Announcements 3/4/13

➤ Electricity test – Everyone has now passed!
➤ Papers: 1 or 2 paragraph prospectus due no later than Monday March 25
➤ Lab Updates
➤ 3x5 time

Lab Updates

➤ EKG-EMG lab (will cover during lecture)

Lab Updates

➤ SCR GKT lab
  ➤ Should ignore first response in series and score remainder
  ➤ How to make dichotomous verdict of guilty?
    ➤ Lykken’s scoring
    ➤ Binomial Probability

Lykken Method

<table>
<thead>
<tr>
<th># with Max Response (N)</th>
<th>Probability of exactly N</th>
<th>Probability of N or fewer</th>
<th>Probability of N or More</th>
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<tr>
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<td>0.17</td>
<td>1.00</td>
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<tr>
<td>1</td>
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<td>0.50</td>
<td>0.83</td>
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<td>0.80</td>
<td>0.50</td>
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<tr>
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<td>0.94</td>
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<td>0.01</td>
<td>1.00</td>
<td>0.01</td>
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<tr>
<td>6</td>
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</tr>
<tr>
<td>8</td>
<td>0.00</td>
<td>1.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Many Options…
➤ Excel: BINOM.DIST function
➤ R: binom.test function
➤ Matlab: binocdf function
➤ SPSS: Nonparametric tests, Legacy Dialogs, Binomial
Returning to EMG….

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

Lab Updates

- EKG-EMG lab
  - EKG – done in QRSTool and CMetX
  - EMG
    - Step 1 in Neuroscan Edit
      - Filter and Rectify signals
    - Step 2 in Matlab
      - Get mean for each condition
      - Convert to within-subject z-scores

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

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

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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

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Figure 2. Standardized (a) corrugator EMG and (b) zygomatic EMG magnitudes (averaged over Times 1 and 2).

Ray, McRae, Ochsner, & Gross, *Emotion*, 2010
Electroencephalogram (EEG)

- The EEG—an oscillating voltage recorded on scalp surface
- Reflects Large # Neurons
- Is small voltage
- Bands of activity and behavioral correlates
  - Gamma 30-50 Hz
  - Beta 13-30 Hz
  - Alpha 8-13 Hz
  - Theta 4-8 Hz
  - Delta 0.5-4 Hz

Utility of EEG

- Relatively noninvasive
- Excellent time resolution

Sources of scalp potentials

- Glial Cells – minimal, some DC steady potentials
- Neurons
  - Action Potentials – NO, brain tissue has strong capacitance effects, acting as Low Pass filter
  - Slow waves
    - Synaptic potentials – YES, both IPSPs and EPSPs from functional synaptic units are major contributors
    - Afterpotentials – May contribute to a lesser extent
Alpha and Synchronization

Why Alpha?
- It is obvious and hard to miss!
- Accounts for ~70% of EEG activity in adult human brain

From where, Alpha?
- Historically, thought to be thalamocortical looping
- Adrian (1935) demolished that theory
  - Recorded EEG simultaneously in cortex and thalamus
  - Damage to cortex did not disrupt thalamic alpha rhythmicity
  - Damage to thalamus DID disrupt cortical alpha rhythmicity
  - Thalamic rhythmicity remains even in decorticate preparations (Adrian, 1941)
  - Removal of ½ thalamus results in ipsilateral loss of cortical alpha

Andersen and Andersen (1968)
- Cooling of Cortex resulted in change in amplitude but not frequency of Alpha
- Cooling of Thalamus resulted in change in amplitude and frequency of Alpha at both thalamus and cortex
Alpha and Synchronization

- In sum, Thalamus drives the alpha rhythmicity of the EEG
- Cortex certainly does feedback to thalamus, but thalamus is responsible for driving the EEG
- Particularly the Reticularis nucleus (Steriade et al. 1985)
- What causes change from rhythmicity to desynchronization?
  - Afferent input to thalamic relay nuclei
  - Mode-specific enhancement observed

Recording EEG

- Systems are surface-based, not anatomically-based
Electrodes, Electrolyte, Preparation

- Ag-AgCl preferred, Gold OK if slowest frequencies not of interest
- Polarizing electrodes act as capacitors in series with signal
- Electrolyte: ionic, conductive
- Affixing
  - Subcutaneous needle electrodes (OUCH)
  - Collodion (YUCK)
  - EC-2 paste; lesser of the evils
  - Electrocap

Recording References

- Measure voltage potential differences
- Difference between what and what else?
- “Monopolar” versus Bipolar
  - No truly inactive site, so monopolar is a relative term
  - Relatively monopolar options
    - Body – BAD IDEA
    - Head
    - Linked Ears or Mastoids
    - Tip of Nose
- Reference choice nontrivial (more later) as it will change your ability to observe certain signals

Recording References

- Bipolar recording
  - Multiple active sites
    - Sensitive to differences between electrodes
    - With proper array, sensitive to local fluctuations (e.g. spike localization)
- Off-line derivations
  - Averaged Mastoids
  - Average Reference (of EEG Leads)
    - With sufficient # electrodes and surface coverage, approximates inactive site (signals cancel out)
    - Artifacts “average in”
  - Current Source Density (more in advance topics)

Dreaded Artifacts

- Three sources
  - 60-cycle noise
    - Ground subject
    - 60 Hz Notch filter
  - Muscle artifact
    - No gum!
    - Use headrest
    - Measure EMG and reject/correct for influence
  - Eye Movements
    - Eyes are dipoles
    - Reject ocular deflections including blinks
    - Use correction procedure (more in advance lecture)

Name That Artifact!
movement in the reference lead

Chewing!

Vertical Eye Roll

Muscle Burst

Smiling!

Talking and Moving Head
AC Signal Recording Options

- Time Constant/HP filter
  - Low frequency cutoff is related to TC by:
    \[
    F = \frac{1}{(2\pi TC)}
    \]
    Where \( F \) = frequency in Hz, \( TC \) = Time Constant in Seconds

Applying formula:

<table>
<thead>
<tr>
<th>Time Constant (sec)</th>
<th>Frequency (Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.00</td>
<td>.016</td>
</tr>
<tr>
<td>5.00</td>
<td>.032</td>
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<td>1.00</td>
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<td>.10</td>
<td>1.592</td>
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<tr>
<td>.01</td>
<td>15.915</td>
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</table>
Hi Frequency/LP Settings

- Do not eliminate frequencies of interest
- Polygraphs have broad roll-off characteristics
- Be mindful of digitization rate (more info soon!)

Digital Signal Acquisition

- Analog Vs Digital Signals
  - Analog
    - Continuously varying voltage as fn of time
  - Discrete Time
    - Discrete points on time axis, but full range in amplitude
  - Digital
    - Discrete time points on x axis represented as a limited range of values (usually 2^n, e.g. 2^12 = 4096)

A/D converters

- Schmidt Trigger as simple example
- The A/D converter (Schematic diagram)
  - Multiplexing (several channels); A/D converter is serial processor
  - Result is a vector [x0, x1, x2, ..., xn] of digital values for each channel
  - 12 bit converters allow 2^12 = 4096 values
  - 16 bit converters allow 2^16 = 65536 values

- 12 bit is adequate for EEG
  - 4096 values allow 1 value for each ~0.02 μvolts of scalp voltage (depending upon sensitivity of amplifier, which will amplify signal ~20,000 times before polygraph output)
  - e.g.,
    - 2.1130 μvolts => 2481 D.U.'s (2480.74)
    - 2.1131 μvolts => 2481 D.U.'s (2480.76)
    - 2.1250 μvolts => 2483 D.U.'s (2483.20)

The Problem of Aliasing

- Definition
  - To properly represent a signal, you must sample at a fast enough rate.
  - Nyquist’s (1928) theorem
    - A sample rate twice as fast as the highest signal frequency will capture that signal perfectly
  - Stated differently, the highest frequency which can be accurately represented is one-half of the sampling rate
  - This frequency has come to be known as the Nyquist frequency and equals ½ the sampling rate

- Comments
  - Wave itself looks distorted, but frequency is captured adequately.
  - Frequencies faster than the Nyquist frequency will not be adequately represented
  - Minimum sampling rate required for a given frequency signal is known as Nyquist sampling rate

Aliasing and the Nyquist Frequency

- In fact, frequencies above Nyquist frequency represented as frequencies lower than Nyquist frequency
  - F_Ny + x Hz will be seen as F_Ny - x Hz
  - “folding back”
    - Frequency 2F_Ny seen as 0,
    - Frequency 3F_Ny will be seen as F_Ny
  - accordion-like folding of frequency axis