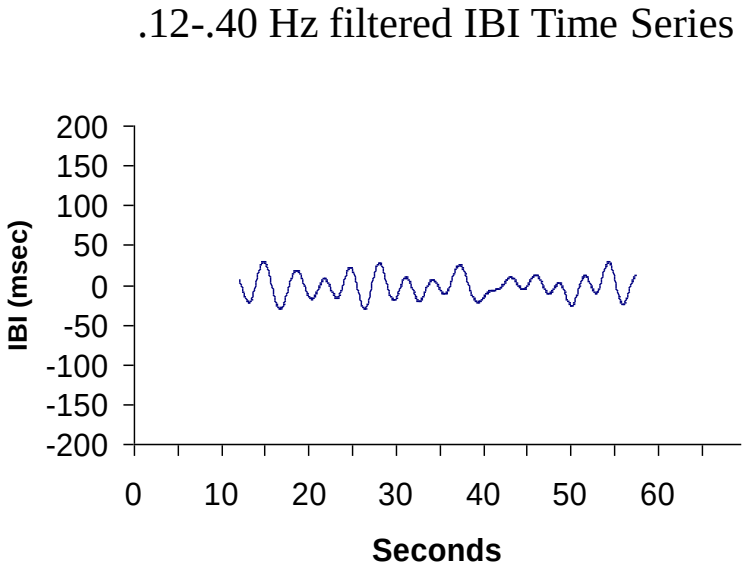
Seconds


.12-.40 Hz filtered IBI Time Series
IBI (msec)
200
150
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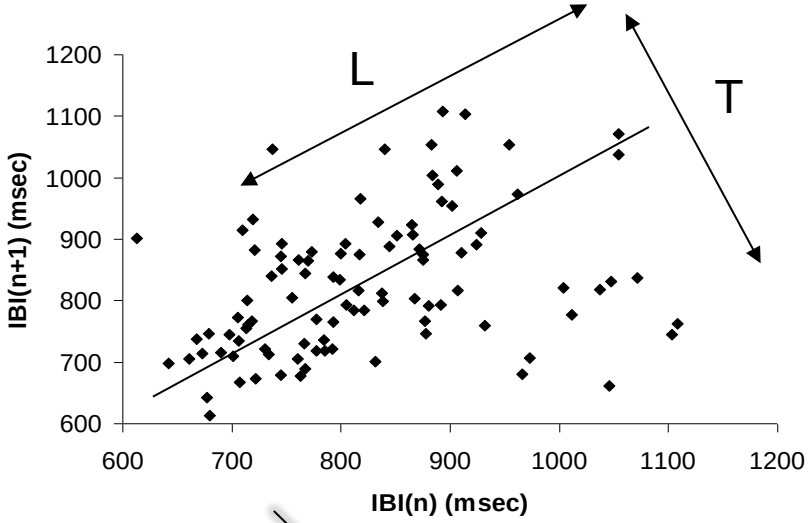
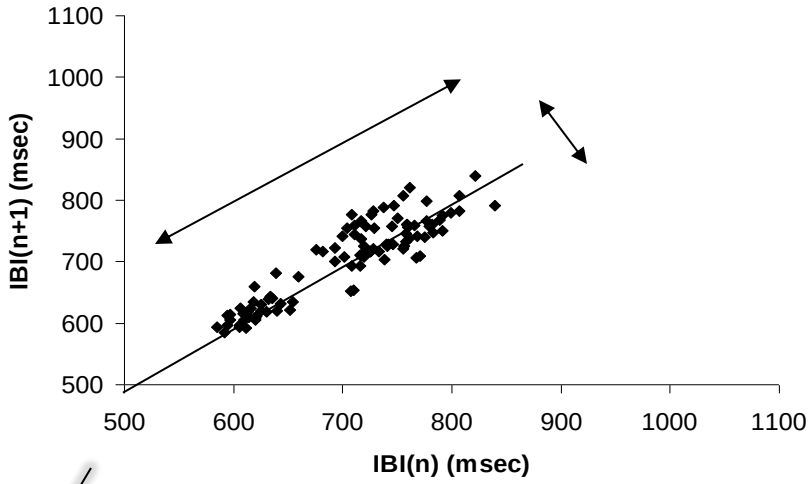
Seconds

High Variability Subject



Low Variability Subject



Rate		
73.3	HR	85.7
832.3	IBI	707.7
Total Variability		
9.2	HRV	8.3
112.4	SDNN	66.3
132.8	RMSSD	27.7
"Sympathetic"		
1.4	CSI	4.7
"Parasympathetic"		
57.1	PNN50	10.8
97.6	MSD	22.0
5.3	CVI	4.5
8.8	RSA	5.3

Metrics output by CMetX, with notes concerning computation

Metrics of rate, which are influenced by both parasympathetic (PNS) and sympathetic (SNS) influences
- Mean interbeat interval (IBI), calculated as simple average of IBIs
- Mean heart rate (HR), calculated as the average of the rate-transformed IBIs, not as the rate-transformation of the average IBI

Metrics summarizing total heart rate variability, which are influenced by both SNS and PNS
- Heart rate variability (HRV), operationalized as the natural log of the variance of the IBI time series
- Standard deviation of IBI series (SDNN); NN in the acronym SDNN is the abbreviation for "normal-to-normal intervals," which is the artifact-free IBI series
- Root mean square of successive differences between IBIs (RMSSD)

Putative sympathetic metric
- A cardiac sympathetic index (CSI; Toichi et al. (1997), see Fig. 1)[a]

Putative parasympathetic metrics
- Mean absolute successive IBI difference (MSD)
- Proportion of consecutive IBI differences >50 ms (pnn50)
- Respiratory sinus arrhythmia (RSA), defined as natural log of band-limited (.12–.40 Hz) variance of IBI time series
- A cardiac vagal index (CVI; Toichi et al. (1997), see Fig. 1)[a]

Spectral approaches

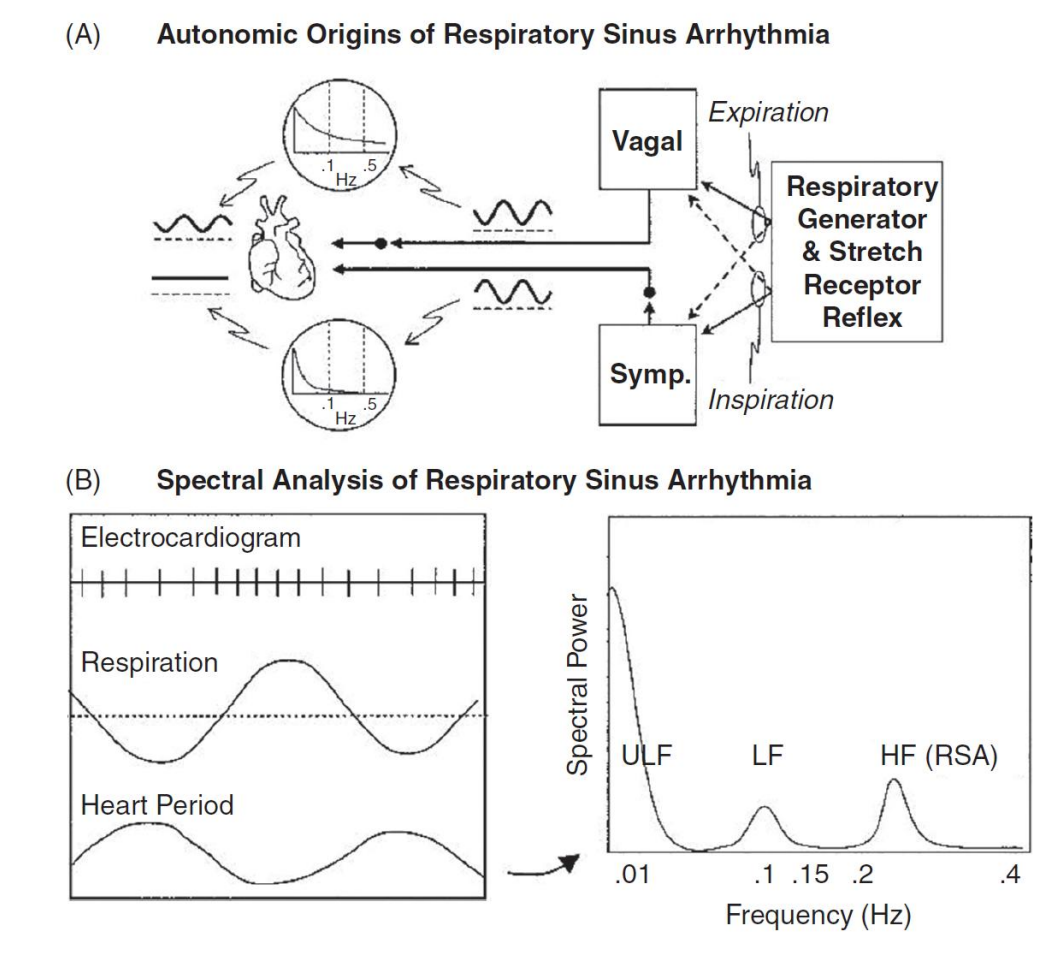
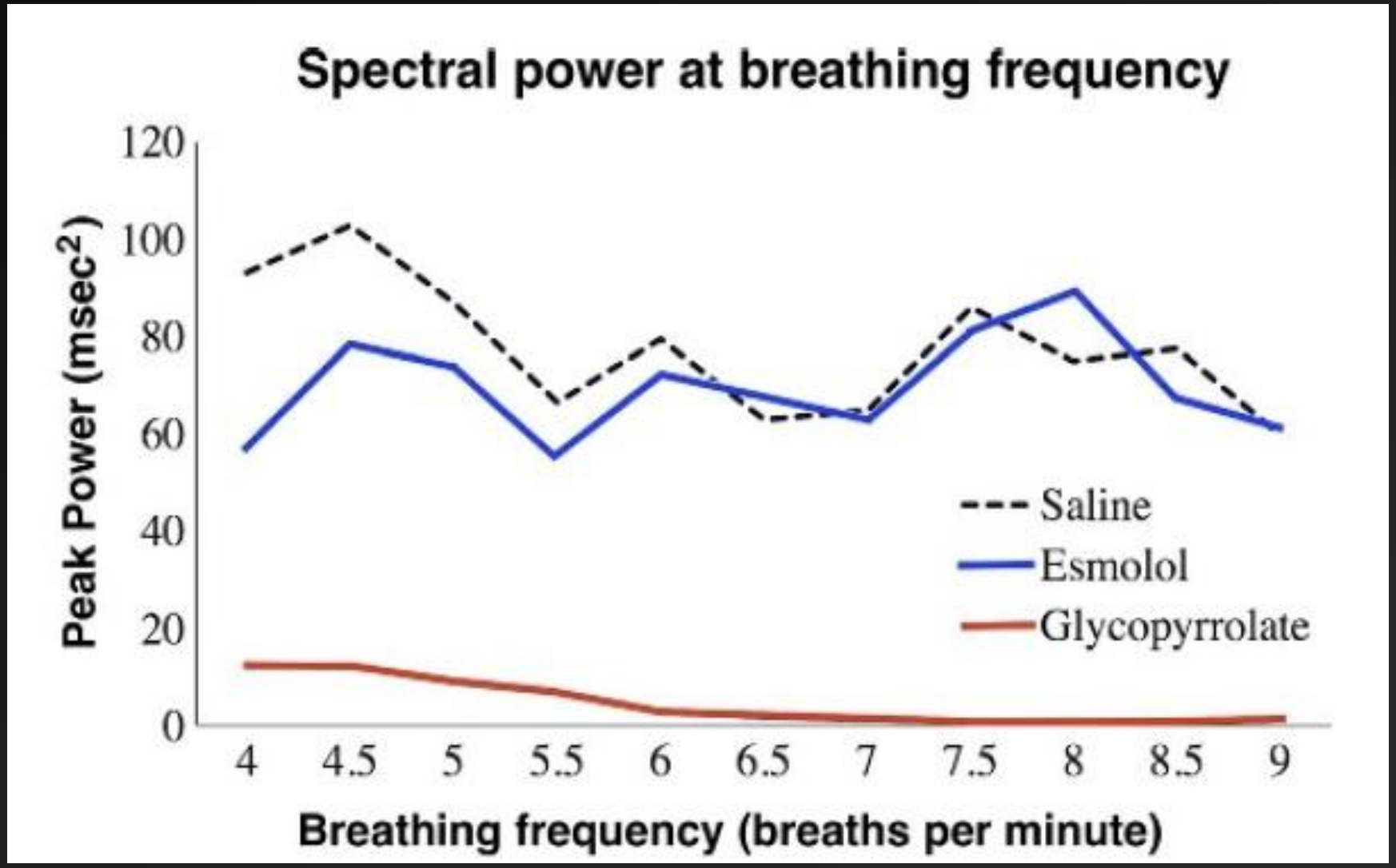


Figure 9.10 Respiratory sinus arrhythmia (RSA). (A) Neurophysiological generators of RSA. Respiratory rhythms are apparent in both sympathetic and parasympathetic nerves, but the different transfer functions (inserts) allow the parasympathetic but not the sympathetic innervations to impart a respiratory rhythm to the beat of the heart. (B) Illustrations of the relation between respiration and heart period, and its quantification by spectral analysis. ULF = ultra-low frequency; LF = low frequency, HF = high frequency.

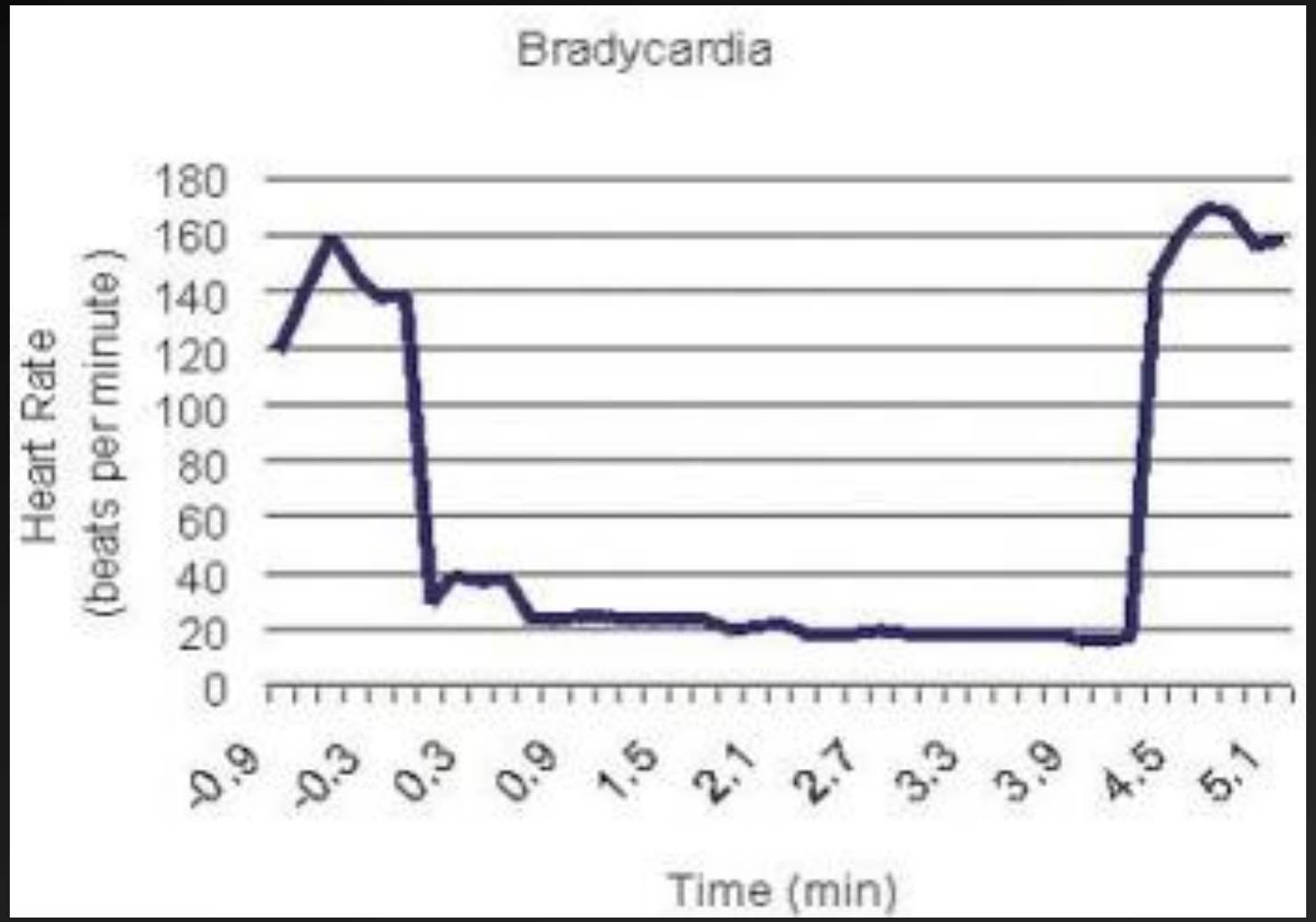
Vagal Control at what Breathing Frequencies?



Kromenacker, Sanova, Marcus, Allen, Lane (2018), *Psychosomatic Medicine*

Cardiac Vagal Control and Modulation

- Two Vagal Efferent Branches which terminate on SA Node (Porges 1995, 2003, 2007)
  - Reptilian "Dumb": Dorsal Motor Nucleus
    - Massive reduction in HR & conservation of oxygen.
    - Dive reflex -- cold water on the face during breath hold
  - Phylogentically newer "smart" Vagus
    - Orginates from Nucleus Ambiguous
    - Modualtes influence to:
      - Promote attentional engagement, emotional expression, and communication.
    - Mobilizes organism to respond to environmental demands
      - Phasicly withdraws inhibitory influence, increasing HR
      - Upon removal of the environmental stressor, resumes its efferent signal
        - Slowing heart rate
        - Allows the organism to self-sooth
- This polyvagal theory is not without its critics (e.g., Grossman & Taylor, 2007).



Bradycardia observed in a diving seal. **Data adapted from R.S. Elsner (1998)**

	ANS Component	Behavioral Function	Lower motor neurons
III	Myelinated vagus *(ventral vagal complex)*	Social communication, self-soothing and calming, inhibit "arousal"	Nucleus ambiguus
II	Sympathetic-adrenal system	Mobilization (active avoidance)	Spinal cord
I	Unmeyelinated vagus *(dorsal vagal complex)*	Immobilization (death feigning, passive avoidance)	Dorsal motor nucleus of the vagus

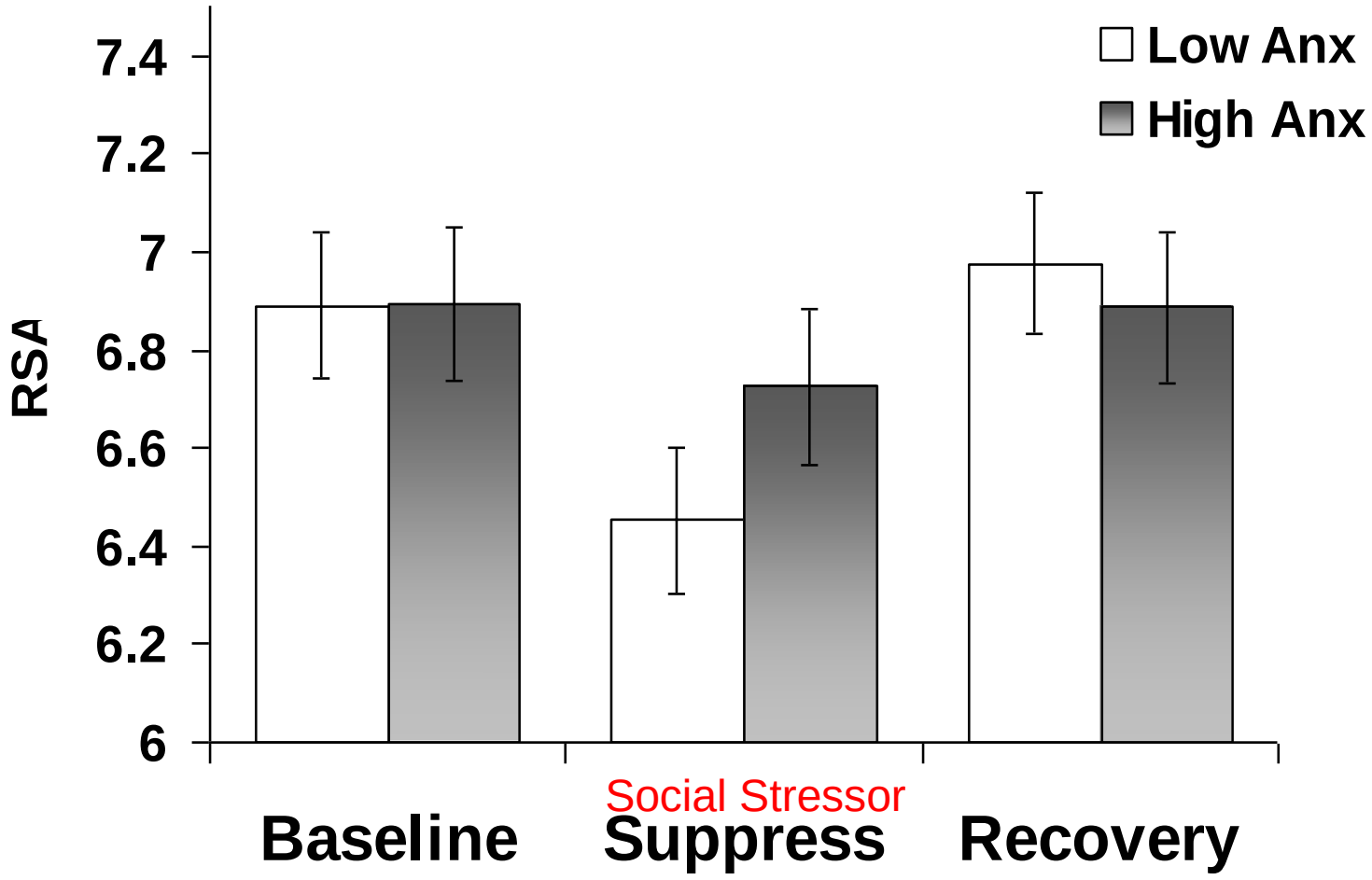
Fig. 1. Phylogenetic stages of the polyvagal theory.

Porges, 2007

Tonic Vs Phasic

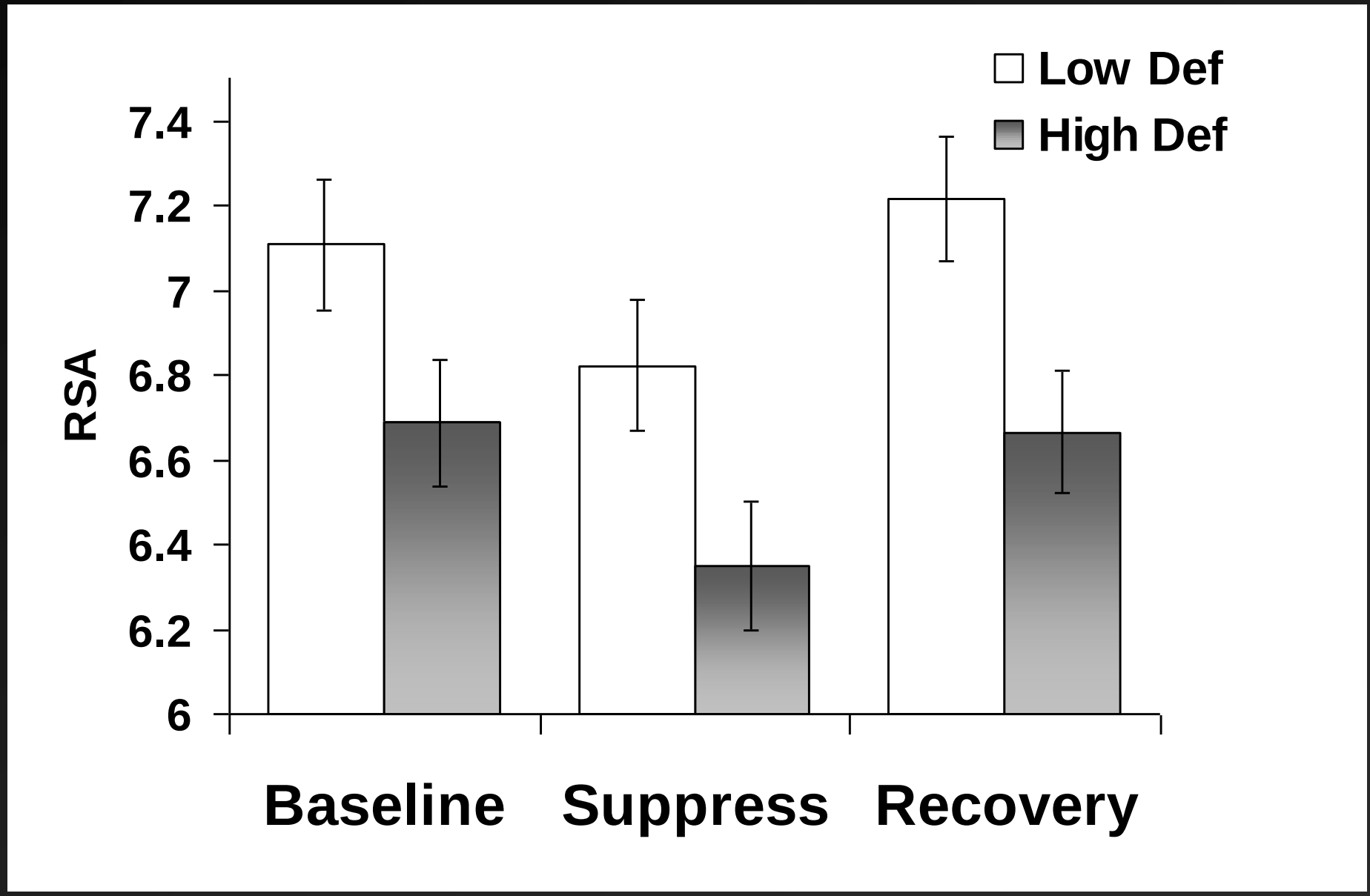
- Tonic Level indexes capacity
- Phasic change indexes actualization of that capacity
- Attention
  - higher vagal “tone” was associated with faster reaction time to a task requiring sustained attention
  - Hyperactive kids treated with Ritalin (Porges, Walter, Korb, & Sprague, 1975).
    - attentional skills improved
    - appropriate task-related suppression of heart rate variability was observed while performing the task requiring sustained attention
- Emotion
  - Beauchaine (2001):
    - low baseline vagal “tone” is related to negative emotional traits
    - high vagal withdrawal is related to negative emotional states

Task-related and Emotion-related modulation



Movius & Allen, 2005

Vagal Control and Defensive Coping



Movius & Allen, 2005

Individual Differences in Cardiac Vagal Control (aka "Trait Vagal Tone")

- Infants
  - Various sick infants have lower vagal tone (Respiratory Distress Syndrome, Hydrocephalic)
  - Infants with higher vagal tone (Porges, various years)
    - More emotionally reactive (both + & -)
    - More responsive to environmental stimuli (behaviorally and physiologically)
- Anxiety Disorders
  - Lower Vagal Tone in GAD (Thayer et al., 1996)
  - Lower Vagal Tone in Panic Disorder (Friedman & Thayer, 1998)
- Depression
  - Depression characterized by lower Vagal tone?
  - State dependent? (Chambers & Allen, 2002)

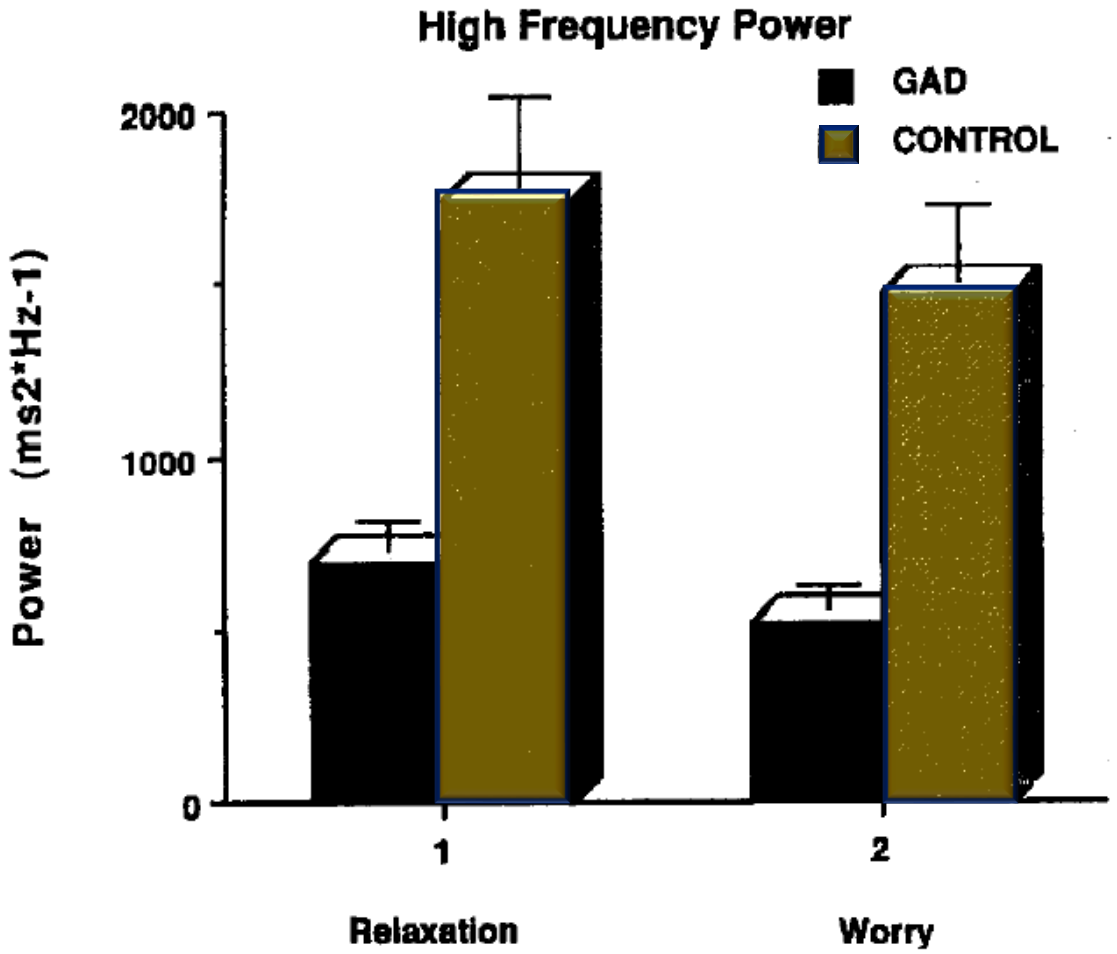
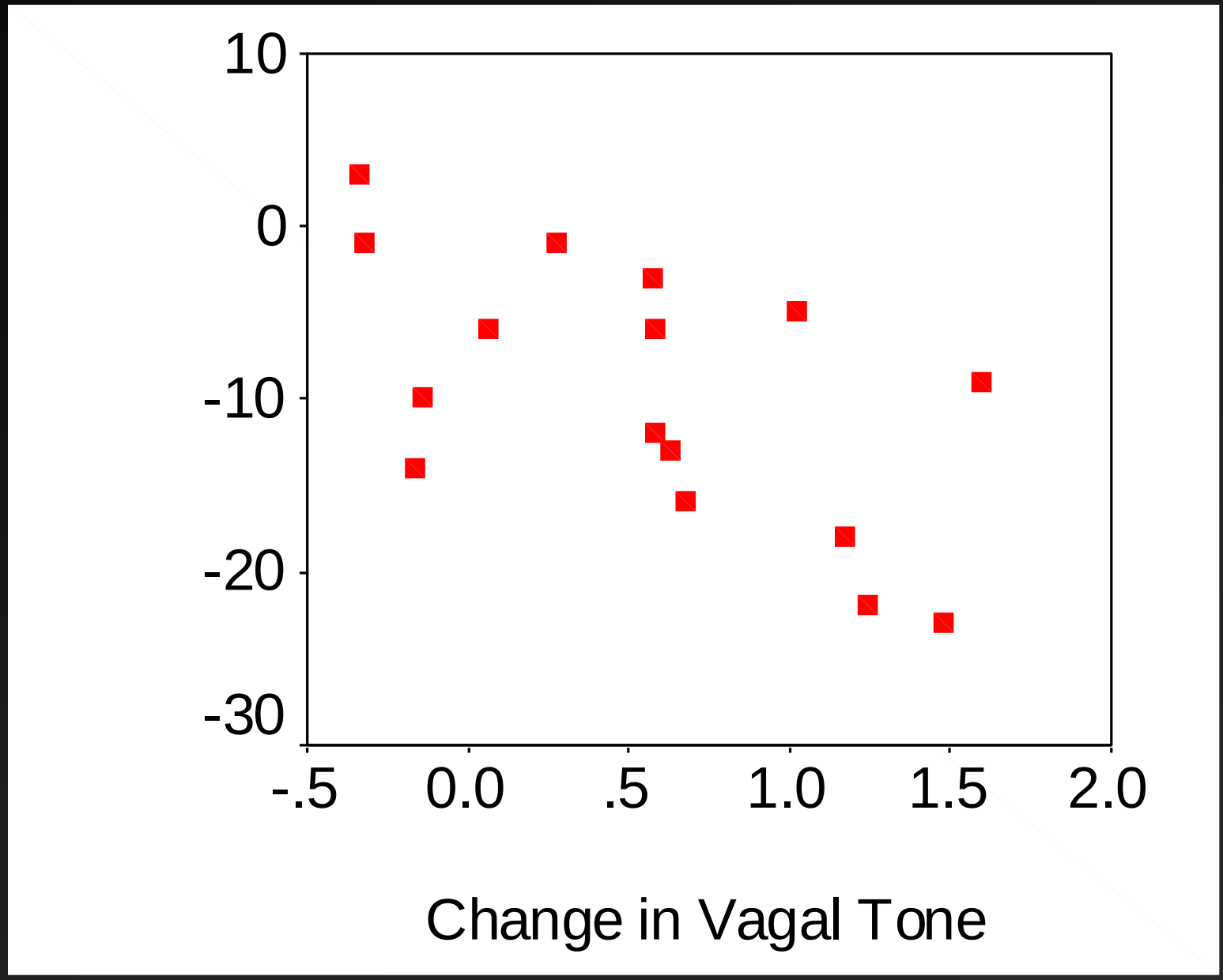


Figure 1. Power in the high frequency (respiratory) component of heart period variability in GAD patients and controls during relaxation and worry.

Table 1
Significant contrasts among panickers, blood phobics, and controls

Variable	Panic (mean, S.D.)	Blood phobic (mean, S.D.)	Control (mean, S.D.)	T ratio, df, p value
IBI (ms)	761.8 (141.0)	837.1 (92.4)	905.2 (132.5)	P < B 4.59 (215) $p<0.001$ P < C 7.65 (214) $p<0.001$ B < C 4.30 (207) $p<0.001$
VAR (ms^2)	3942 (4009)	4334 (2663)	6112 (4563)	P < C 3.70 (214) $p<0.001$ B < C 3.44 (207) $p<0.001$ P = B N.S.
MSD (ms)	44.4 (31.2)	55.6 (22.7)	71.4 (32.1)	P < B 3.05 (215) $p<0.001$ P < C 6.34 (214) $p<0.001$ B < C 4.11 (207) $p<0.001$
HF power (ms^2 Hz^{-1})	991 (1225)	1385 (1073)	2239 (1911)	P < B 2.49 (212) $p<0.01$ P < C 5.67 (212) $p<0.001$ B < C 3.90 (203) $p<0.001$
LF/HF	2.1(2.5)	1.3 (1.8)	1.0 (1.5)	P < B 2.41 (209) $p<0.005$ P < C 3.64 (203) $p<0.001$ B = C N.S.

P, panic; B, blood phobic; C, control.



Chambers and Allen (2002) *Psychophysiology*

Can Vagal Control predict development of anxiety following stressors?

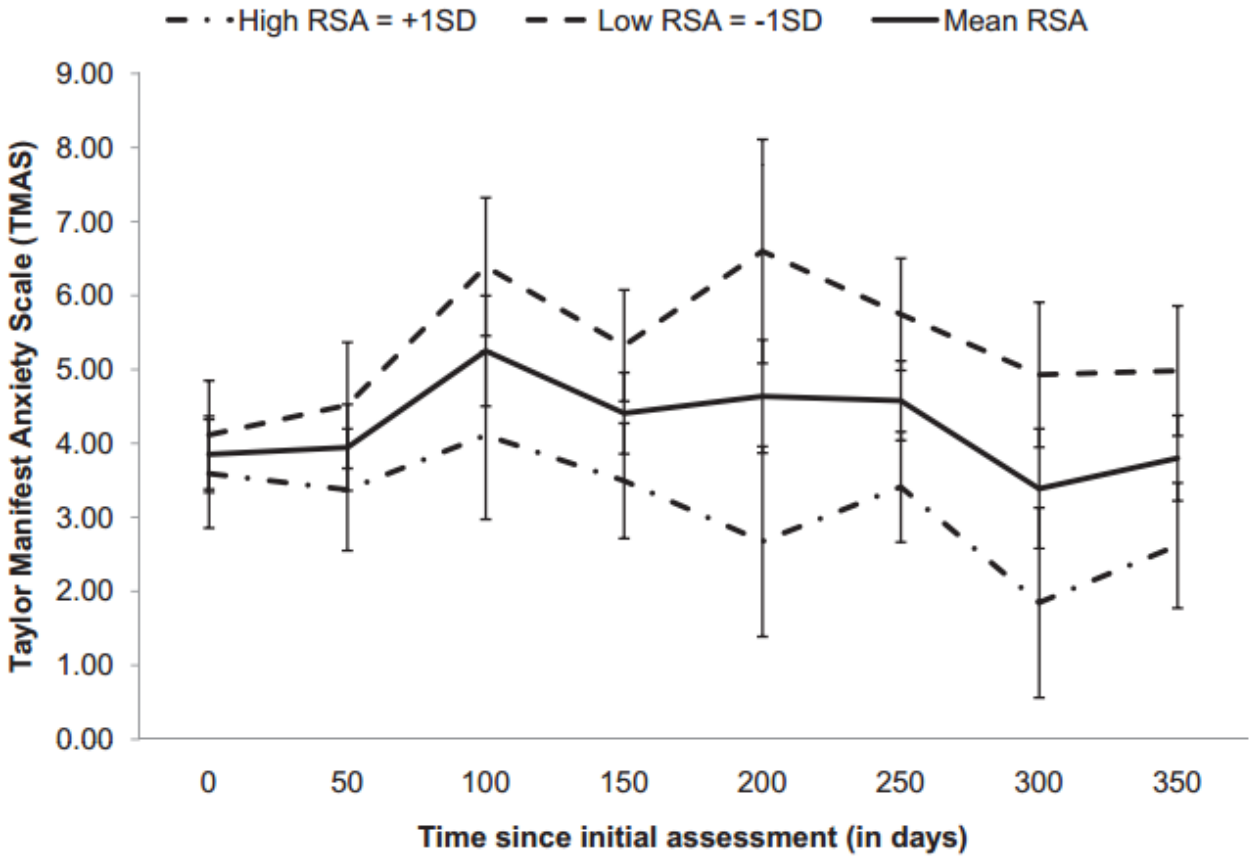


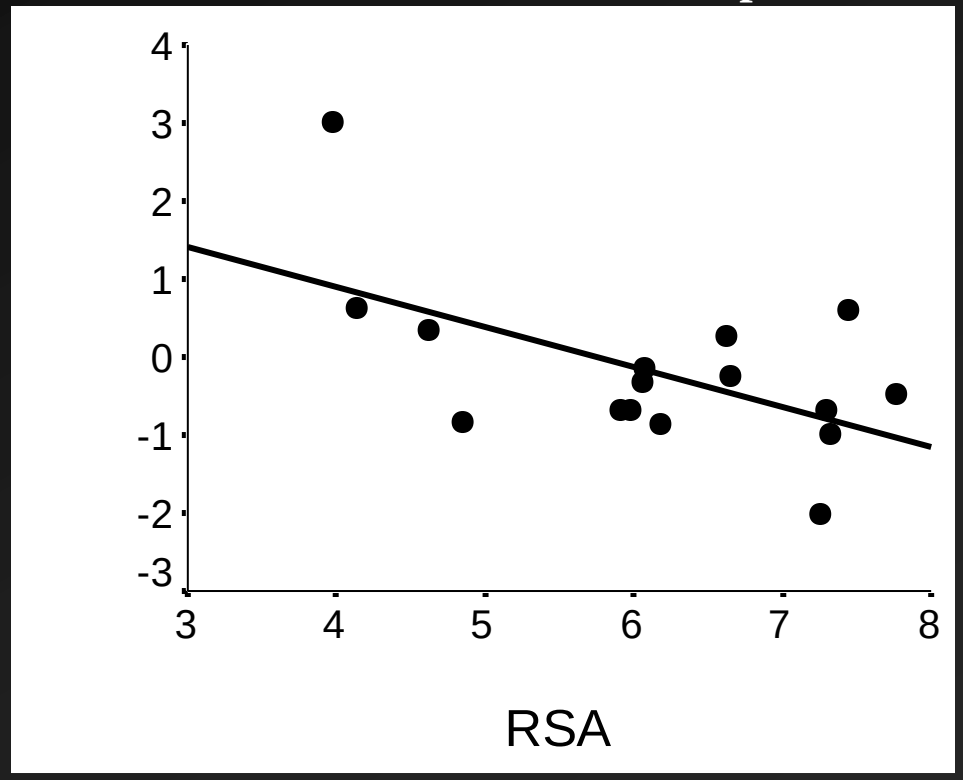
Fig. 1. Effect of the interaction between RSA adjusted for age and Time since initial assessment on TMAS over a 1-year period. Although RSA is a continuous variable, for illustrative purposes, its effect on TMAS is plotted at ±1 SD from the mean. Error bars represent standard errors. RSA: respiratory sinus arrhythmia; SD: standard deviation; TMAS: Taylor Manifest Anxiety Scale.

Kogan, Allen, Weihs (2012)
Biological Psychology

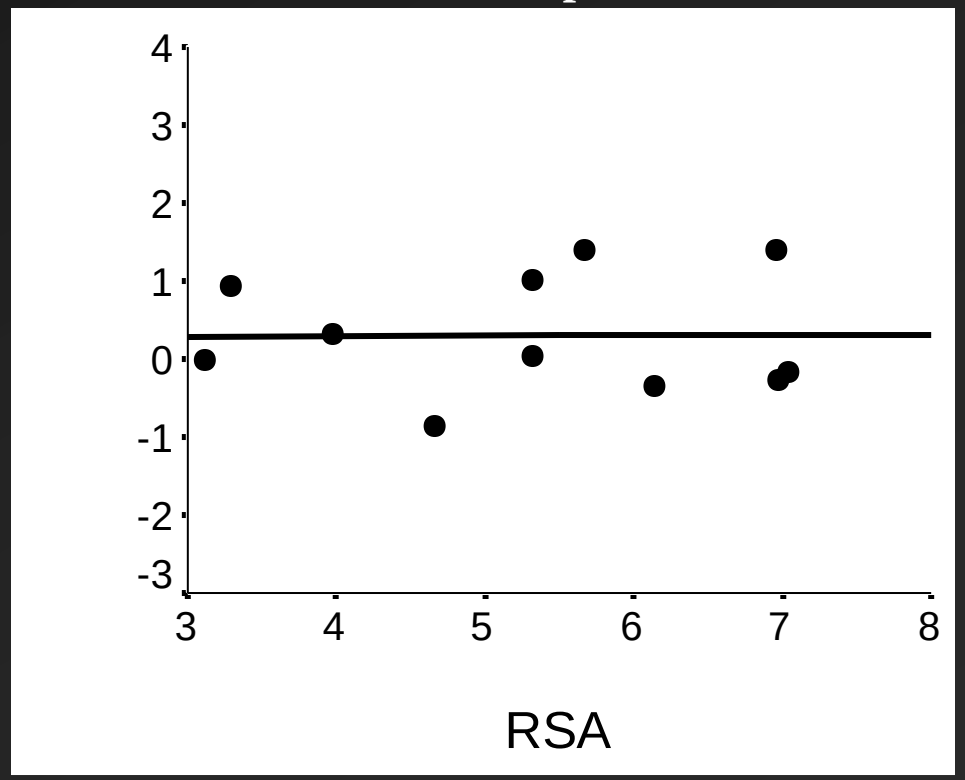
Trait Vagal Tone as Moderator of Response following Bereavement

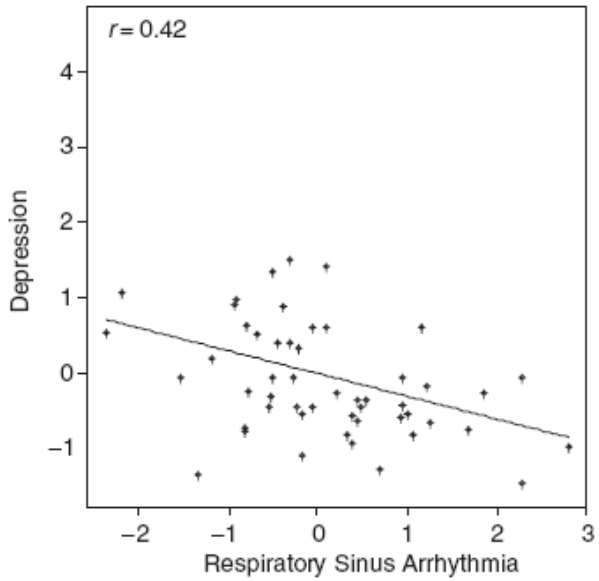
- Bereavement as a period of cardiovascular risk
- Disclosure as an intervention for Bereavement (O'Connor, Allen, Kaszniak, 2005)
- Overall, all folks get better, but no differential impact of intervention
- BUT… Vagal Tone as moderator

Intervention Group



Control Group





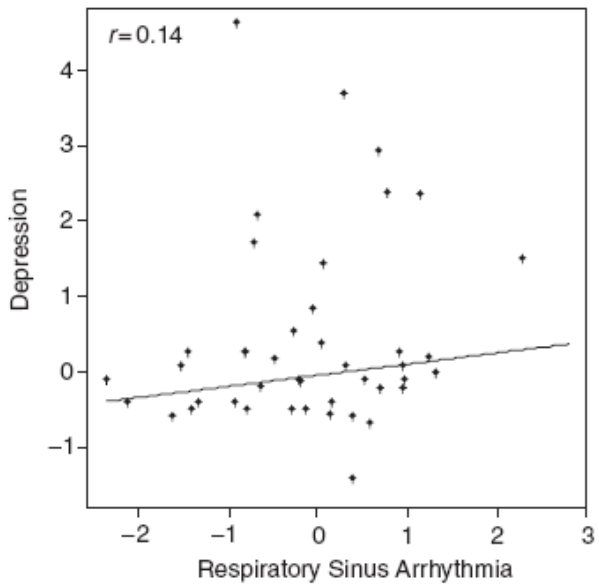
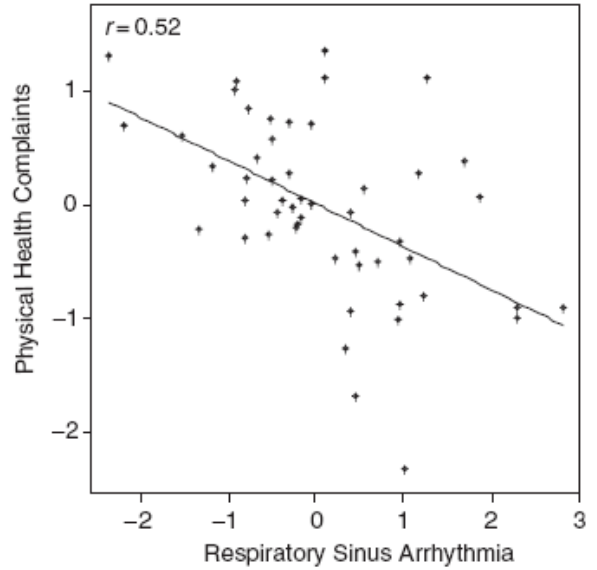


Figure 1. Scatterplot, prediction line, and prediction equation for the relationship between respiratory sinus arrhythmia (log of the variance of the band-limited [.12–.40 Hz] IBI series) and depression score (residualized on baseline depression score), for the disclosure group (top panel) and the control group (bottom panel). Negative depression score represents improvement from baseline to follow-up.



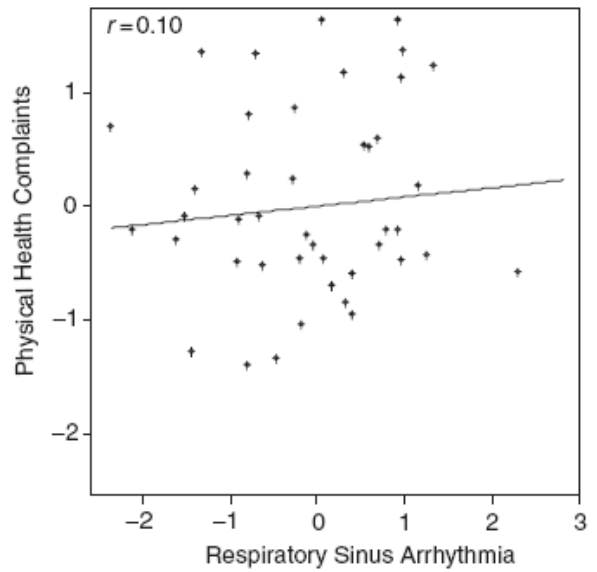
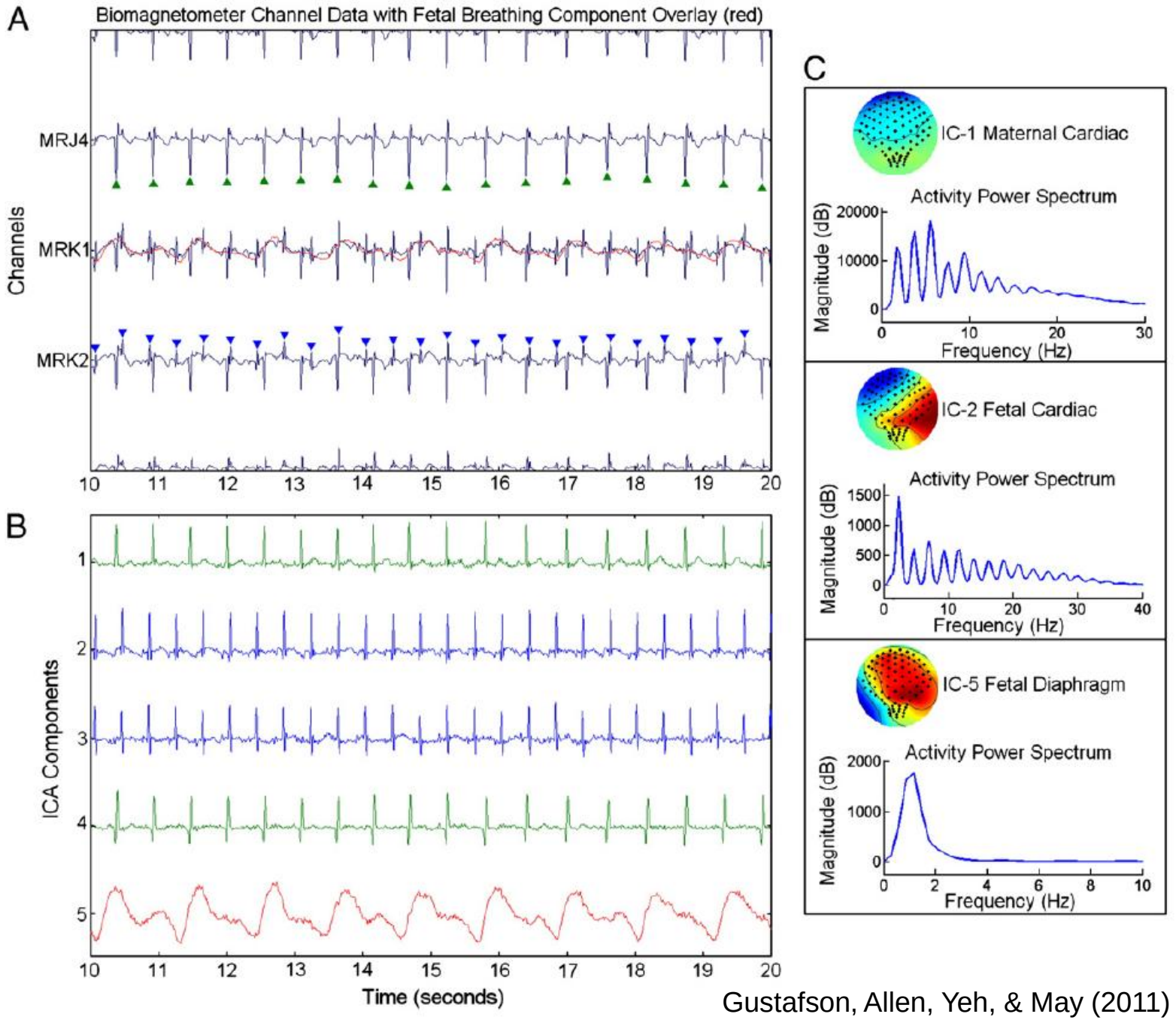


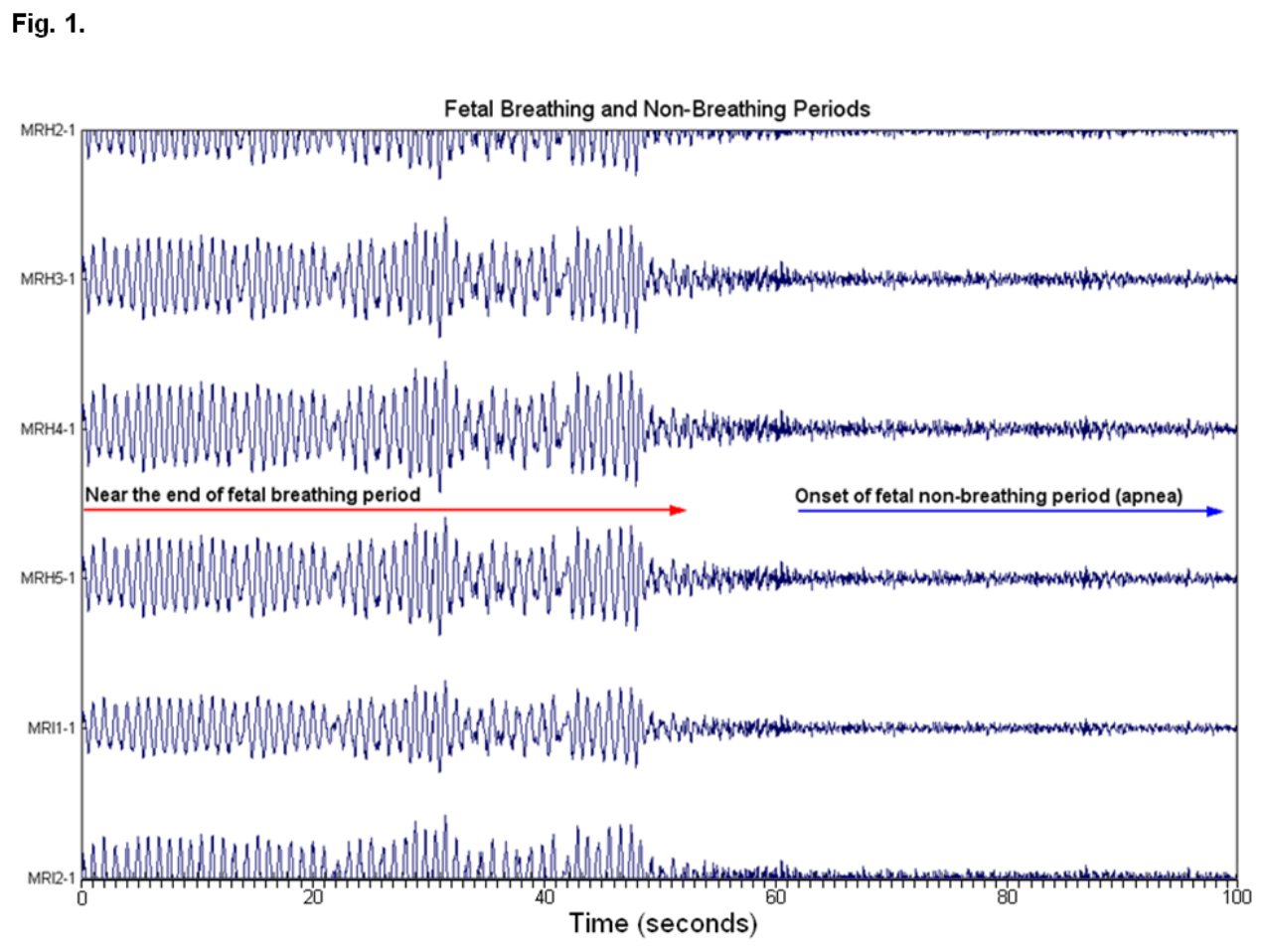
Figure 2. Scatterplot, prediction line, and prediction equation for the relationship between respiratory sinus arrhythmia (log of the variance of the band-limited [.12–.40 Hz] IBI series) and physical health complaint score (residualized on baseline physical health complaints score) for the disclosure group (top panel) and the control group (bottom panel). Negative physical health complaint score represents improvement from baseline to follow-up.

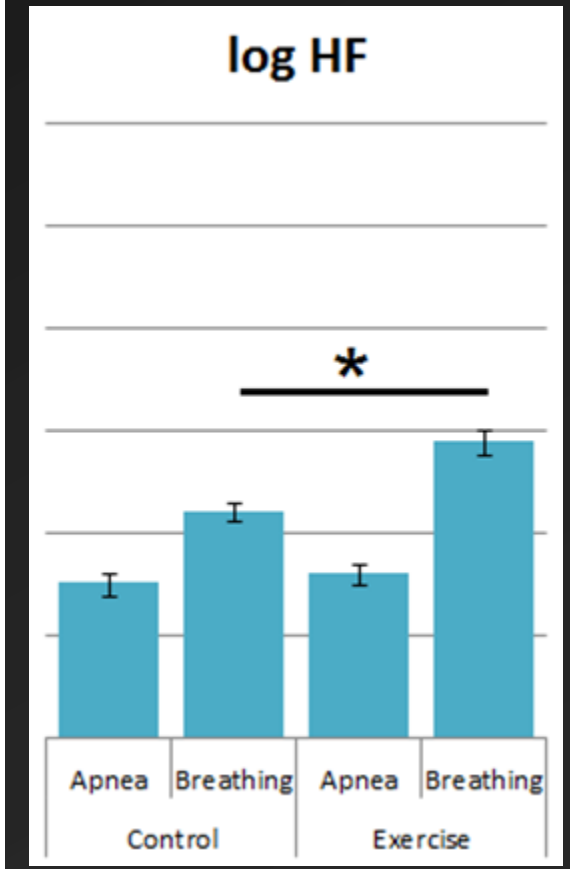
Fetal Vagal Control?



Gustafson, Allen, Yeh, & May (2011)

Do Maternal Behaviors Affect Fetal Cardiac Vagal Control?

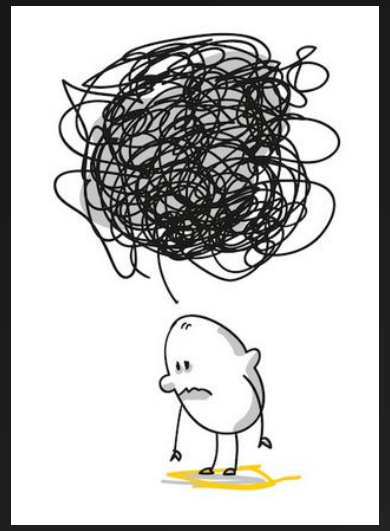




Gustafson, May, Yeh, Million, & Allen (2012)

Perseverative Thinking

- Transdiagnostic feature for distress disorders
- Worry: Anticipation of future negative consequences (that may or may not happen)
- Rumination: Dwelling on negative thoughts about past events
- Induces stress unrelated to the current environmental context



Perseverevereverevereverative

Physiological Concomitants of Perseverative Cognition: A Systematic Review and Meta-Analysis

Cristina Ottaviani
IRCSS Santa Lucia Foundation, Rome, Italy

Julian F. Thayer
The Ohio State University

Bart Verkuil
Leiden University

Antonia Lonigro
IRCSS Santa Lucia Foundation, Rome, Italy

Barbara Medea and Alessandro Couyoumdjian
Sapienza University of Rome

Jos F. Brosschot
Leiden University

Blood Pressure

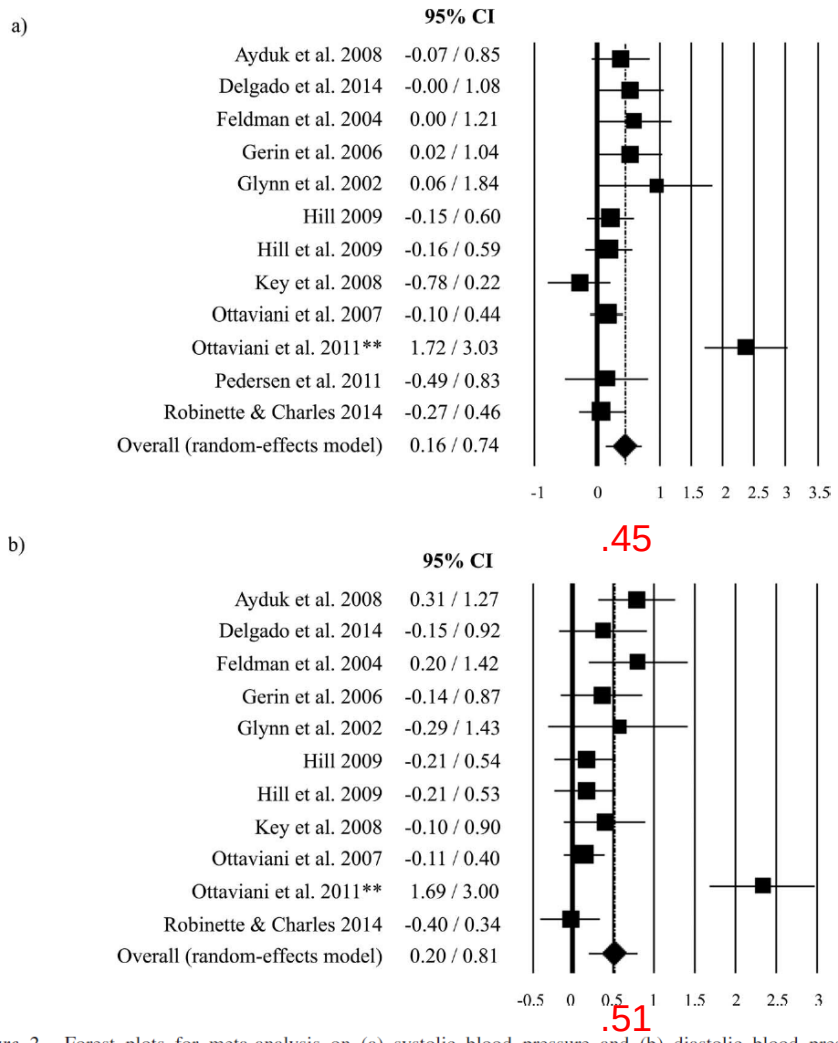


Figure 2. Forest plots for meta-analysis on (a) systolic blood pressure and (b) diastolic blood pressure concomitants of perseverative cognition when experimental studies were examined.

Heart Rate

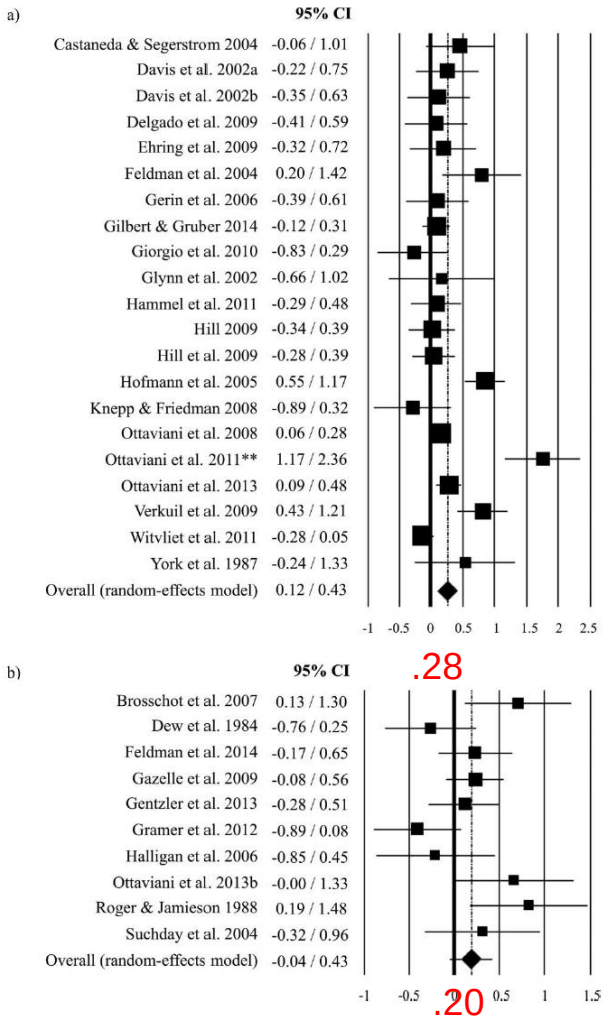


Figure 3. Forest plot for meta-analysis on heart rate concomitants of perseverative cognition when experimental (a) and correlational (b) studies were examined.

HRV

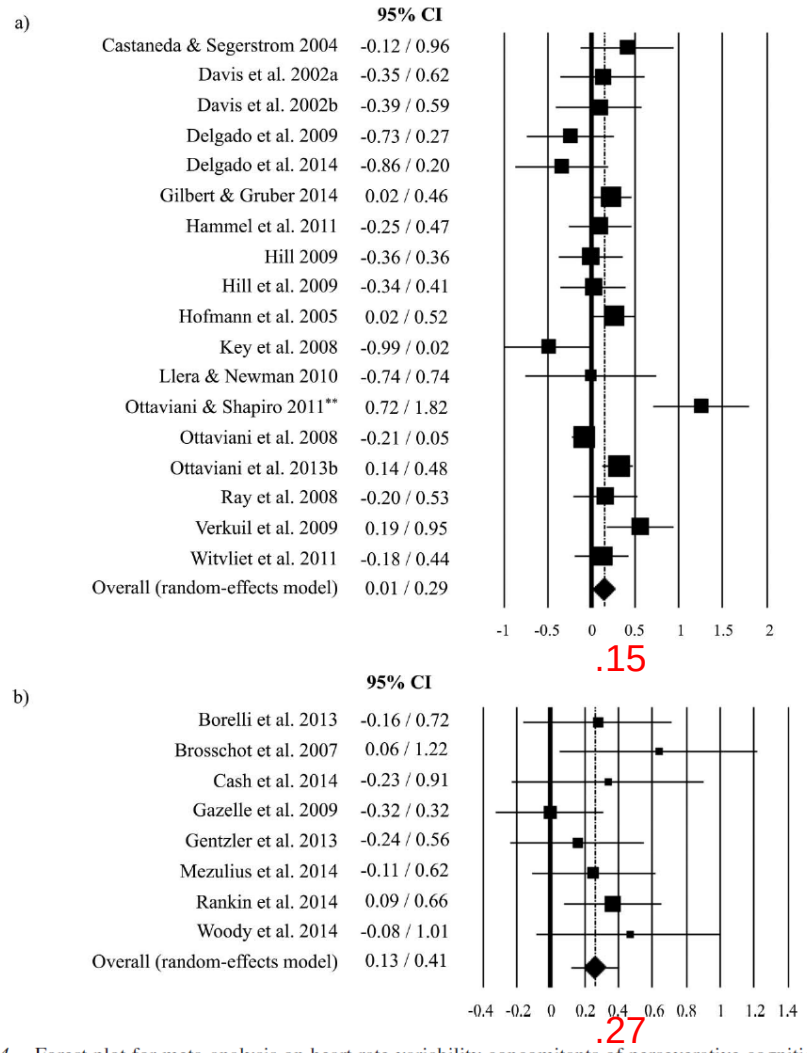
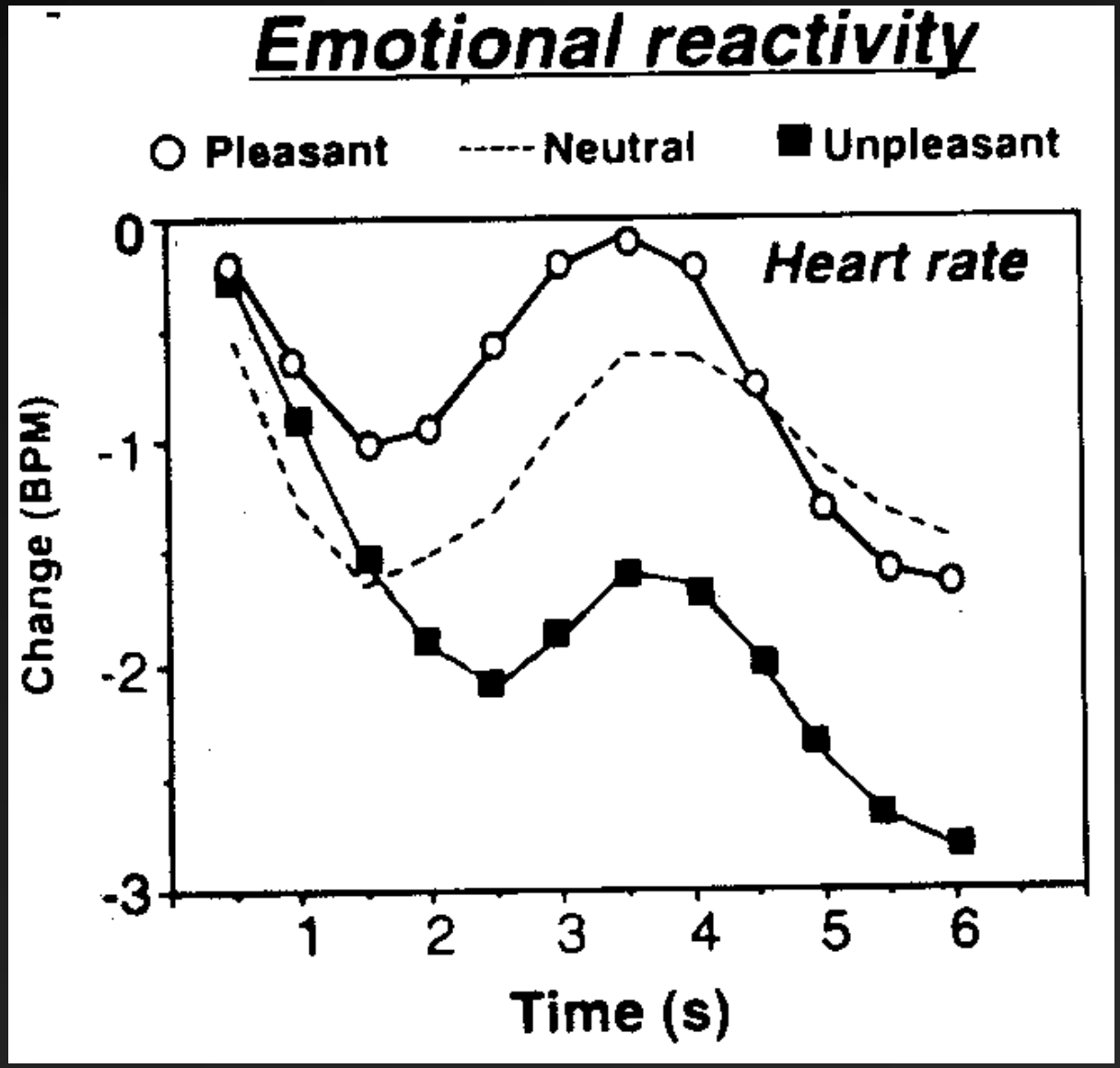


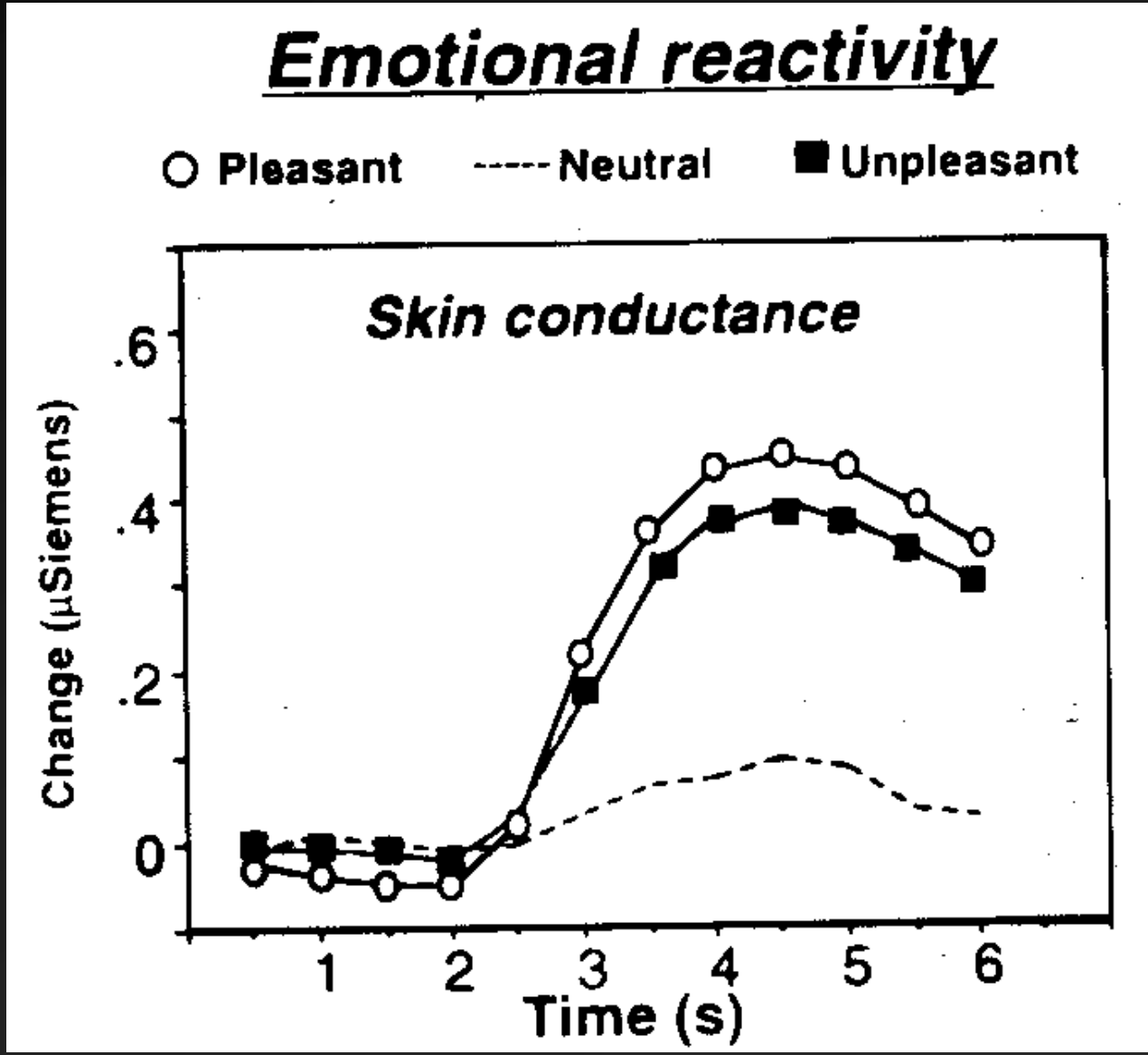
Figure 4. Forest plot for meta-analysis on heart rate variability concomitants of perseverative cognition when experimental (a) and correlational (b) studies were examined.

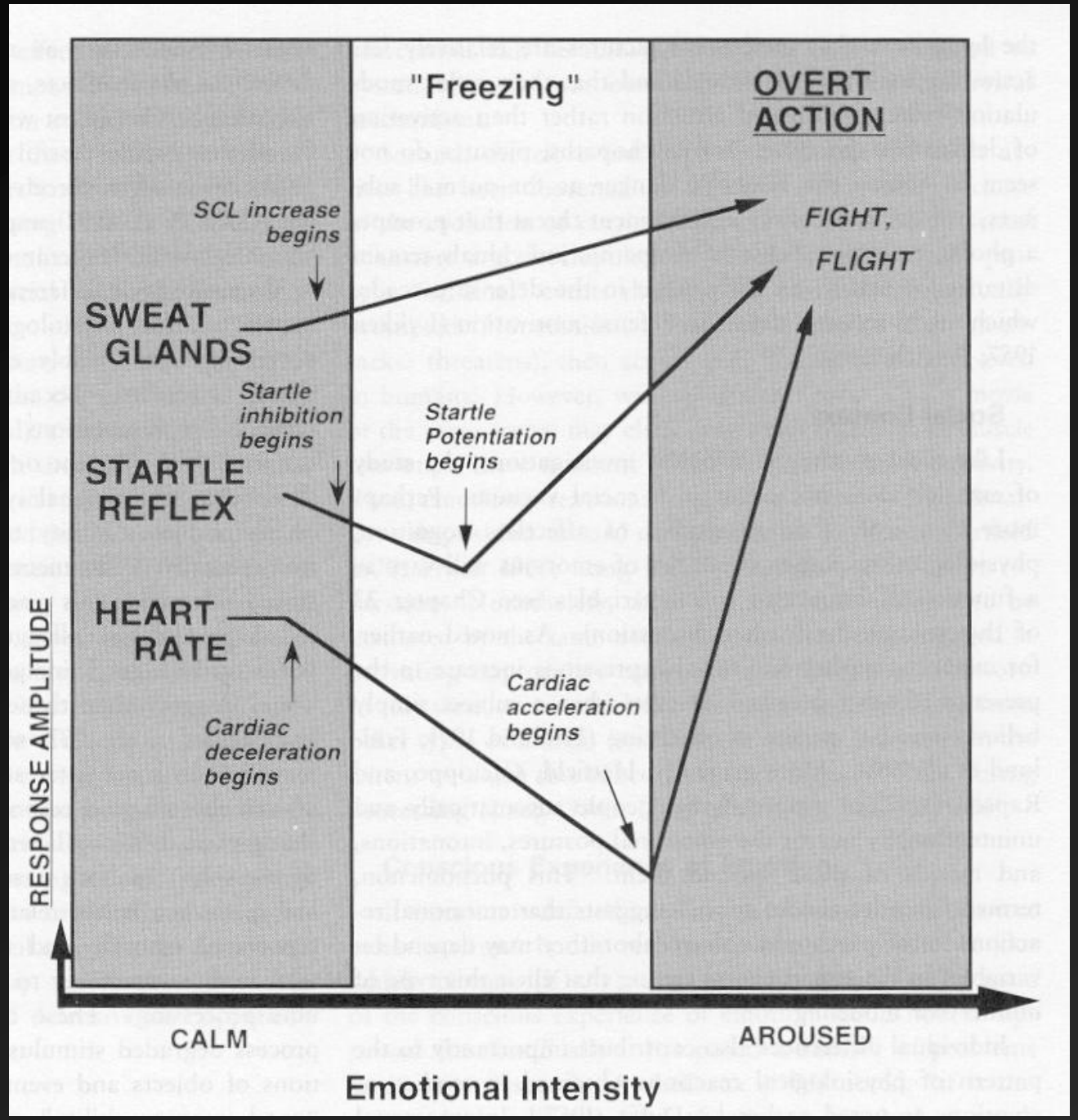
INTEGRATING MEASURES TO ASSESS ORIENTING VS DEFENSIVE RESPONSES

Orienting, Attention, and Defense



SCR (by contrast)




"Freezing"
OVERT ACTION
SCL increase begins
SWEAT GLANDS
FIGHT, FLIGHT
Startle inhibition begins
STARTLE REFLEX
Startle Potentiation begins
HEART RATE
Cardiac deceleration begins
Cardiac acceleration begins
RESPONSE AMPLITUDE
CALM
AROUSED
Emotional Intensity

OR Vs DR

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 actually comprise smaller fibrils
  - Fibrils have repeating cross striations (Z-lines)
  - Fibrils plus tissue between = Sarcomeres

Striated Muscle

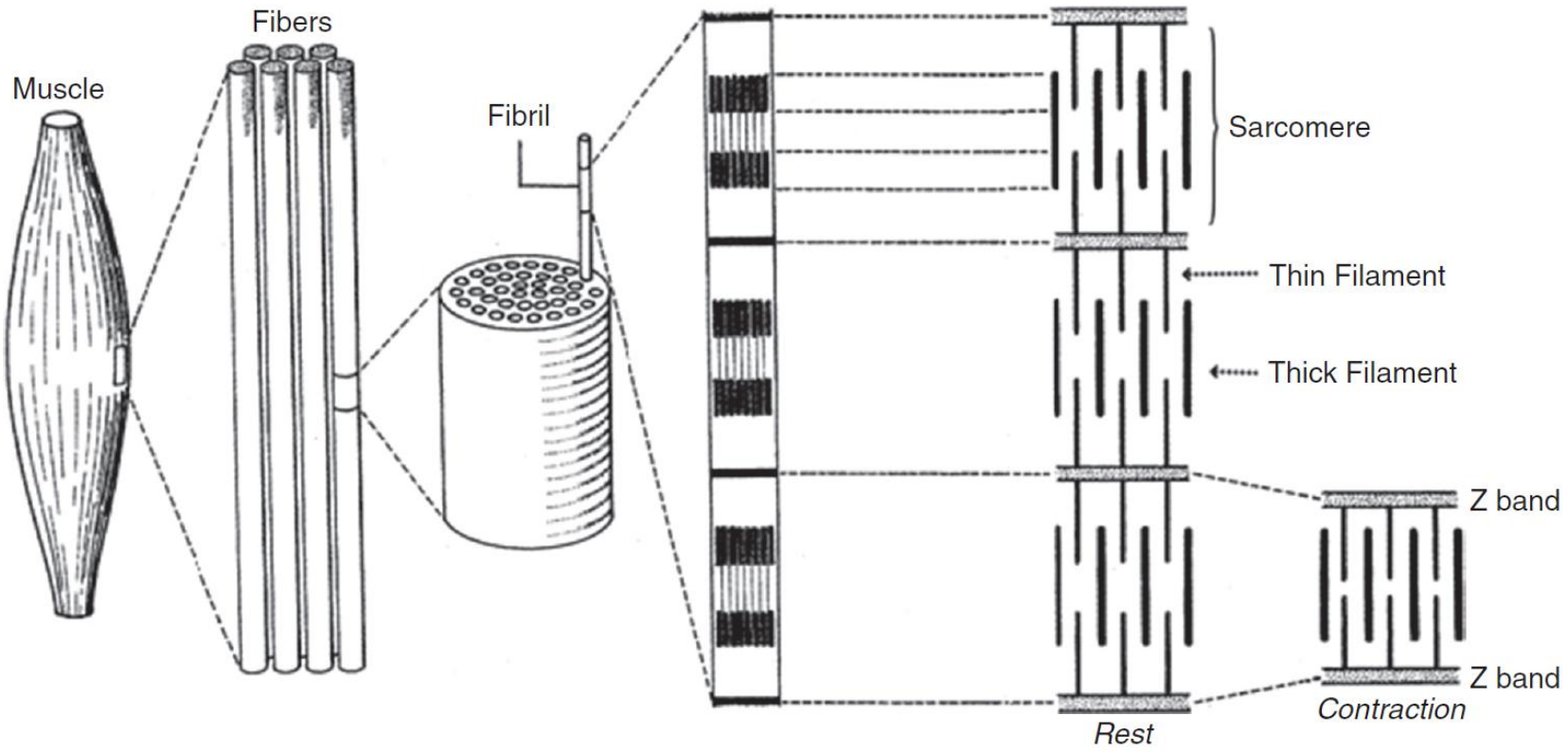


Figure 8.2 Diagram of the structure of the muscle with increasing magnification going from left to right. The bottom corner of the figure illustrates the microgeometric changes that occur with contraction (modified from Figure 10.7 of Schmidt-Nielsen, 1997).

Striated Muscle

- During contraction:

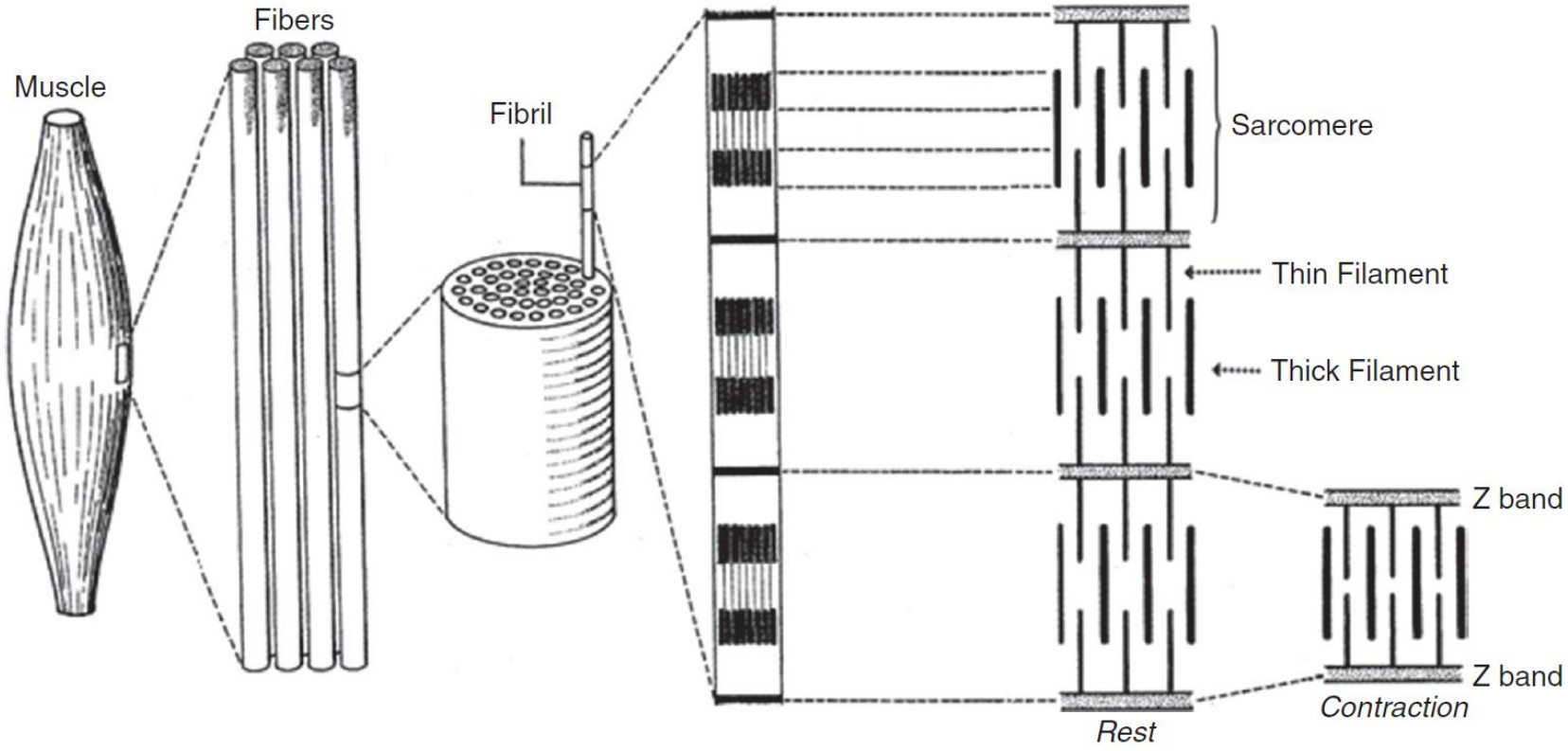


Figure 8.2 Diagram of the structure of the muscle with increasing magnification going from left to right. The bottom corner of the figure illustrates the microgeometric changes that occur with contraction (modified from Figure 10.7 of Schmidt-Nielsen, 1997).

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

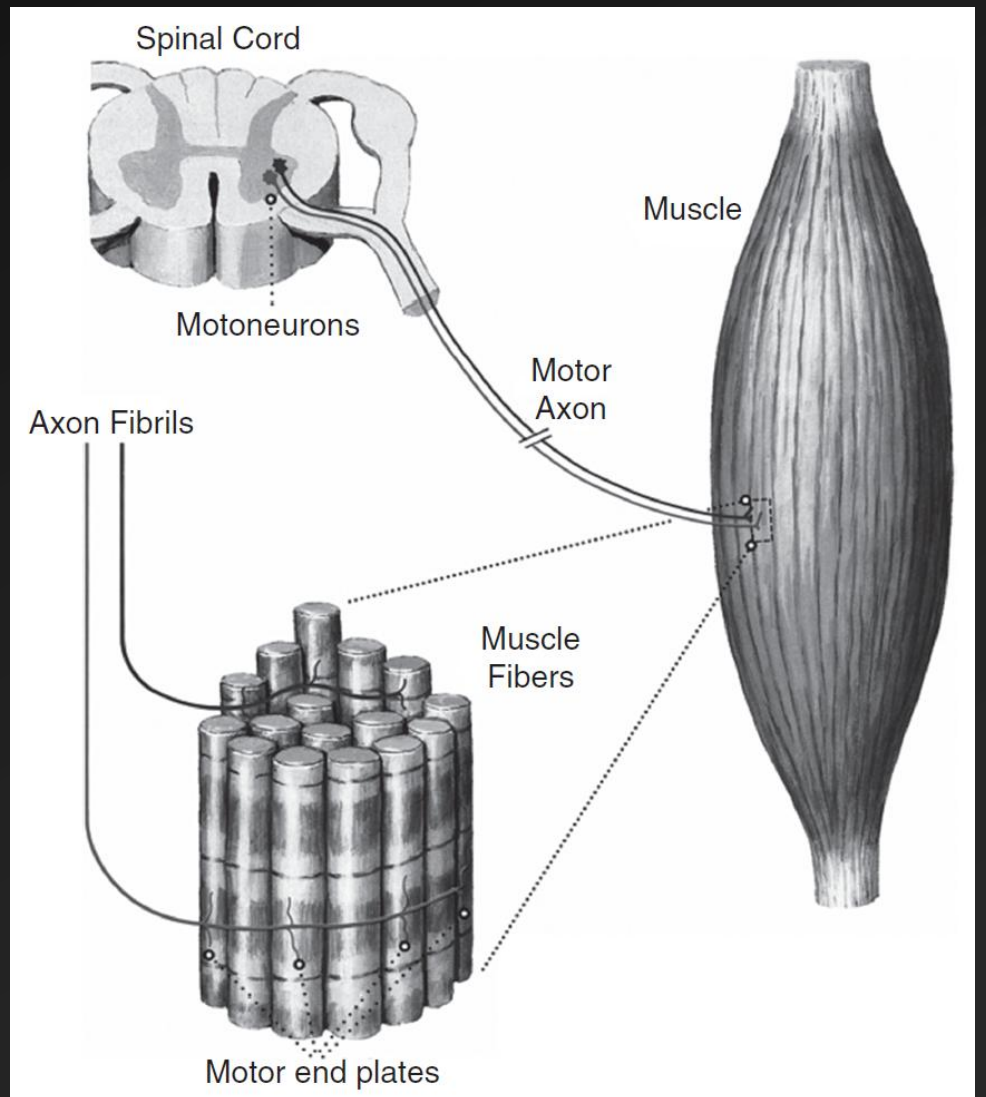


Figure 8.3 Diagram of two motor units (modified from slide 3705 of Netter, 1991).

Innervation

- Each motoneuron innervates several to many muscles (innervation ratios 10:1 to 2000:1), but each muscle innervated by only one motoneuron
  - Therefore, muscle fibers fire simultaneously or in concert with one another
  - Stronger contractions due to either more motoneurons firing, or increases in rate of already firing motoneurons

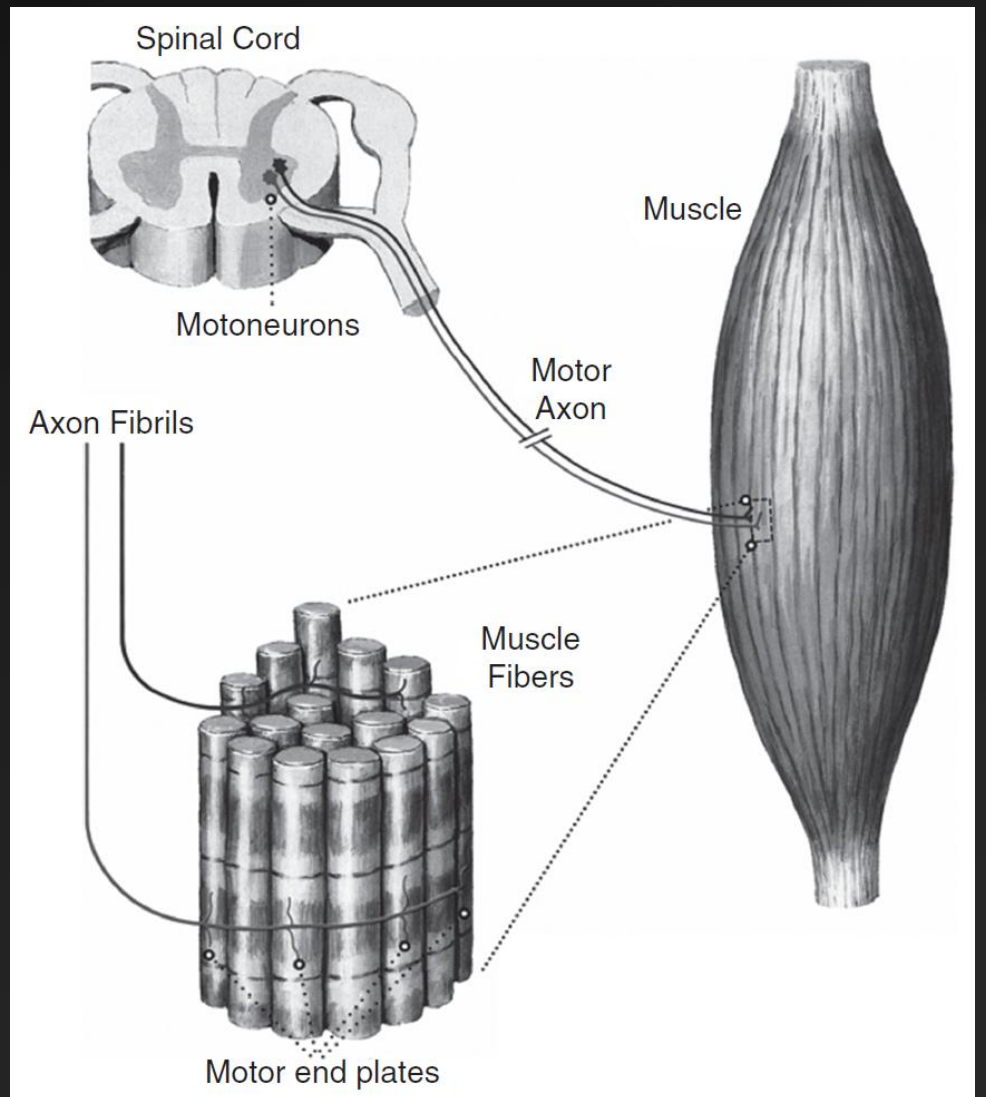
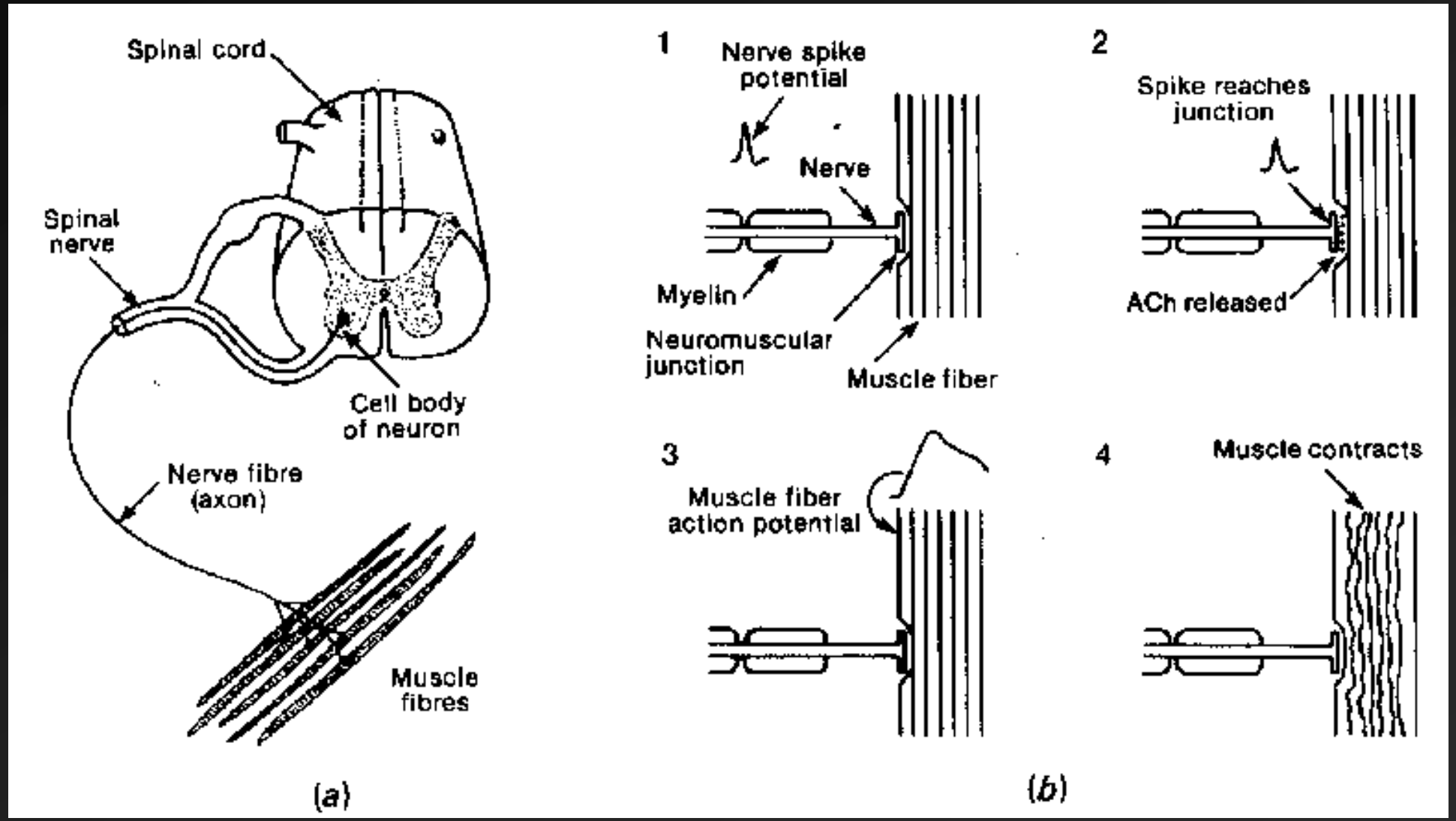


Figure 8.3 Diagram of two motor units (modified from slide 3705 of Netter, 1991).

Cartoon of how it works

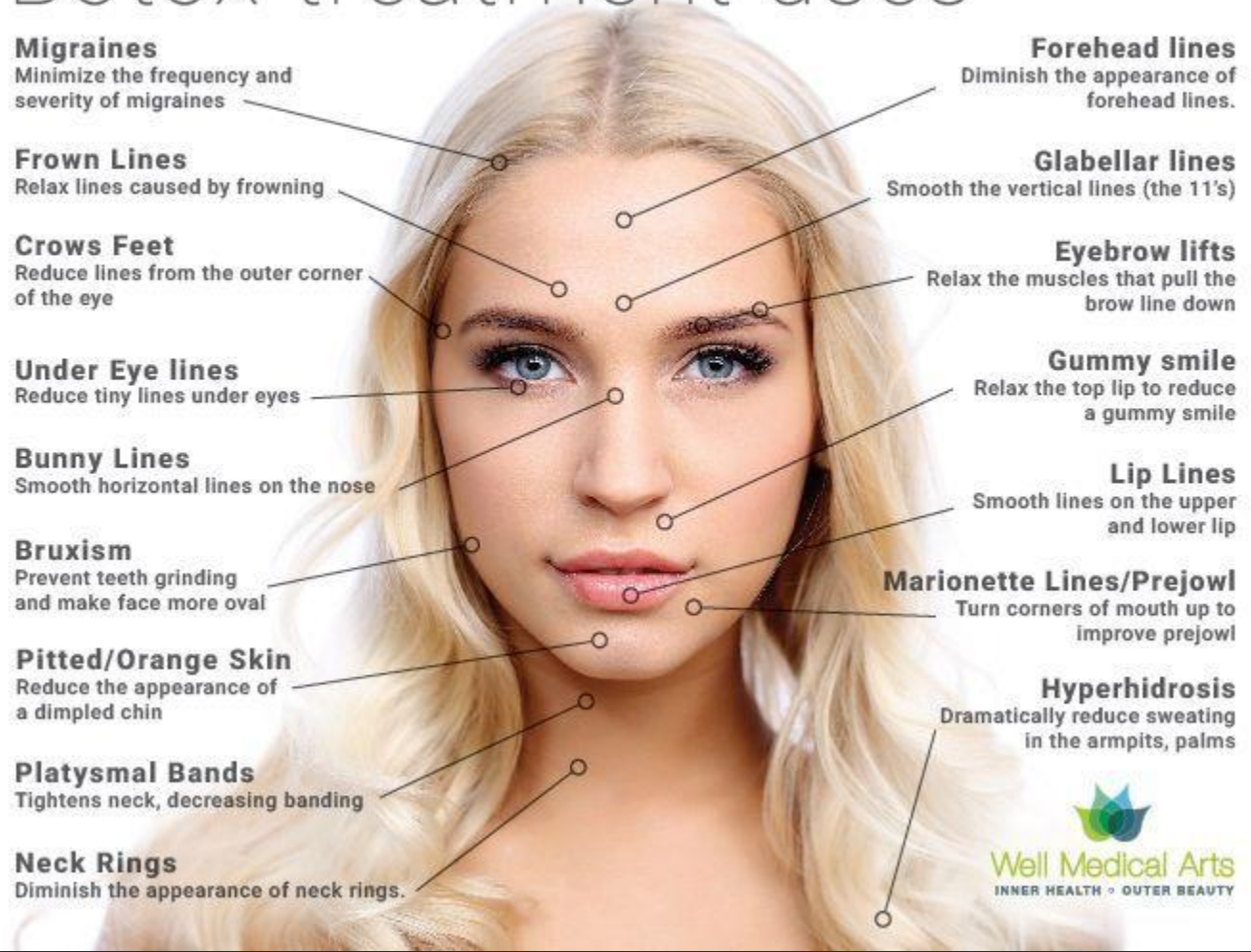


BOTOX® Cosmetic

Before

After

Botox treatment uses



Migraines
Minimize the frequency and severity of migraines

Frown Lines
Relax lines caused by frowning

Crows Feet
Reduce lines from the outer corner of the eye

Under Eye lines
Reduce tiny lines under eyes

Bunny Lines
Smooth horizontal lines on the nose

Bruxism
Prevent teeth grinding and make face more oval

Pitted/Orange Skin
Reduce the appearance of a dimpled chin

Platysmal Bands
Tightens neck, decreasing banding

Neck Rings
Diminish the appearance of neck rings.

Forehead lines
Diminish the appearance of forehead lines.

Glabellar lines
Smooth the vertical lines (the 11's)

Eyebrow lifts
Relax the muscles that pull the brow line down

Gummy smile
Relax the top lip to reduce a gummy smile

Lip Lines
Smooth lines on the upper and lower lip

Marionette Lines/Prejowl
Turn corners of mouth up to improve prejowl

Hyperhidrosis
Dramatically reduce sweating in the armpits, palms

Well Medical Arts
INNER HEALTH • OUTER BEAUTY

OK! Politics

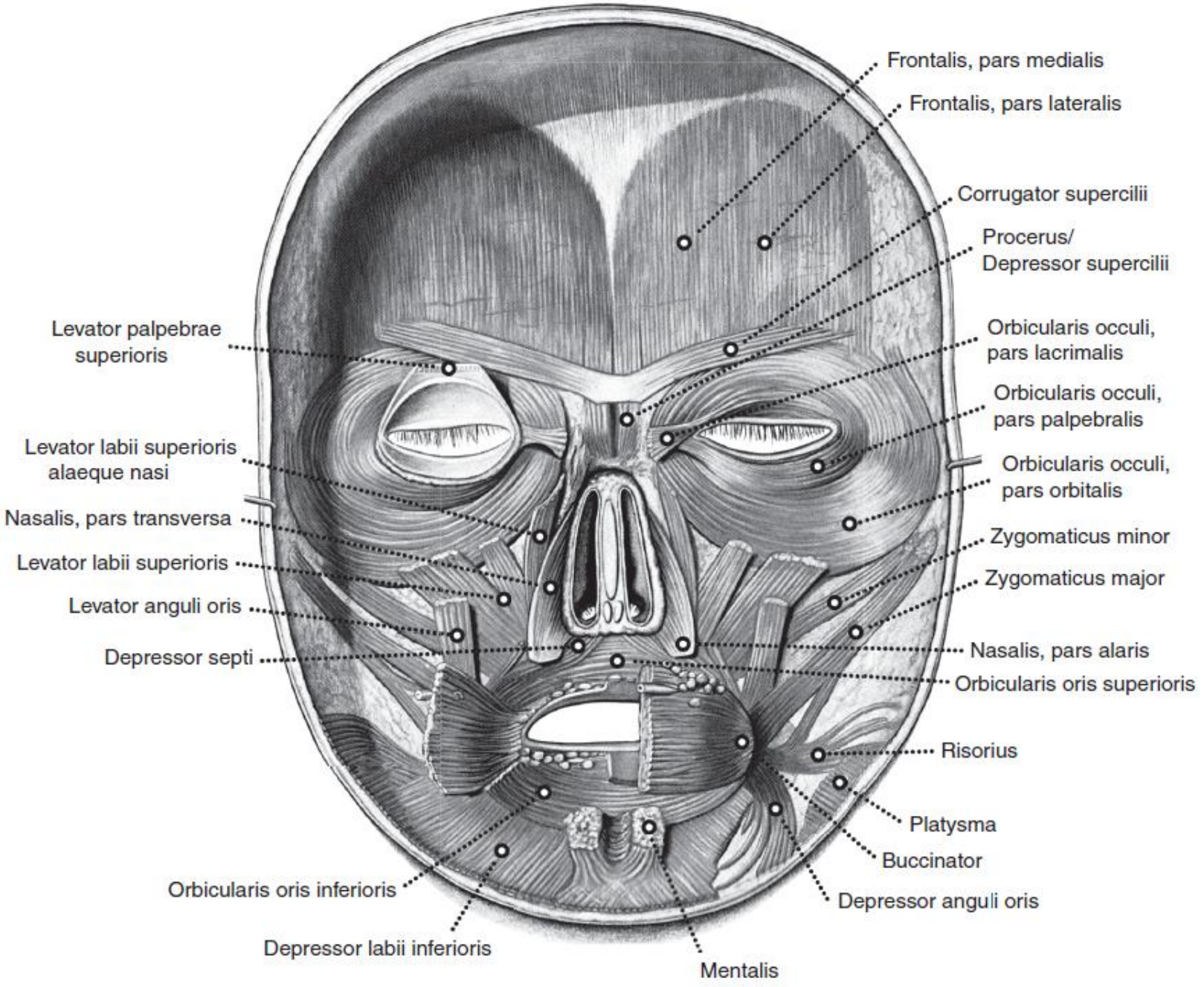
'Fridge Full of Botox': Representative Matt Gaetz's Physical Appearance at the RNC Ridiculed as He's Compared to 'Beavis and Butthead' Character

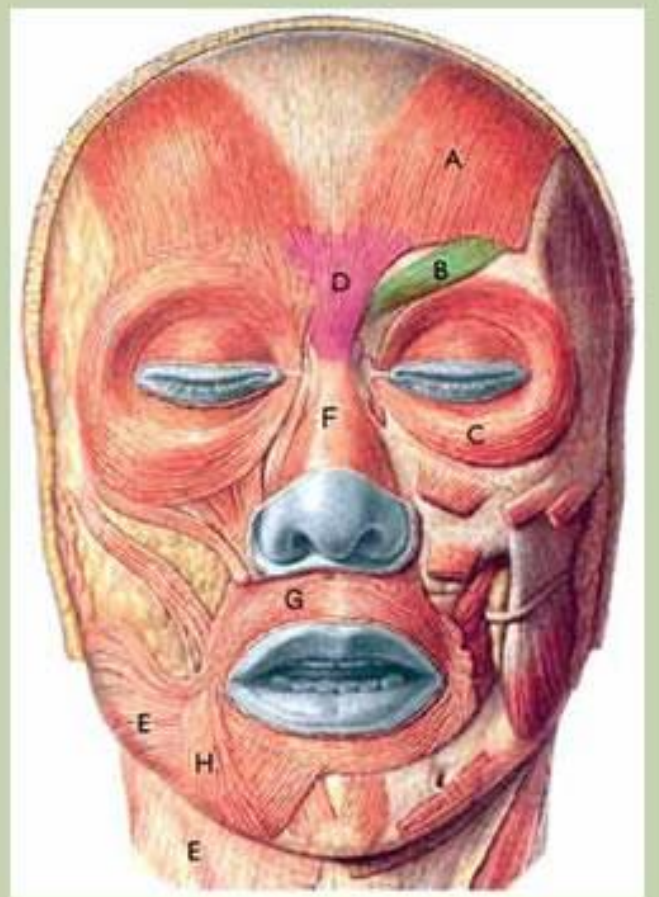
SOURCE: MEGA; X

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

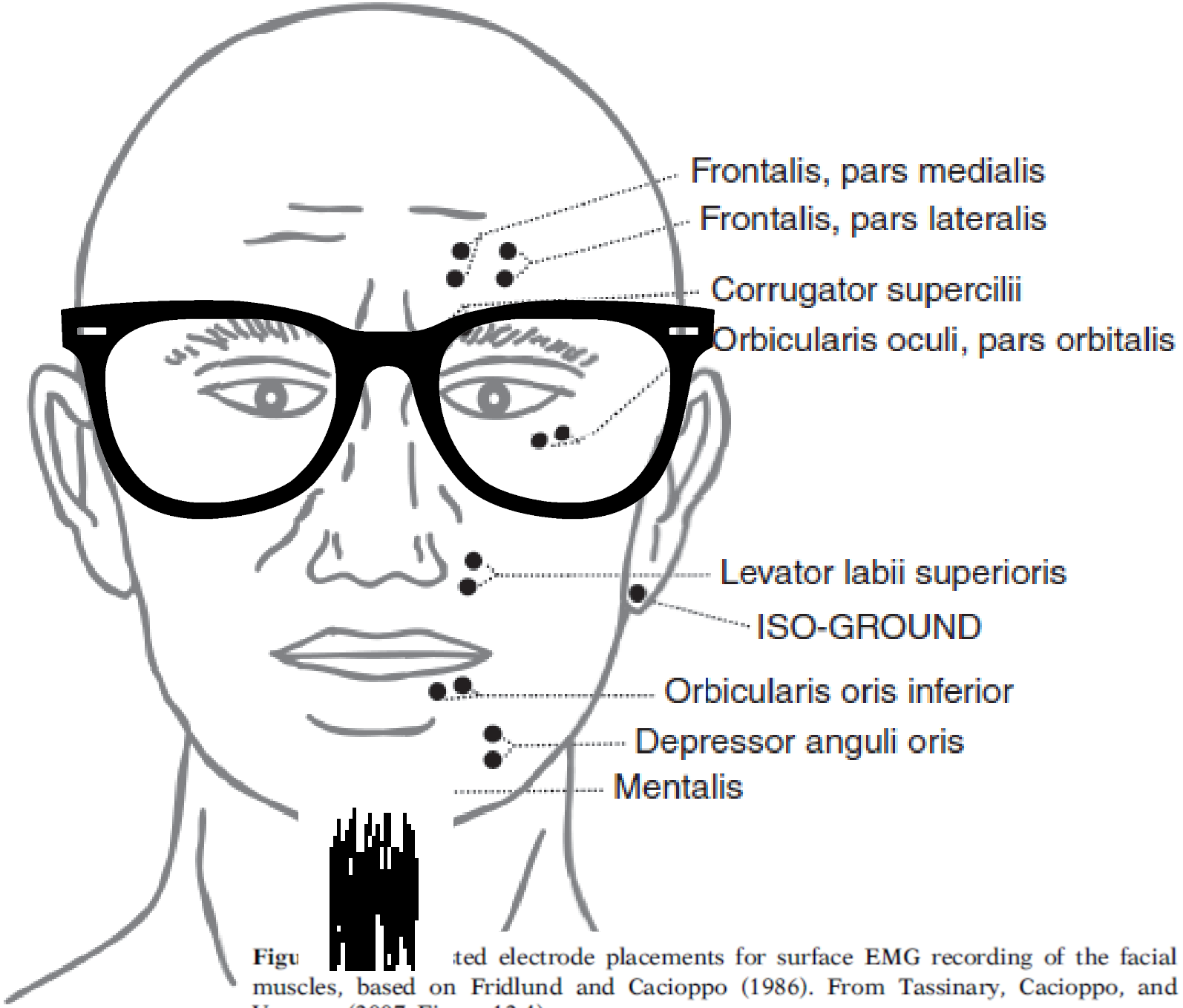




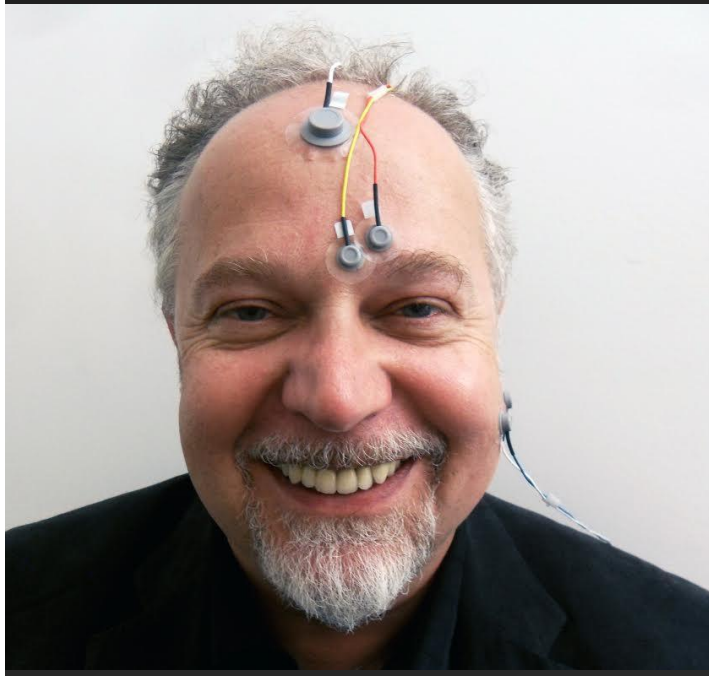
The primary muscles of facial expression treated with BOTOX:

(A) Frontalis
(B) Corrugator and Depressor supercilli complex
(C) Orbicularis oculi
(D) Procerus
(E) Platysma
(F) Nasalis
(G) Orbicularis oris
(H) Depressor anguli oris

From the educational website of
S. Sean Younai, MD,
Board Certified Plastic, Cosmetic,
and Reconstructive Surgeon



Figu ted electrode placements for surface EMG recording of the facial muscles, based on Fridlund and Cacioppo (1986). From Tassinary, Cacioppo, and Vanman (2007, Figure 12.4).



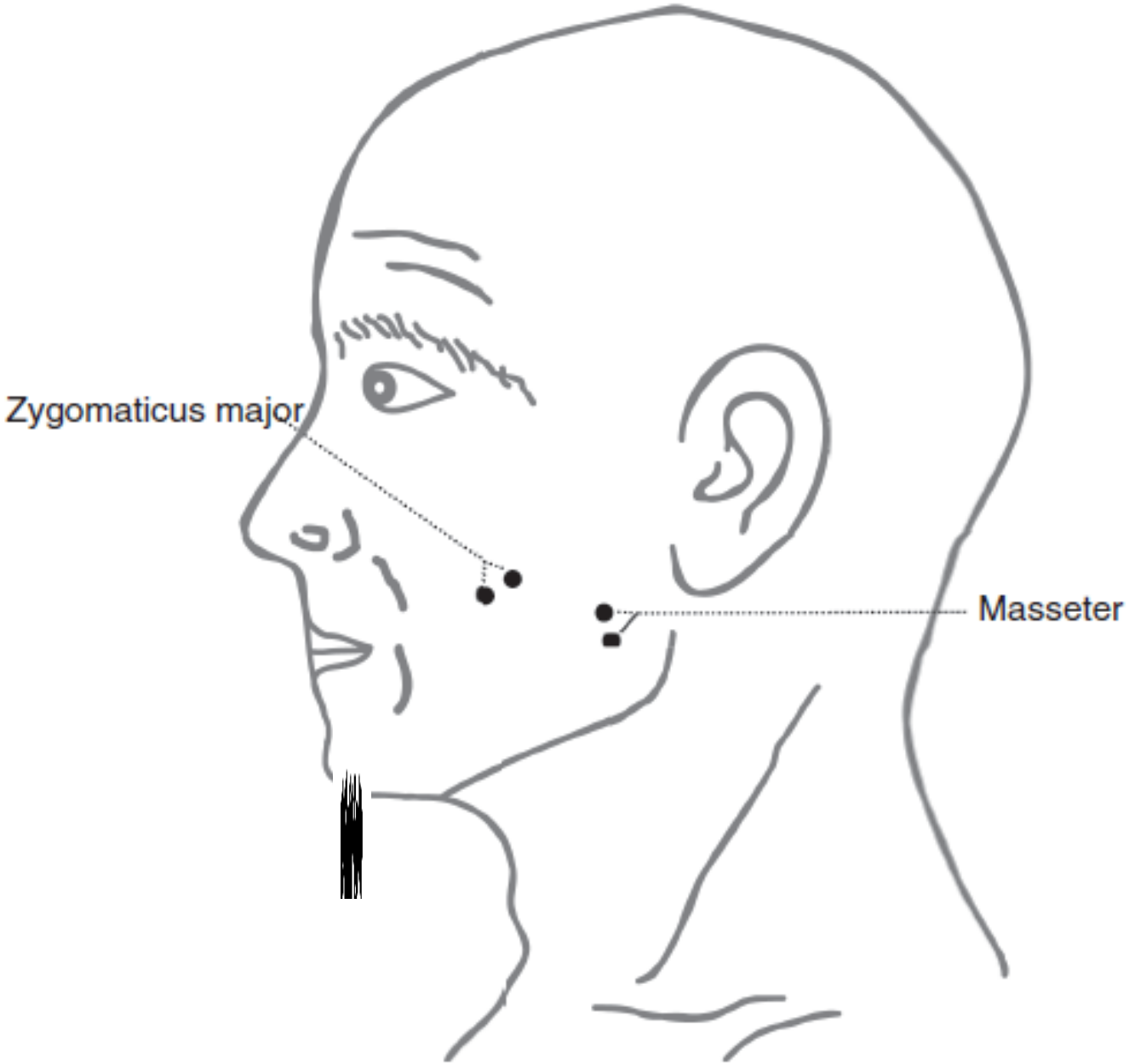
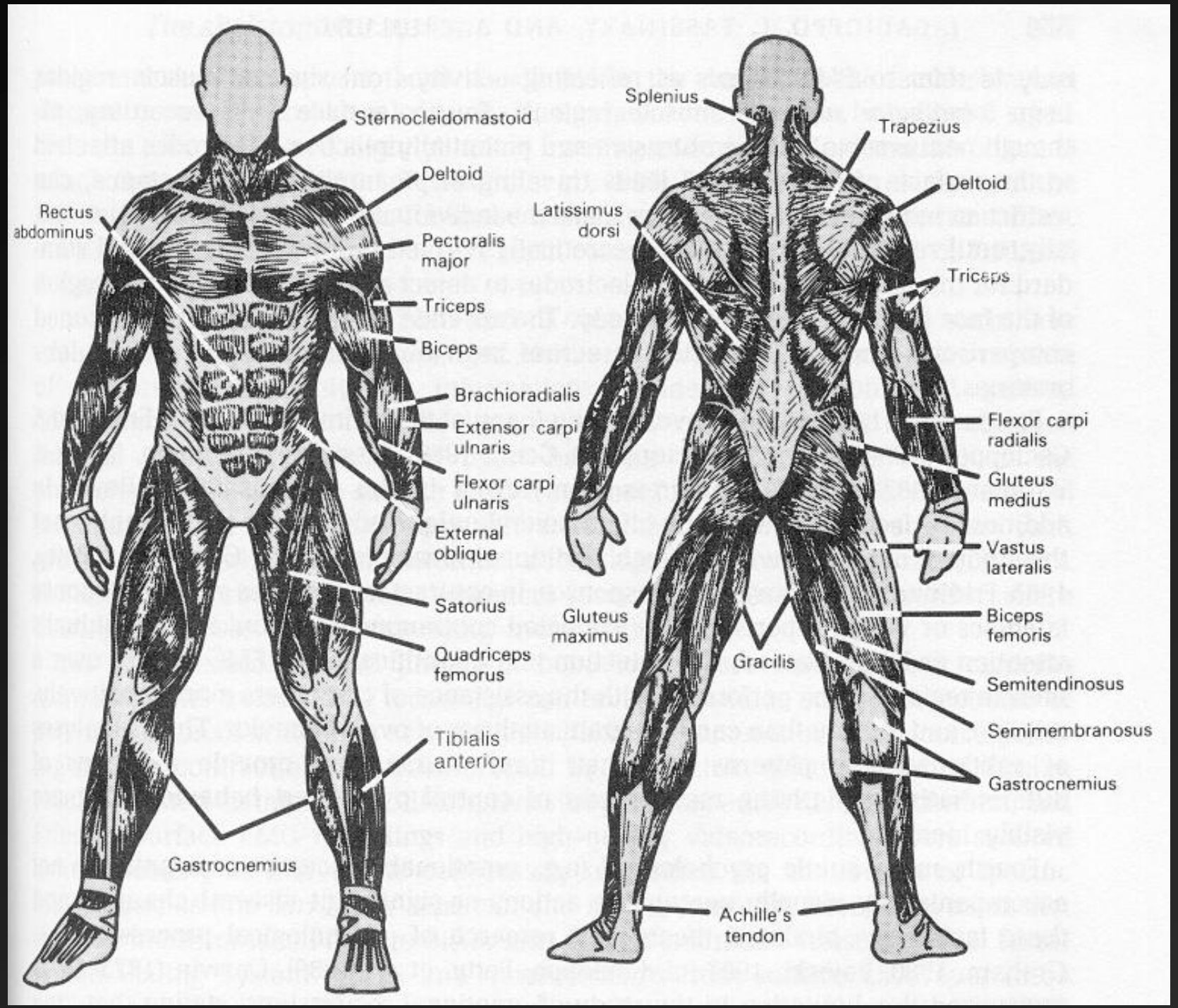
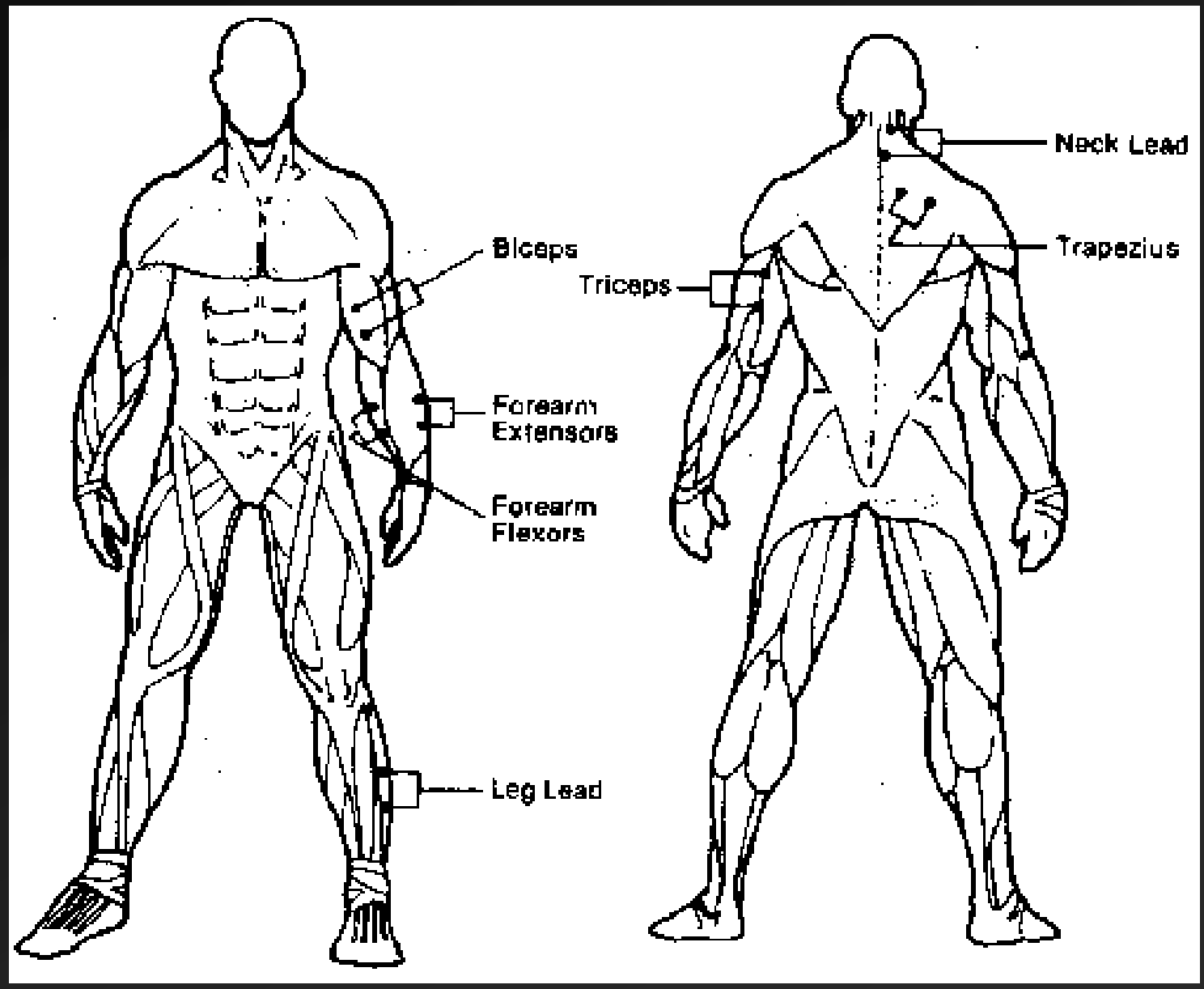


Figure 8.4 Suggested electrode placements for surface EMG recording of the facial muscles, based on Fridlund and Cacioppo (1986). From Tassinary, Cacioppo, and Vanman (2007, Figure 12.4).

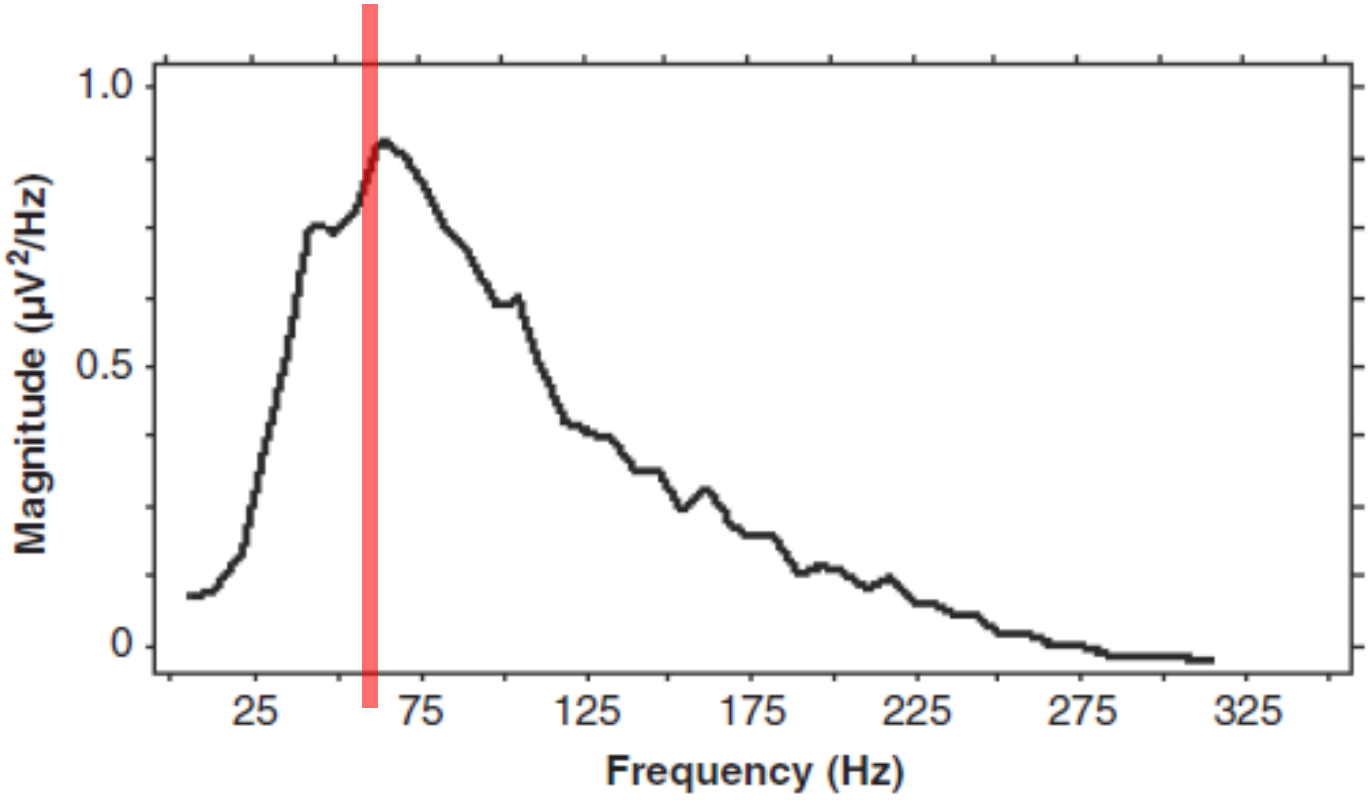

Sternocleidomastoid
Deltoid
Rectus abdominus
Pectoralis major
Triceps
Biceps
Brachioradialis
Extensor carpi ulnaris
Flexor carpi ulnaris
External oblique
Satorius
Quadriceps femorus
Tibialis anterior
Gastrocnemius
Splenius
Trapezius
Deltoid
Latissimus dorsi
Triceps
Flexor carpi radialis
Gluteus medius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

EMG Power



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

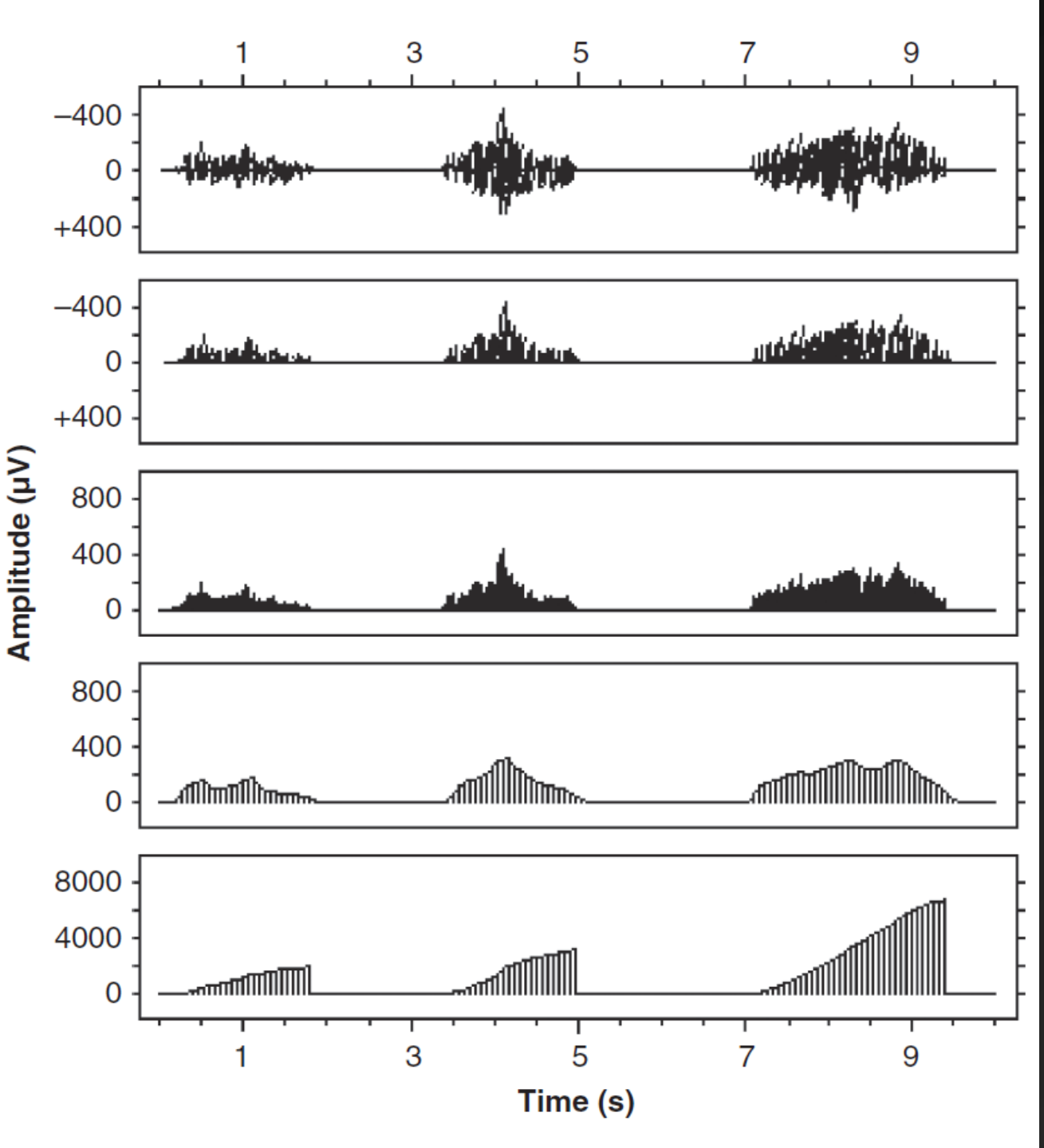
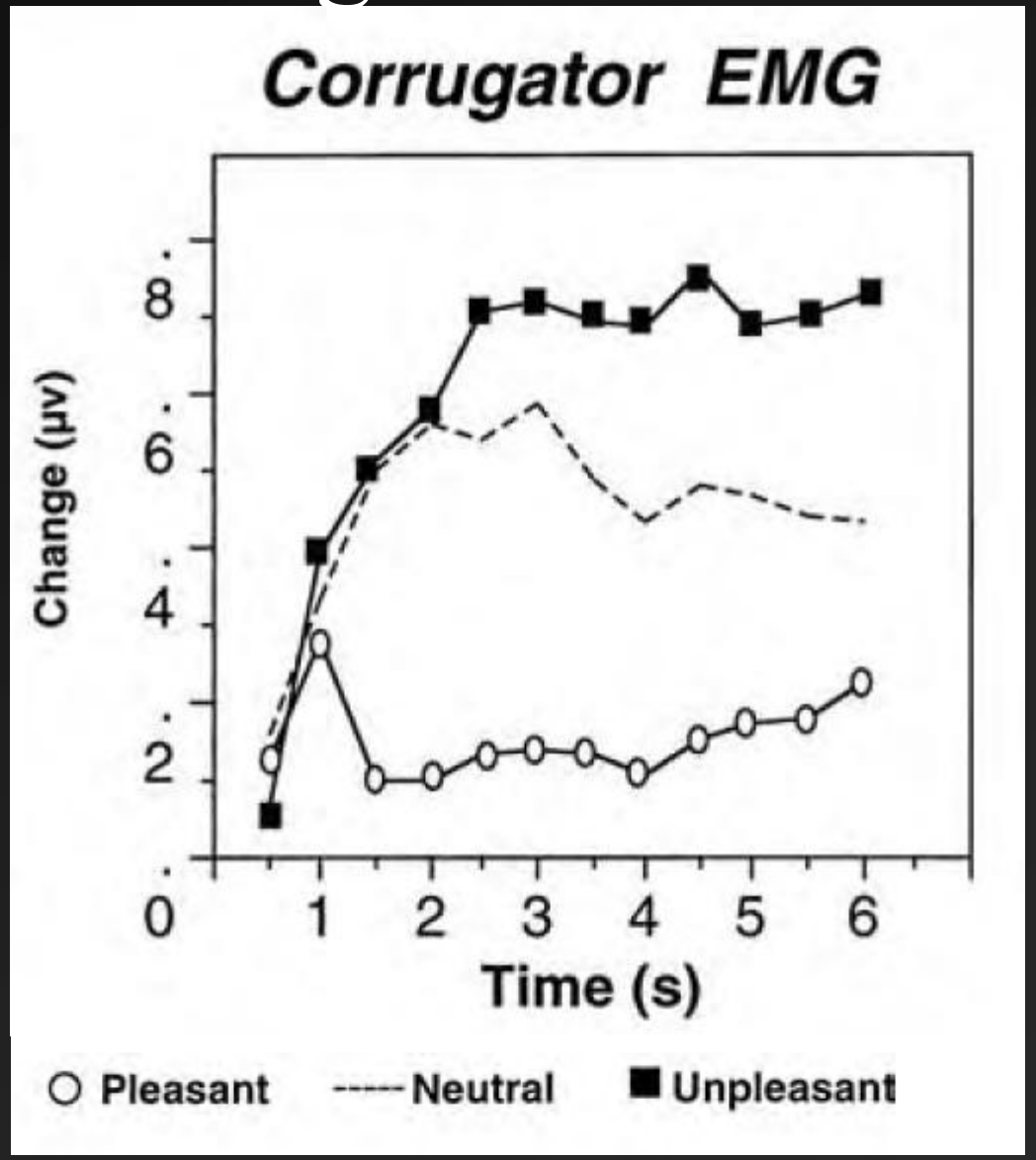
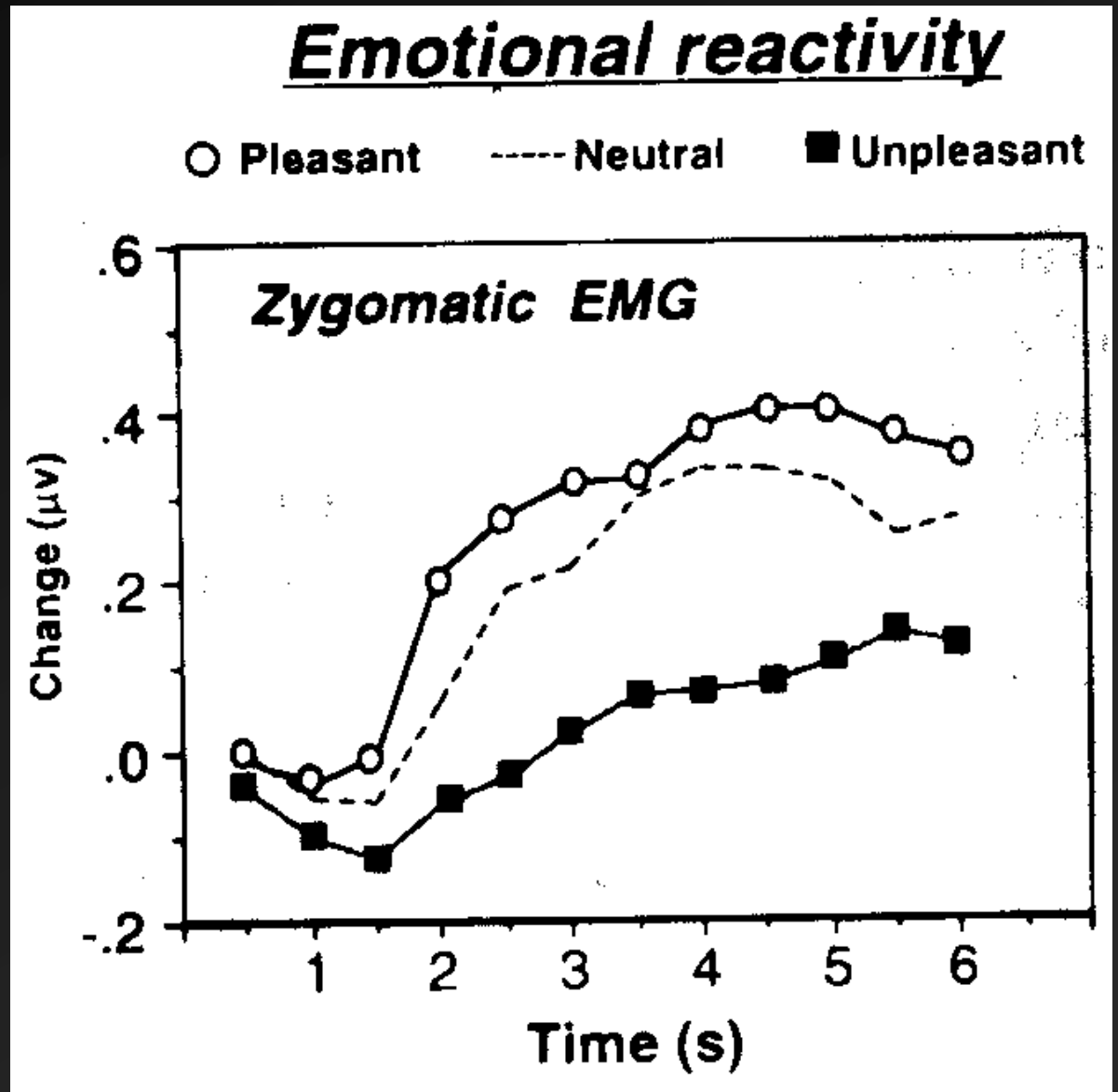


Figure 8.5 Common alternative representations of the surface EMG signal. The top five smaller panels depict three distinct non-fatigued responses. Going from top to bottom: the first represents "raw" (amplified and bandpass filtered only) waveforms; the second, half-wave rectified waveforms; the third, full-wave rectified waveforms; the fourth, "smoothed" waveforms; and the fifth, true integrated waveforms.The larger bottom panel depicts how one of these responses might appear if represented in the frequency domain. From Tassinary et al. (2007, Figure 12.5).

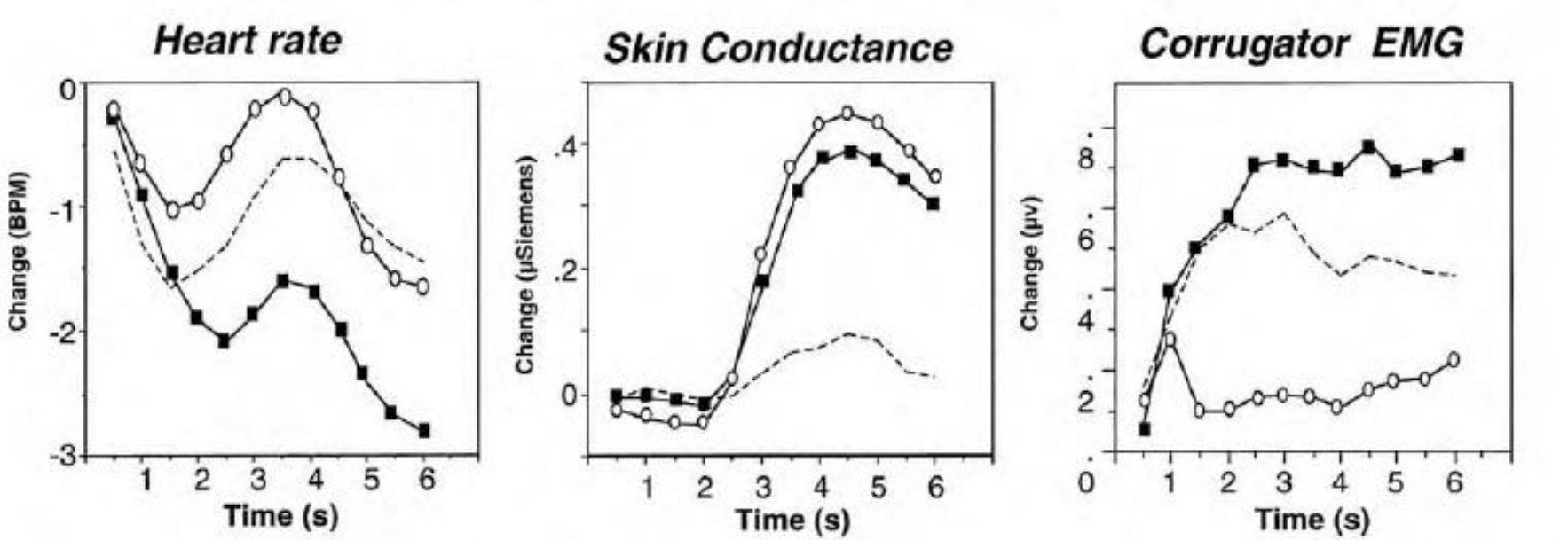
Corrugator "Frown"



Zygomatic "Smile"

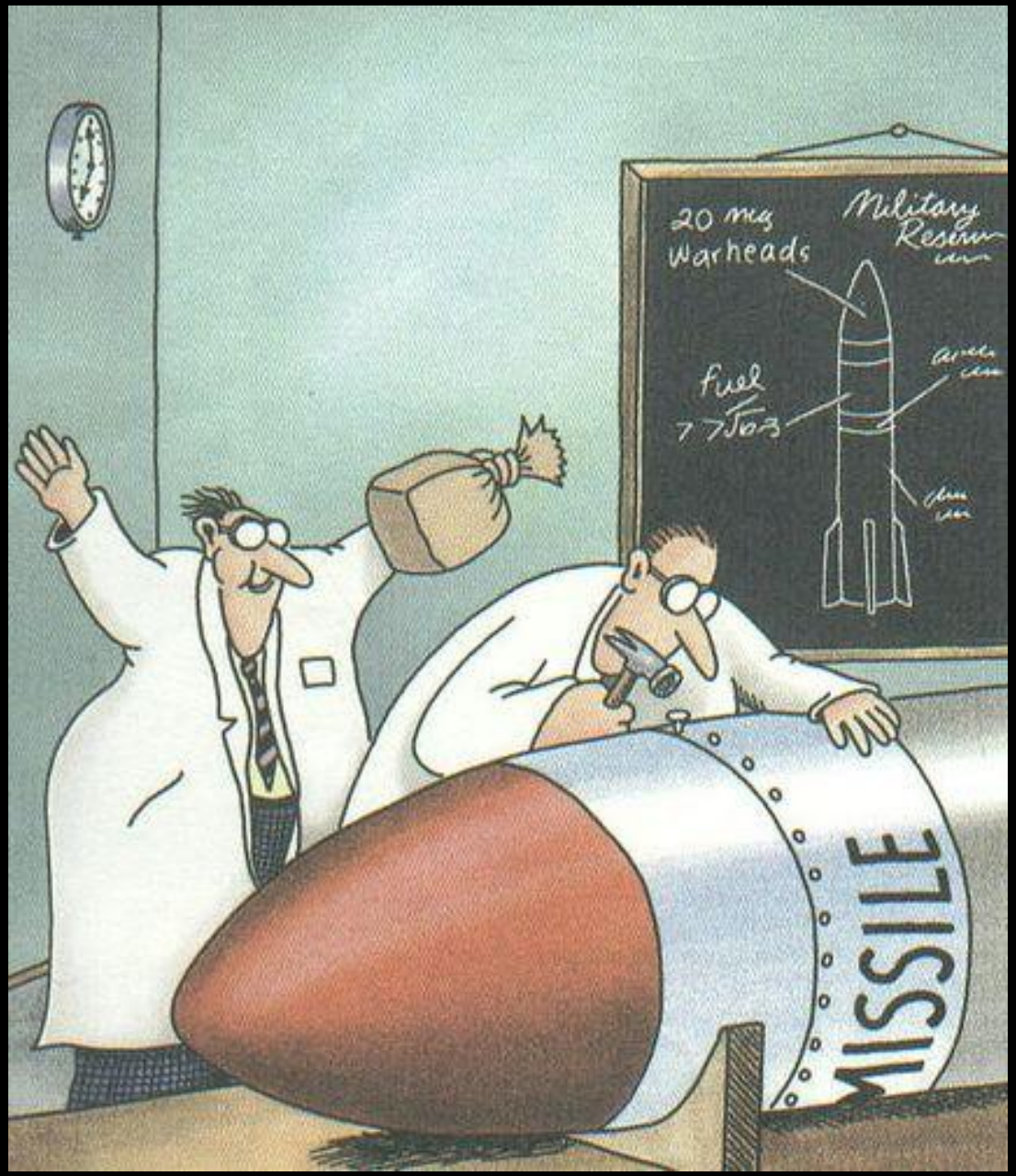


Looking at PICTURES

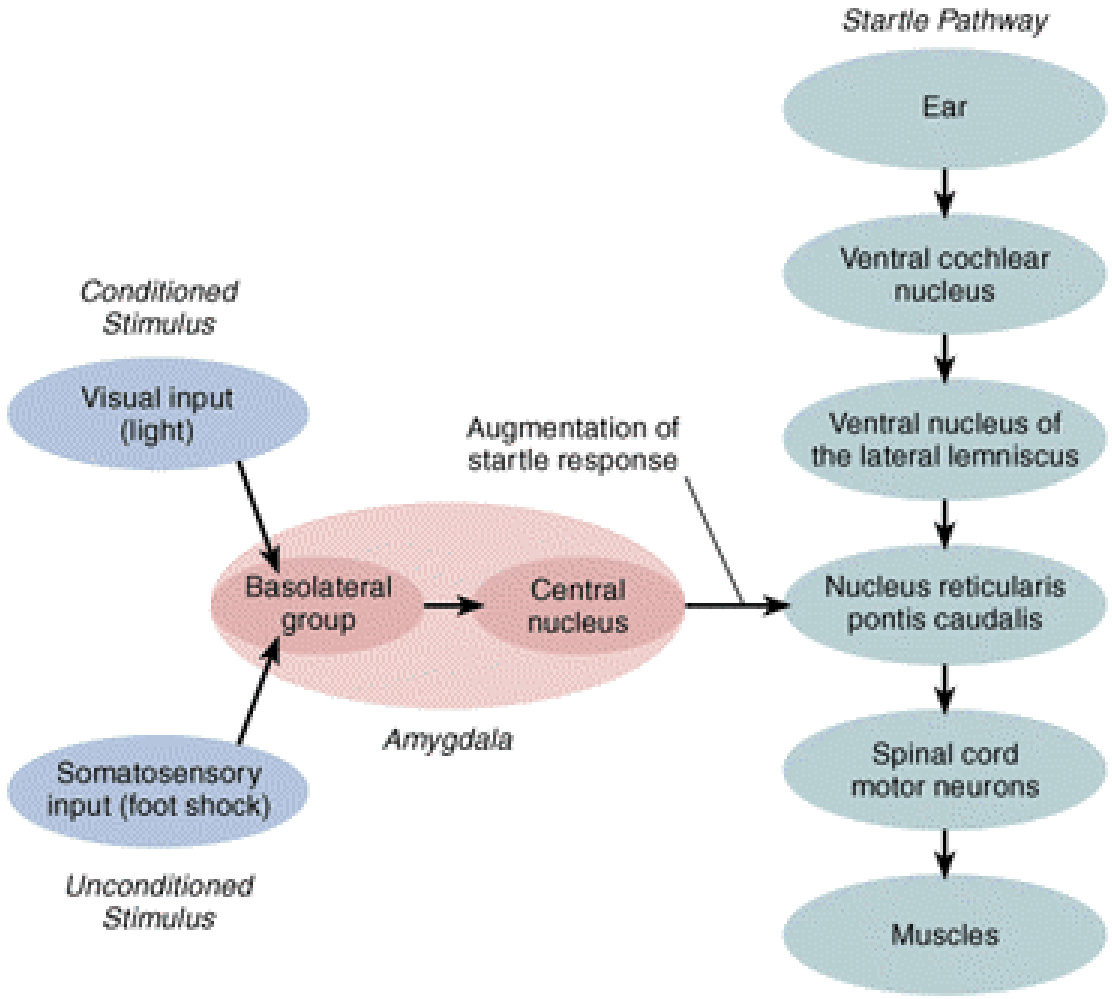


A few Applications

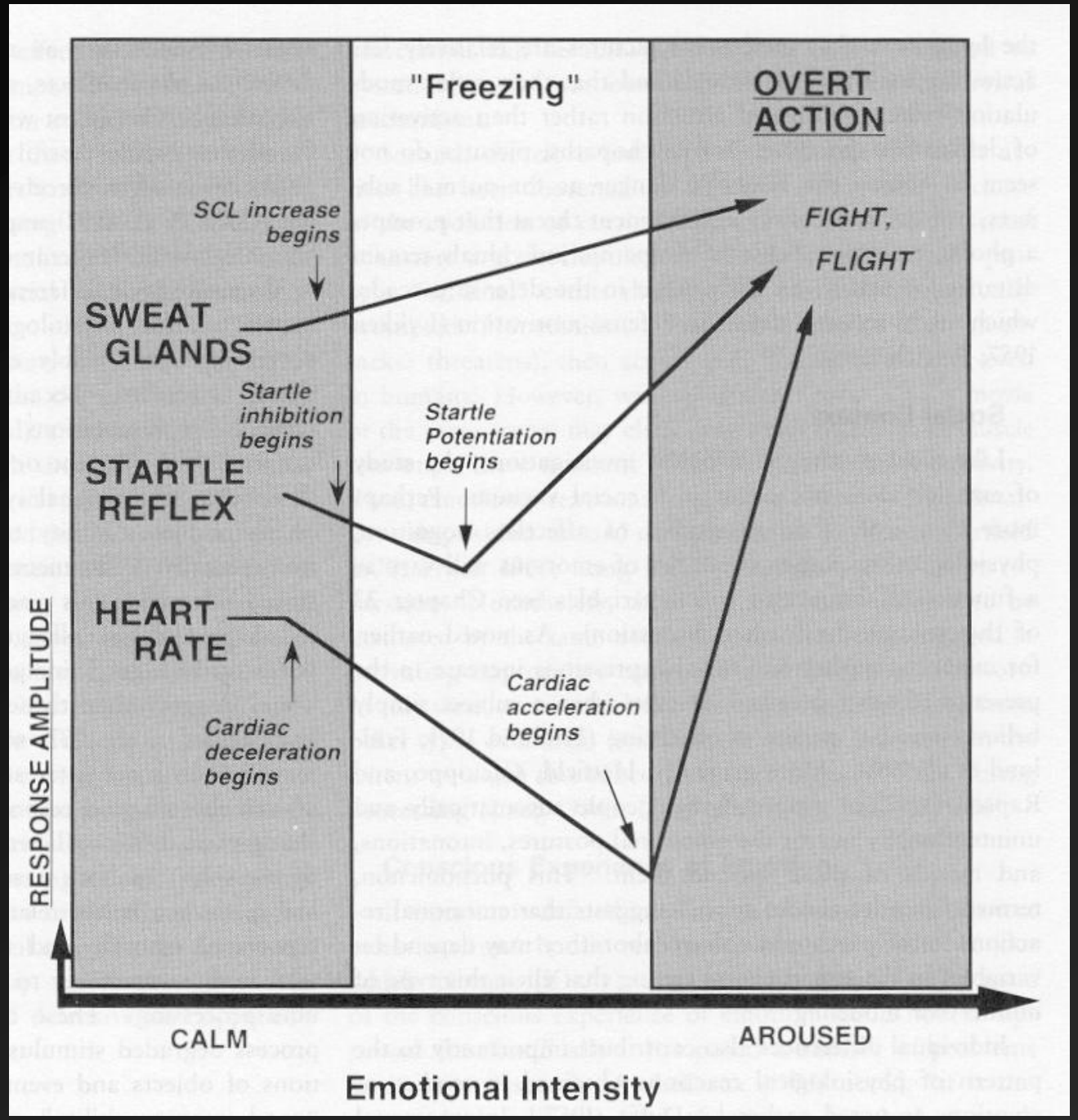
- Startle Probe
- Subtle affect
  - Mere Exposure
  - Subliminal effects
  - Mortality Salience
  - Biofeedback of EEG -- outcome measure
  - Emotion Regulation – outcome measure
  - Empathy – individual difference measure


20 mg
Warheads
Military
Reserve
fuel
MISSILE

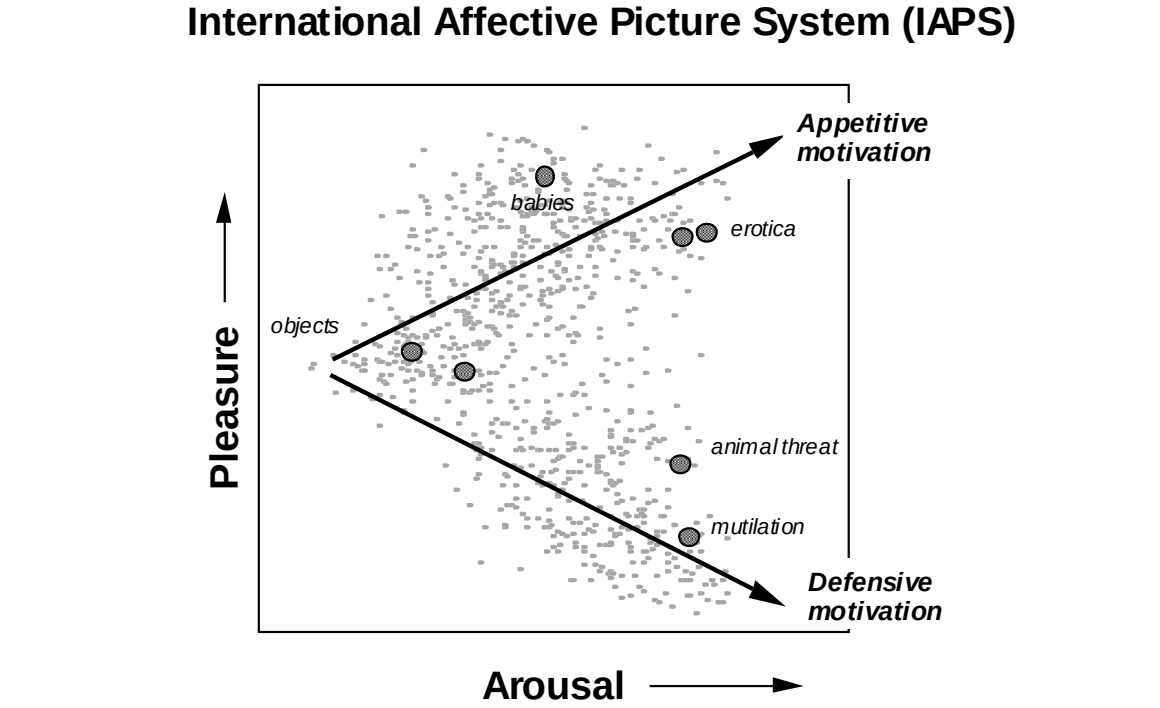
▶ Neural Circuits Responsible for an Auditory Startle Response and for Its Augmentation by Conditioned Aversive Stimuli

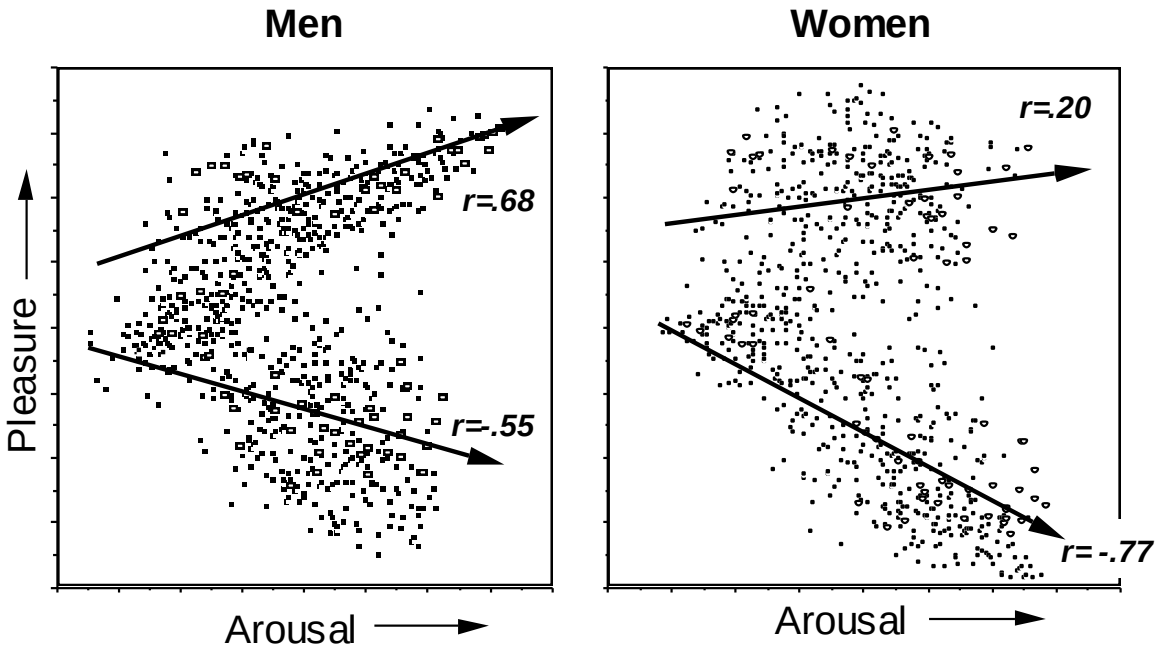


Source: Adapted from Davis, M., *Trends in Pharmacological Sciences*, 1992, *13*, 35–41.

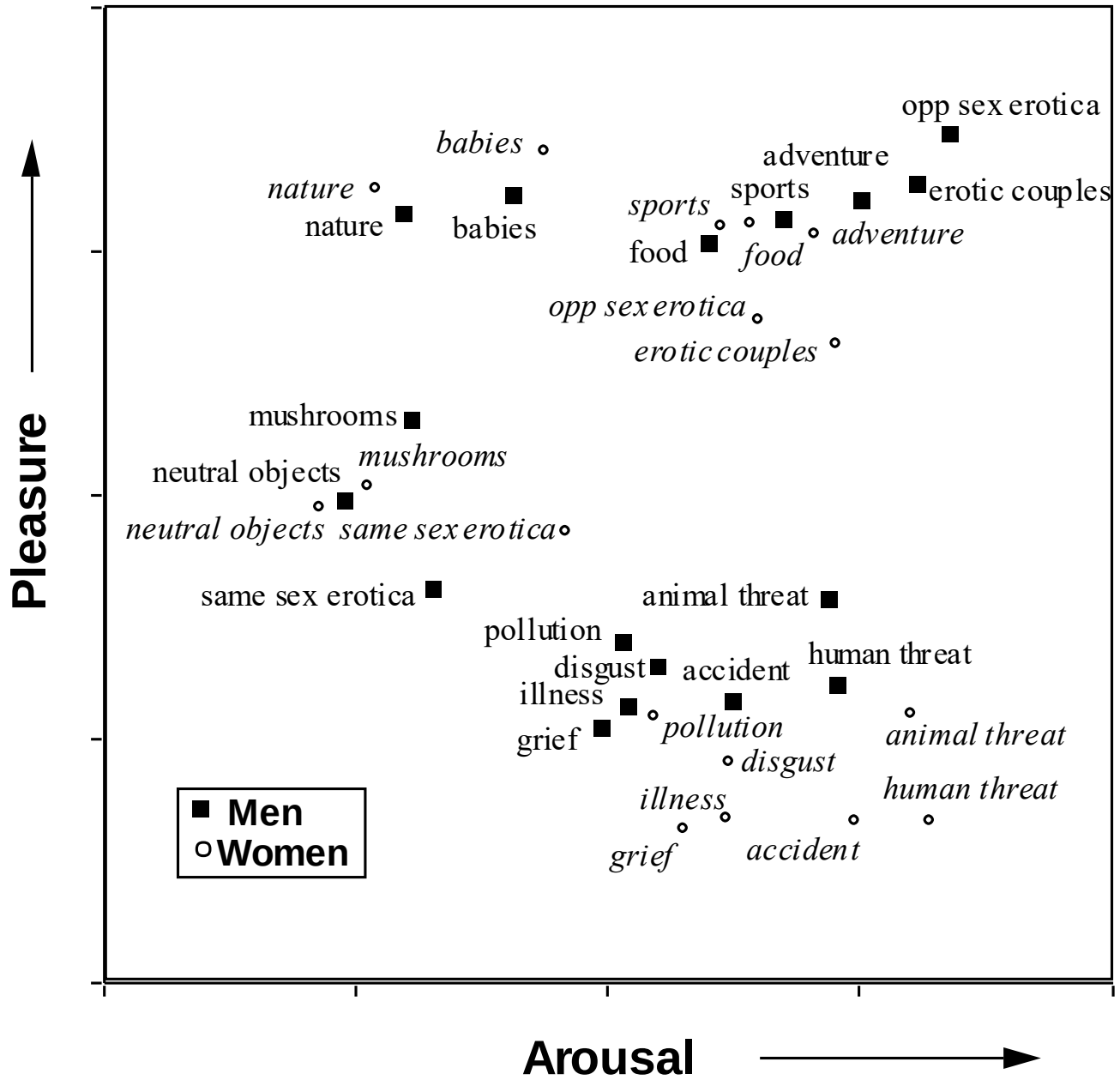

"Freezing"
OVERT ACTION
SCL increase begins
SWEAT GLANDS
FIGHT, FLIGHT
Startle inhibition begins
STARTLE REFLEX
Startle Potentiation begins
HEART RATE
Cardiac deceleration begins
Cardiac acceleration begins
RESPONSE AMPLITUDE
CALM
AROUSED
Emotional Intensity

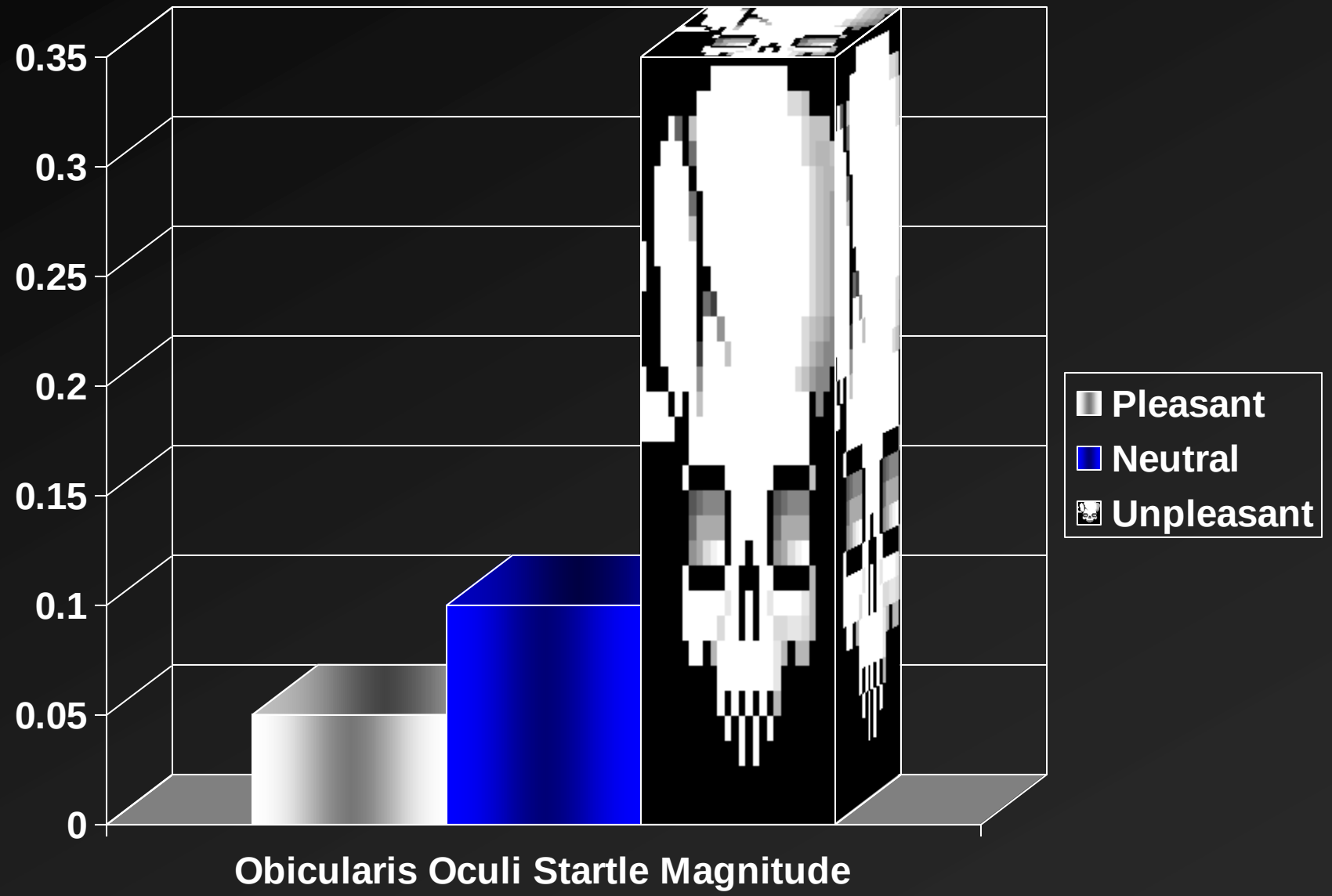
OR Vs DR


International Affective Picture System (IAPS)
Appetitive motivation
babies
erotica
objects
animal threat
mutilation
Defensive motivation
Pleasure
Arousal


Men
Women
r=.68
r=-.55
r=.20
r=-.77
Pleasure
Arousal
Arousal

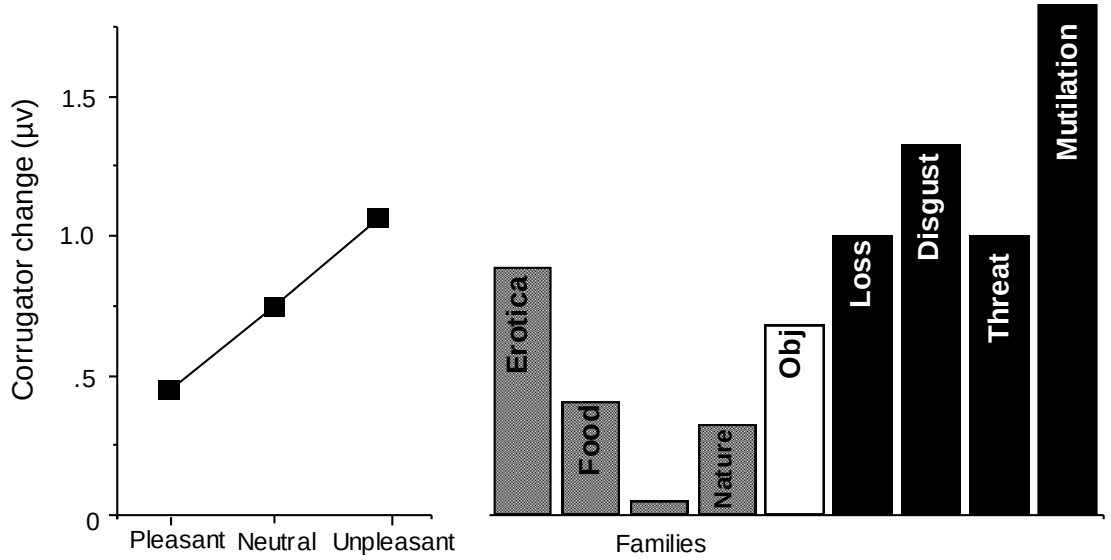
Affective Space:
Picture Content and Gender



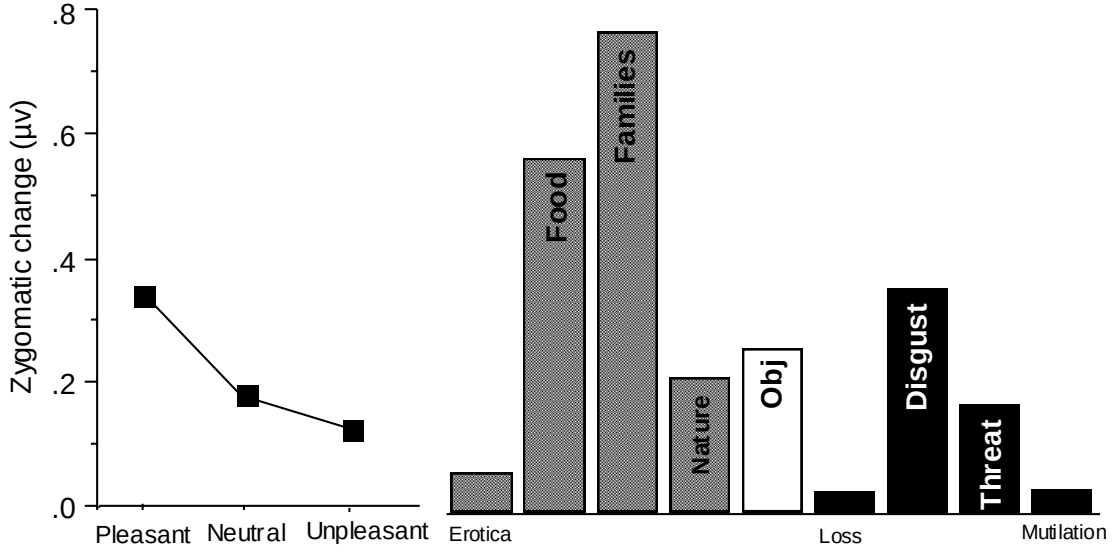


Note: same physical acoustic stimulus to elicit startle, only visual background picture differs

Corrugator EMG



Zygomatic EMG



Resting HRV as moderator of Startle Potentiation

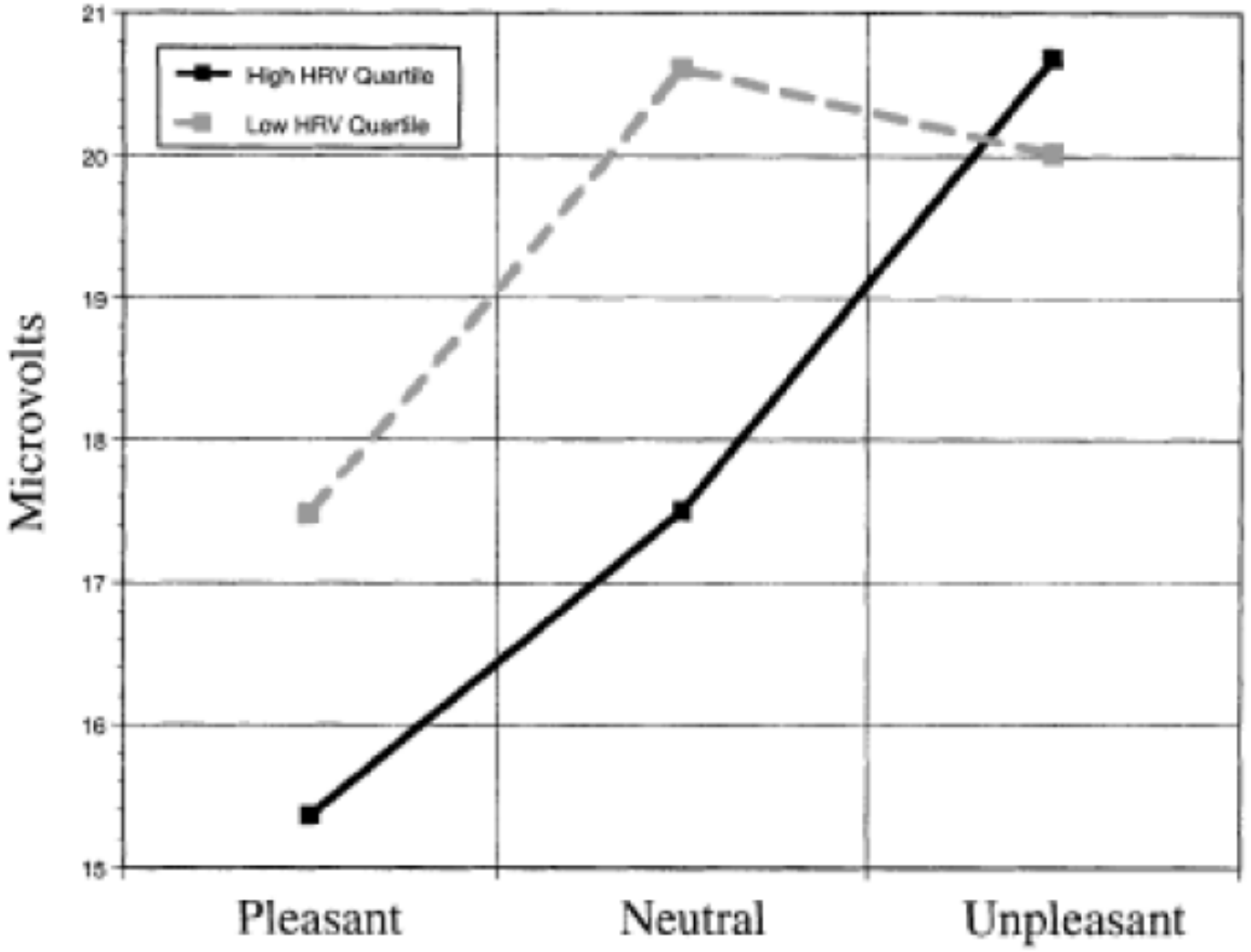


Figure 1. Mean startle amplitude as a function of baseline HRV and valence. Startle amplitudes are in microvolts.

From: Ruiz-Padiala, Sollers, Vila, & Thayer (2003) *Psychophysiology*

A few Applications

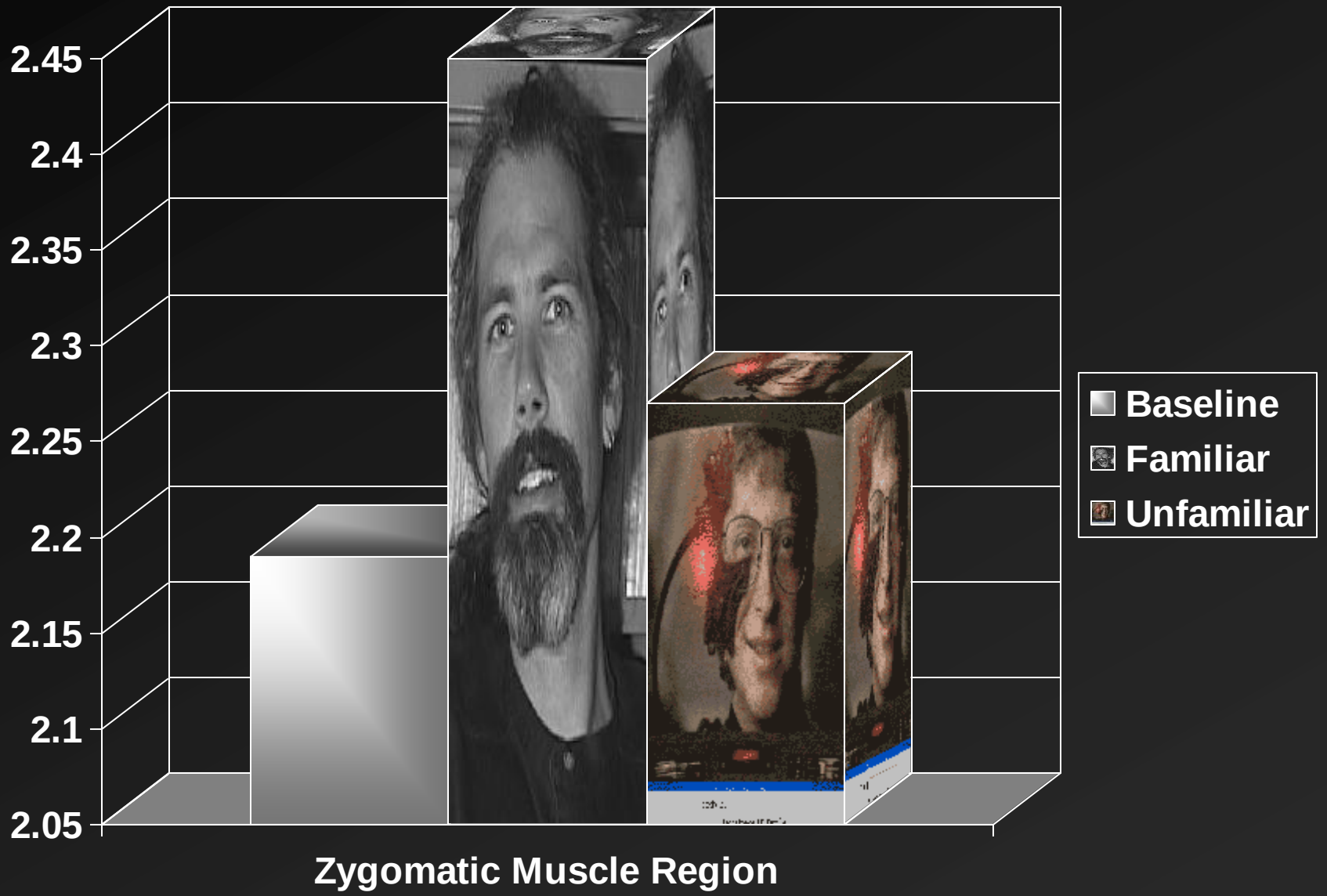
- Startle Probe
- Subtle affect
  - Mere Exposure
  - Subliminal effects
  - Mortality Salience
  - Biofeedback of EEG -- outcome measure
  - Emotion Regulation – outcome measure
  - Empathy – individual difference measure

The Phenomenon:

- People prefer stimuli to which they have been previously exposed to unfamiliar stimuli
- In absence of any reinforcement (“mere” exposure)
- Examples:
  - People we see incidentally in our routines
  - Songs
  - Scientific journal preferences
- Effect size r=.26 (Meta-analysis,Bornstein, 1989)

The logic:

- Evolutionary account Bornstein (1989)
  - it may be adaptive to prefer the familiar over the novel
  - novel objects could present a potential threat
  - organisms that had a fear of the strange and unfamiliar were more likely to survive, reproduce, and pass on genetic material
  - Preferring the familiar may thus be an adaptive trait that has evolved in humans and nonhumans
- Prediction:
  - unfamiliar as compared with familiar stimuli may be associated with more negative attitudes because of the unfamiliar stimuli's association with potential danger
  - Thus may see greater corrugator activity to novel than to familiar
  - No prediction for positive affect (Zygomaticus activity)



Loosely translated from Harmon-Jones & Allen, 2001

A few Applications

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  - Empathy – individual difference measure

30 ms

5 ms

Dimberg et al *Psychological Science* 2000

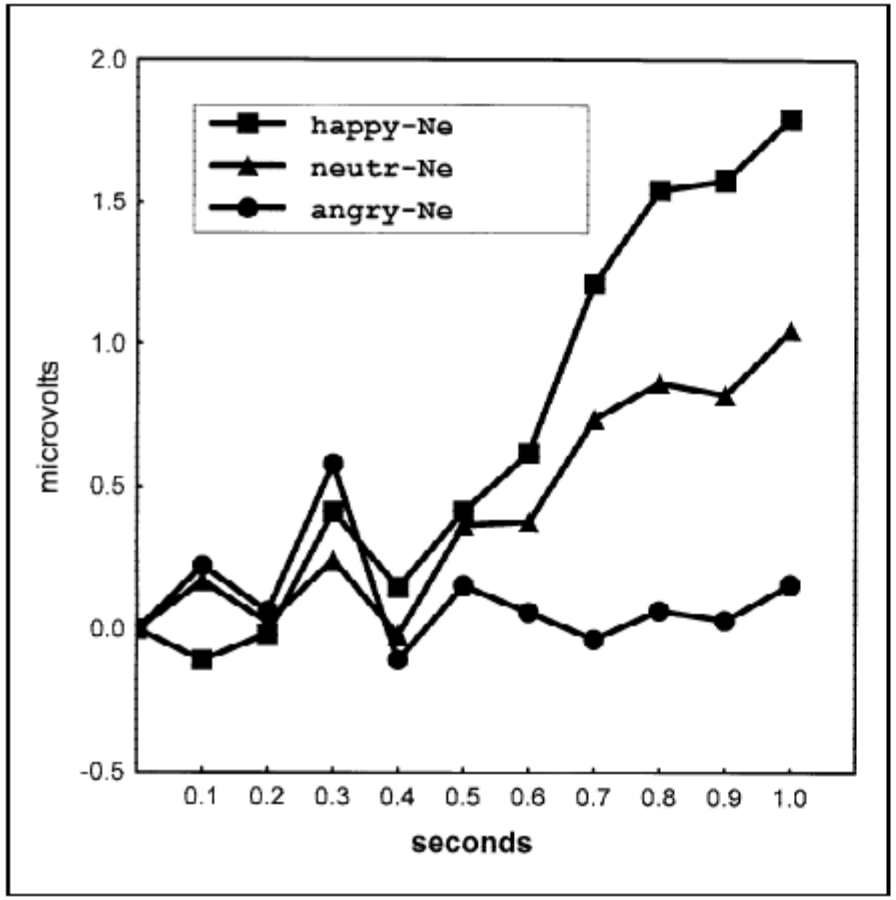

Fig. 1. Mean facial electromyographic response for the *zygomatic major* muscle, plotted in intervals of 100 ms during the first second of exposure. Three different groups of participants were exposed to identical neutral faces ("Ne"), preceded by unconscious exposure of happy, neutral ("neutr"), or angry target faces, respectively.

Dimberg et al *Psychological Science* 2000

A few Applications

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Another loose translation: Arndt, J., Allen, J.J.B., & Greenberg, J. (2001). Traces of terror: Subliminal death primes and facial electromyographic indices of affect. *Motivation and Emotion*, *25*, 253-277.

A few Applications

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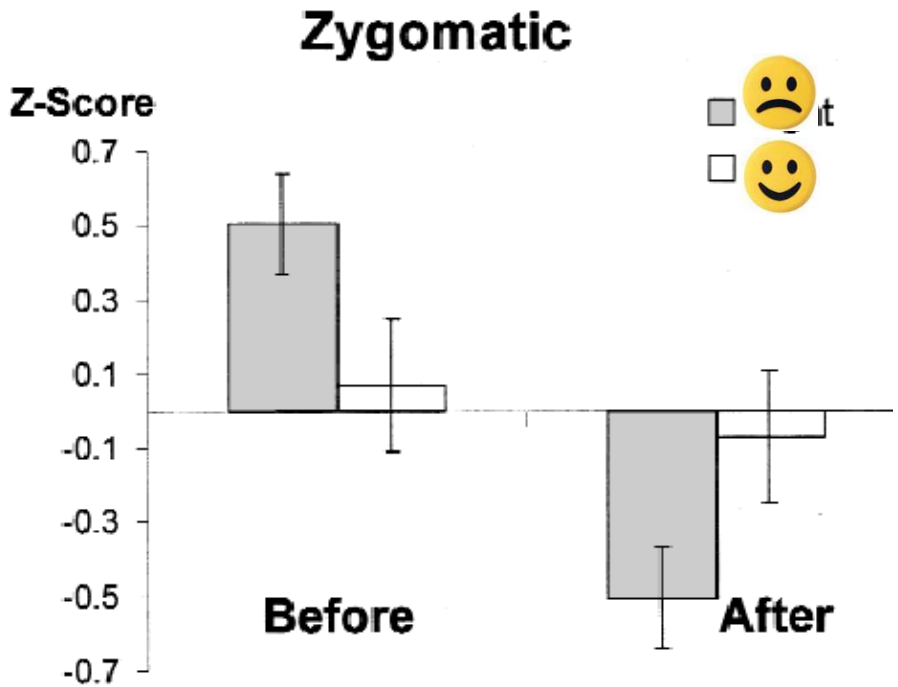

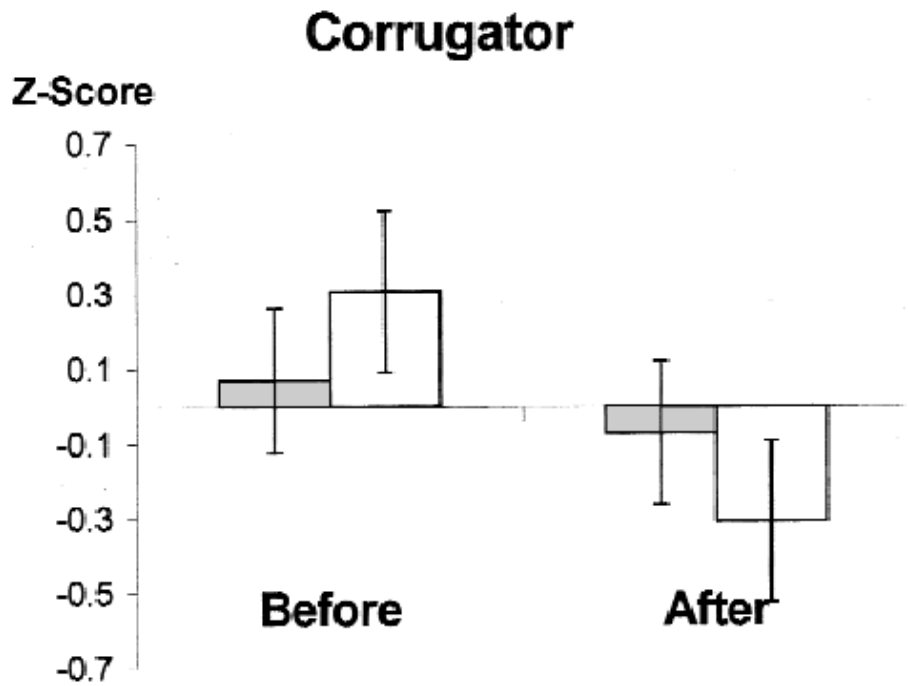

Allen, Cavender, Harmon-Jones, *Psychophysiology* 2001

A few Applications

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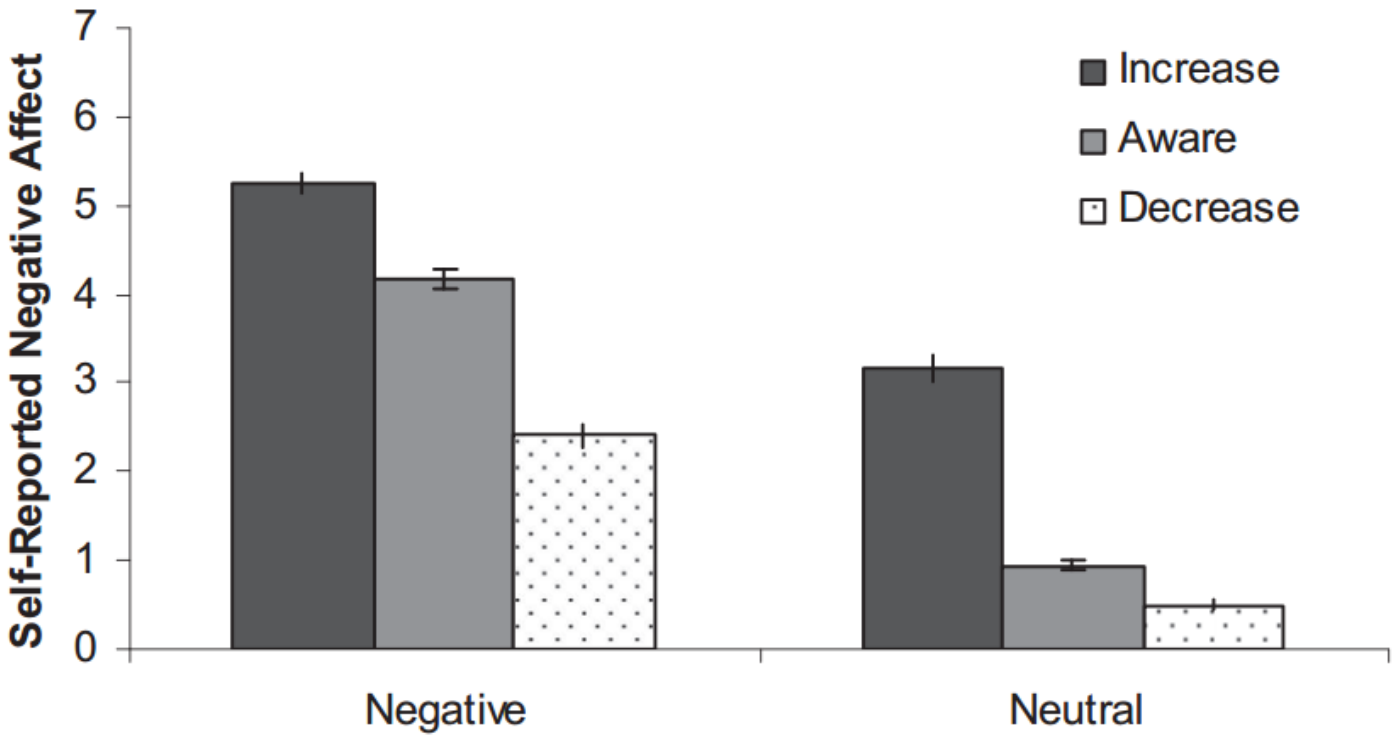

Figure 1. Self-reported negative affect on a 7-point Likert scale, where 0 = "not negative at all" and "7" = "strongly negative."

Ray, McRae, Ochsner, & Gross, *Emotion*, 2010

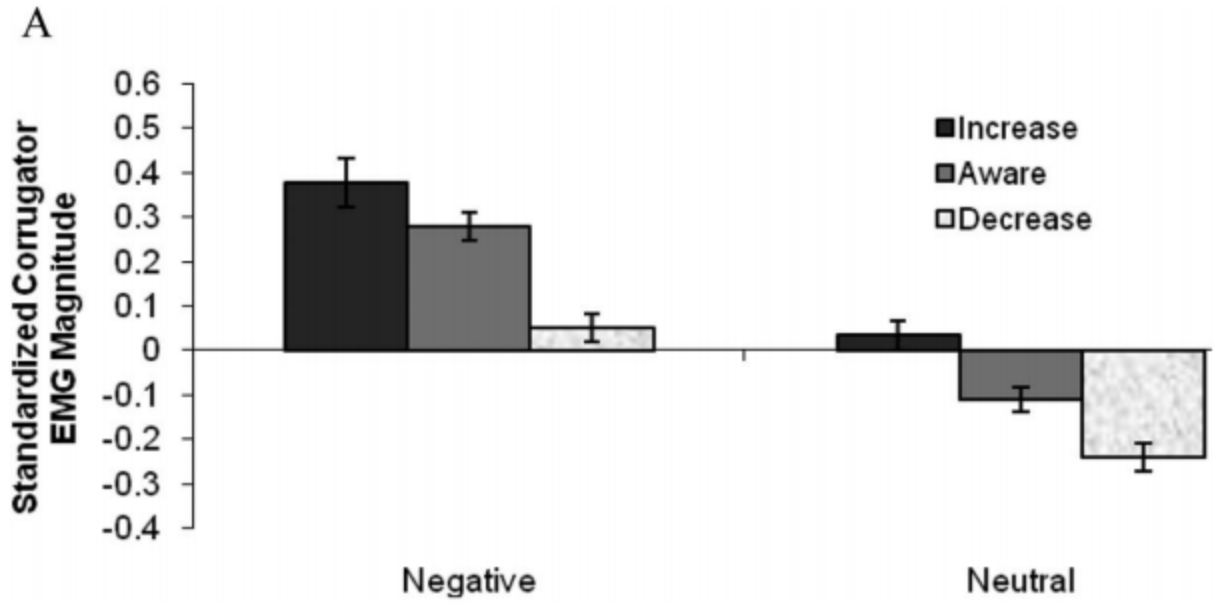

Figure 2. Standardized (A) corrugator EMG and (B) startle magnitude (averaged over Times 1 and 2).

Ray, McRae, Ochsner, & Gross, *Emotion*, 2010

A few Applications

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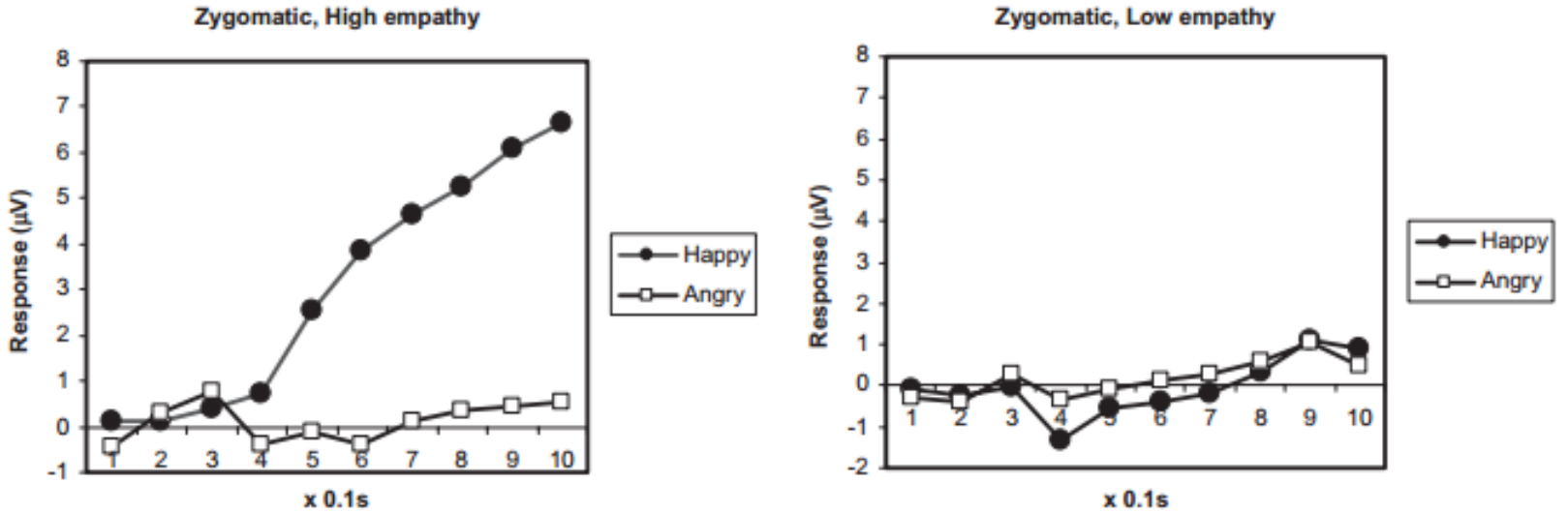

Faces

Figure 1. The *zygomaticus major* muscle response to pictures of happy and angry facial expressions for the High and Low empathy groups, plotted as a function of 100-ms intervals during the first second after stimulus onset.

Dimberg & Thunberg (2012) *PsyCh Journal*

EMG vs Video vs Automated Video

PLOS ONE

RESEARCH ARTICLE

Measuring facial mimicry: Affdex vs. EMG

Jan-Frederik Westermann*, Ralf Schäfer, Marc Nordmann, Peter Richter, Tobias Müller, Matthias Franz

Medical Faculty, Clinical Institute for Psychosomatic Medicine and Psychotherapy, University Hospital of the Heinrich-Heine-University, Düsseldorf, Germany

* westermannjan@yahoo.de

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Abstract

Facial mimicry is the automatic imitation of the facial affect expressions of others. It serves as an important component of interpersonal communication and affective co-experience. Facial mimicry has so far been measured by Electromyography (EMG), which requires a complex measuring apparatus. Recently, software for measuring facial expressions have become available, but it is still unclear how well it is suited for measuring facial mimicry. This study investigates the comparability of the automated facial coding software Affdex with EMG for measuring facial mimicry. For this purpose, facial mimicry was induced in 33 subjects by presenting naturalistic affect-expressive video sequences (anger, joy). The response of the subjects is measured simultaneously by facial EMG (corrugator supercilii muscle, zygomaticus major muscle) and by Affdex (action units lip corner puller and brow lowerer and affects joy and anger). Subsequently, the correlations between the measurement results of EMG and Affdex were calculated. After the presentation of the joy stimulus, there was an increase in zygomaticus muscle activity (EMG) about 400 ms after stimulus onset and an increase in joy and lip corner puller activity (Affdex) about 1200 ms after stimulus onset. The joy and the lip corner puller activity detected by Affdex correlate significantly with the EMG activity. After presentation of the anger stimulus, corrugator muscle activity (EMG) also increased approximately 400 ms after stimulus onset, whereas anger and brow lowerer activity (Affdex) showed no response. During the entire measurement interval, anger activity and brow lowerer activity (Affdex) did not correlate with corrugator muscle activity (EMG). Using Affdex, the facial mimicry response to a joy stimulus can be measured, but it is detected approximately 800 ms later compared to the EMG. Thus, electromyography remains the tool of choice for studying subtle mimic processes like facial mimicry.