Announcements 2/29/16

- Happy Leap Day!
- Electricity test — See me about retake if needed
- Lab: Get your scored data done by tomorrow!
- 3x5 time

Last session’s 3-by-5’s (and other inquiries)

Baroreceptors adapt to sustained changes in arterial pressure.

- Rate and volume of respiration are possible confounds.
- Must examine to be sure differences in RSA cannot be accounted for by differences in rate (easy) or volume (difficult).

Could you speak a little more about conditions under which RSA might be a problematic measure?

- BRS is defined as the change in interbeat interval (IBI) in milliseconds per unit change in systolic BP (SBP).
- For example, when the SBP rises by 10 mmHg and IBI increases by 10 ms, BRS would be 10/10 = 10 ms/mmHg.
- Can be manipulated (pharmacologically, challenges) or can take advantage of normal fluctuations.

BP and Stress?

Cardiovascular effects in adolescents while they are playing video games: A potential health risk factor?

- significantly elevate BP during Video Game (VG)
- Energy consumption during Video Game unaltered compared to Rest, and significantly lower compared to Exercise!
- “Comparing all measured parameters it can be said that the relation of blood pressure and energy consumption during VG might not be favorable.”
Ballistocardiography

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!

Cardiac Vagal Control and Modulation

  - Reptilian “Dumb”: Dorsal Motor Nucleus
  - Massive reduction in HR & conservation of oxygen.
  - Dive reflex – cold water on the face during breath hold
  - Phylogenetically newer “smart” Vagus
  - Originates from Nucleus Ambiguous
  - Modulates influence to:
    - Promote attentional engagement, emotional expression, and communication.
    - Mobilizes organism to respond to environmental demands
    - Phasically 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), courtesy of http://www.deeperblue.net/article.php/225
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

| ANS Component        | Behavioral Function                              | Lower motor
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>III</td>
<td>Myelinated vagus (sensory/vagal complex)</td>
<td>Nucleus ambiguus</td>
</tr>
<tr>
<td></td>
<td>Social communication, self-soothing, calming, inhibit &quot;arousal&quot;</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>Sympathetic-adrenal system</td>
<td>Spinal cord</td>
</tr>
<tr>
<td></td>
<td>Mobilization (active avoidance)</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>Unmyelinated vagus (dorsal vagal complex)</td>
<td>Dorsal motor nucleus of the vagus</td>
</tr>
<tr>
<td></td>
<td>Immobilization (death feigning, passive avoidance)</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 1. Phylogenetic stages of the polyvagal theory.

Porges, 2007

**Task-related and Emotion-related modulation**

**Vagal Control and Defensive Coping**

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)
Can Vagal Control predict development of anxiety following stressors?

![Graph showing relationship between Time since initial assessment and RSA](image1)

**Fig. 1.** Effect of the interaction between RSA adjusted for age and Time since initial assessment on TMAS over a 0-1 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

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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

![Graph showing changes in RSA](image2)

**Intervention Group**

**Control Group**

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Orienting, Attention, and Defense

**Emotional reactivity**

- Pleasant
- Neutral
- Unpleasant

**Heart rate**

![Graph showing changes in heart rate over time](image3)
SCR (by contrast)

**Electromyography**

- 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

**Why Record EMG?**

- Skin conductance
- OR Vs DR

![Graph showing skin conductance over time](image-url)
Striated Muscle

- During contraction:
  - Very small changes in length of filaments
  - But big changes in the distance between the Z-bands as the thick filaments slide between the thin

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 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

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
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

Corrugator “Frown”

Zygomatic “Smile”

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

![Diagram](image)

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

International Affective Picture System (IAPS)

![Graphs](image)

Affective Space: Picture Content and Gender

![Graph](image)

Corrugator EMG

![Graph](image)

Zygomatic EMG

![Graph](image)
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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)
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From Allen, Harmon-Jones, and Cavender (2001)
Allen, Cavender, Harmon-Jones, Psychophysiology 2001
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Ray, McRae, Ochsner, & Gross, Emotion, 2010

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

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Dimberg & Thunberg (2012) PsyCh Journal