Due Thursday 1/24/06 in class
COGS 179/279
Homework Problem Set A

1. a) Briefly define ERP component. b) What are 3 ways an ERP component can be characterized? c) Give an example of a characterization of an ERP component (any component) described in the readings.

2. Martina is very interested in testing whether advanced stages of Alzheimer's disease are associated with changes in the beta rhythm in the EEG. She decides to collect EEG data from patients in a nearby nursing home, some with Alzheimer's and some with osteoarthritis. She plans to set up a temporary lab in the nursing home and record EEG as people listen to different kinds of music. a) In setting up the bioamplifiers, what should she consider when choosing analog filter settings? b) In programming the A/D converter, what sampling rate would you recommend to her? (Explain your rationale.) c) In planning her analysis, should she do a time-domain or a frequency-domain analysis?

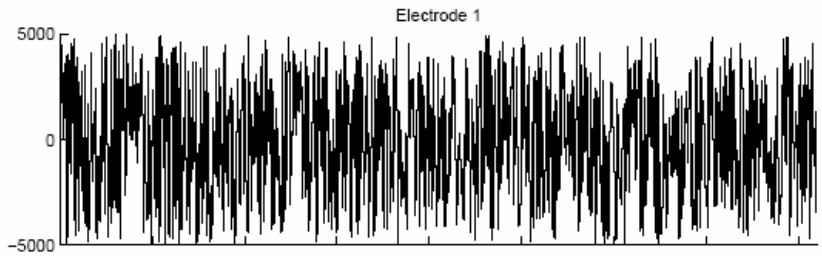
3. The N400 is largest over centroparietal scalp areas and is usually slightly larger on the right side of the head than the left. a) Can we infer from this that the N400 reflects mostly right hemisphere activity? b) Tell why or why not.

4. A friend of yours works in a lab in the psychology department and has found an exciting new cognitive phenomenon using a reaction time paradigm. He is considering doing an ERP version of his study but is unsure of whether it is likely to yield any new information. What would you tell him about the relationship between behavioral and ERP data to convince him to run the study?

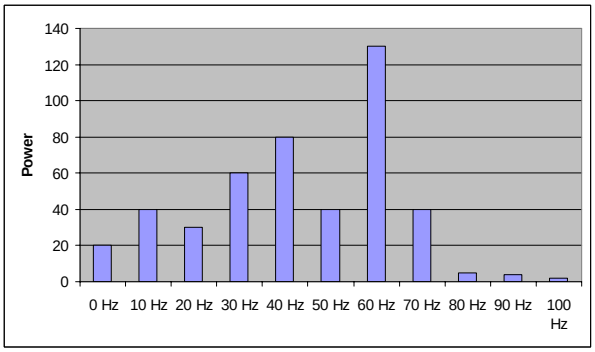
5. Dr. Frankenstein has identified a positive component in the brainwaves that indexes the operation of a neural module for devising deceptive communication strategies. He calls it the LPC (for Lie Production Component). He records EEG from students as they respond to questions from either their instructors (Condition 1) or their friends (Condition 2). He finds that the amplitude of the LPC is larger in Condition 1 than in Condition 2. a) What is the most natural inference (from this amplitude difference) regarding the operation of the neural module for devising deceptive communication strategies? b) What is one alternative explanation of the observed amplitude difference? c) What assumption about the signal underlying the ERP would have to be untrue for the explanation you gave in b to be valid?
[Caveat: this is a made up example. There is no Dr. Frankenstein. There is no Lie Production Component, or known neural module for devising deceptive communication strategies. EEG has, however, been used for lie detection.]

6. While working as a volunteer at the hospital, you meet an epileptic patient who is soon to be implanted with intracranial electrodes to help identify the source of her seizures. You tell her about an experiment you're doing on EEG and ERP responses to pictures of living versus non-living objects. She agrees to participate in the EEG study before she gets the intracranial electrodes, and later in a study using the intracranial electrodes as she views a very similar set of stimuli (living versus non-living objects). How do the signals recorded with the intracranial electrodes differ from those recorded with the scalp electrodes?

7. Using an amplifier he built himself, Jacob recorded the following activity from an electrode at the vertex of the scalp (Cz).



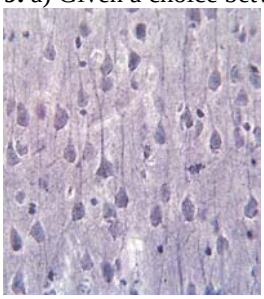
The frequency profile looks like this.



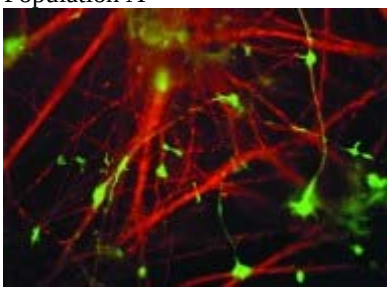
You advise Jacob to build a differential amplifier (he's an electronics whiz) and to use a reference electrode placed on the mastoid process. a) Explain how differential amplification combines the data recorded at each electrode (very simple answer here). b) Explain why collecting the data this way will yield a more informative record of the EEG. c) Graph the frequency profile of data from the new arrangement, and d) explain your rationale for why you depicted the change that you did. (I'm more interested in your rationale than the exact nature of the graph in c.)

8. In "Electrifying Results", Coulson describes a number of constraints on ERP research. Think of an example of an experimental paradigm that tests some issue in cognitive science but would not be a practical ERP experiment. (Feel free to be creative.) a) Describe the issue your (ill-fated) experiment would address in about 1 sentence. (It doesn't have to be deep.) b) Briefly describe the experiment. c) Explain why this experiment is *not* a practical ERP experiment. Be explicit about what constraint or constraints it would violate.

9. a) Given a choice between the following:



Population A



Population B

Which is more likely to produce activity detectable at the scalp? b) Justify your answer to a. and mention 3 conditions that have to obtain in order for neural activity to be detectable at the scalp.

10. Differences in the scalp distribution of ERPs indicate differences in the neural activity in the two conditions. a) What is meant by scalp distribution? b) What do people typically infer about neural generators of ERPs that have the same scalp distribution? c) Give an alternative explanation for the observation of two ERPs with the same scalp distribution. d) Explain the relationship (if any) of the significance of similarly distributed ERPs (over the scalp) to the inverse problem (be sure to briefly define it). 279/ExtraCredit179) When are differences in the scalp distribution of ERPs meaningful to the cognitive neuroscientist, and when are they not? (There is no definitive answer to this part, just give a brief 1-paragraph discussion of the issue.)