

Questions, Week 2

Neural Bases of Language

Submitted September 18, 2005

1 Short Answer

- (1) How does Broca's Aphasia differ from Wernicke's Aphasia?
- (2) Describe some of the characteristics of a person with Broca's Aphasia
- (3) Briefly describe the principles of how MEG and fMRI function respectively and name one flaw or drawback of each method.
- (4) The speech produced by patients with Broca's aphasia is different than the speech produced by patients with a lesion in Wernicke's area. Explain the difference between the two types of speech.
- (5) In what are based the differences between the hemodynamic and the electro-magnetic techniques? What are the names of the neuroimaging technology used for each technique, what are the pros and cons of each?
- (6) List three methods that neuroscientists used to study how language is represented and processed in the human brain and name what each method helped to discover.
- (7) Explain why the hemodynamic technology of fMRI results in poor temporal resolution.
- (8) Why would an EEG or an MEG be a more effective method of inquiry than a hemodynamic method when investigating a linguistic phenomenon like priming?
- (9) Define, locate and give an example of 3 different specific types of aphasia.
- (10) Why are PET scans declining in popularity compared to fMRI? Mention at least two advantages of fMRI over PET scans.
- (11) How might someone with Broca's Aphasia interpret the following sentence: *The boy was chased by the girl.*
- (12) Explain why the blocked design is necessary for PET scans.
- (13) As per the standard model what brain systems are involved in the repetition of a spoken phrase?
- (14) Dichotic listening studies have shown that when holding a phone receiver to their right ear, right handed (but not left handed) people perceive speech coming from the phone as clearer and louder (right ear advantage) than they would speech heard from the left ear. What is the reason for which this phenomenon is observed in these right handed individuals?

- (15) What is the key difference in the developing of functional fMRI images as opposed to functional MEG images?
- (16) By combining aspects of both MEG and fMRI imaging, is it possible to measure the precise location, source, and values of activated brain currents at the exact moment it occurs?
- (17) Why is it that Broca's aphasia is considered a syntactic disorder?
- (18) A person suffering from anemia has a lower red blood cell count, and consequently, lower levels of hemoglobin. Would the fMRI of a specific individual at a particular instance differ significantly if he/she were anemic? Please explain why or why not.
- (19) Fully explain Conduction Aphasia:
- (20) Explain a hemodynamic and electro-magnetic technique in functional brain imaging, listing a pro and con of each.
- (21) How does the sentence structuring of Wernicke's aphasics differ from Broca's aphasics?
- (22) Jill was admitted into the hospital after suffering from a stroke. Soon after, her doctor noticed that her speech was awkward and halting. Jill was unable to repeat words and phrases and could not utter a sentence with the correct function words and inflection. Her writing was equally poor, although she exhibited little difficulty in reading aloud. What possible area(s) of her brain was/were affected by the stroke?
- (23) Why are visual problems more common than auditory problems?
- (24) Right-handers are left lateralized for language (language is represented in the left cerebral hemisphere). Why are left-handers not right lateralized for language?
- (25) What does studying aphasia help us to understand about the brain?
- (26) The two major types of electromagnetic currents that can be recorded outside of the head are: secondary/volume currents, picked up in EEGs, and magnetic flux, recorded in MEGs. What is the major problem with the former that leads to the development of the latter?
- (27) In terms of language production, what is the difference between Broca's and Wernicke's aphasia?

2 Multiple Choice

- (28) If a person is given the word "FOOTBALL" to read, but produces the reading error "BASE-BALL", what is his/her likely syndrome?
 - a. Phonological dyslexia
 - b. Deep dyslexia
 - c. Surface dyslexia
 - d. Agrammatism
- (29) According to the readings, someone with acquired phonological dyslexia would have trouble pronouncing the word:
 - a. yacht
 - b. Mississippi

- c. vell
 - d. dog
- (30) What follows is a transcript between a patient and Dr. Samuel. From this dialogue where might we assume the patient has localized damage in their brain?
- Dr. Samuel: How are you today?
- Patient: Yes, I am please.
- Dr. Samuel: Did you do anything special this weekend?
- Patient: Okay, if you think its best. I can't meet you now.
- Dr. Samuel: Do you recall our last visit?
- Patient: I don't celebrate telephones.
- a. Temporal lobe
 - b. Broca's area
 - c. Frontal lobe
 - d. Parietal lobe
- (31) Why would a person with Broca's aphasia have trouble with the question: "Which fruit did the girl eat?"
- a. the subject is displaced
 - b. the object is displaced
 - c. the question is active
 - d. the person has a lesion on their arcuate fasciculus
- (32) What would be the symptoms experienced by a patient with Wernicke's aphasia?
- a. Brain damage in the posterior part of the left third frontal convolution
 - b. Slow, laborious, non-speech. Output limited to short utterances.
 - c. Impaired understanding of speech and impaired reading.
 - d. Fluent but disordered speech and fluent organized writing.
- (33) Which of the following statements is not true about fluent aphasia?
- a. It is also known as "sensory aphasia."
 - b. It is associated with a lesion in the temporal lobe, below the most posterior portion of the lateral fissure.
 - c. These patients have no difficulty producing language.
 - d. These patients have no difficulty selecting, organizing, and monitoring their language production.
- (34) The performance of Broca's Aphasics on which question poses evidence against the Trace Deletion Hypothesis?
- a. Which gentleman kissed the woman.
 - b. Who did the gentleman kiss?
 - c. Which woman did the gentleman kiss?
 - d. Was it the gentleman who kissed the woman?
- (35) Conduction aphasia, or the impairment of a person's ability to repeat words, is caused by...

- a. Damage to Broca's area.
 - b. Damage to the corpus callosum.
 - c. Damage to both Broca's and Wernicke's areas.
 - d. Damage to the arcuate fasciculus.
- (36) If you were conducting an experiment concerned with the exact location of a function in the brain, which Neuroimaging technique would you use?
- a. MEG
 - b. fMRI
 - c. EEG
 - d. EKG
- (37) People with Broca's aphasia (non-fluent aphasia) are noted to have impairment processing syntactically complex sentences, such as those containing elements with trace positions. Which of the following types of syntactic constructions would a person Broca's aphasia have difficulty processing?
- a. Subject Clefts (It was the hammer that hit the nail.)
 - b. Passive Constructions (The nail was hit by the hammer.)
 - c. Object Relatives (The nail that the hammer hit was blue.)
 - d. A & B
 - e. B & C
- (38) Which of the following would a person with Broca's Aphasia have difficulties with?
- a. Syntax
 - b. Speech comprehension
 - c. Audition
 - d. both (A and B)
- (39) What is the best functional brain imaging technique to obtain a detailed view of a constant brain state?
- a. a hemodynamic technique
 - b. an electronic technique
 - c. a magnetic technique
 - d. a electro-magnetic technique
- (40) Given a Wernicke's Aphasic's response, how would he interpret the following sentence:
The gazelle was chased by the lion.
- a. The lion chased the gazelle
 - b. The gazelle chased the lion
 - c. Both lion and gazelle chased something else
 - d. None of the above
- (41) Why is it that an MEG is incapable of detecting sources located at the very crest of gyrii in the brain, despite the fact that they are the closest to the skull, and therefore closest to the sensors?

- a. These sources create a closed magnetic field in the brain, making them undetectable by external sensors which measure those magnetic fields.
 - b. These sources do not create magnetic fields.
 - c. Poor spatial resolution makes it impossible to identify the signal as originating from that location.
 - d. The direction of the magnetic field is reversed at these locations, making them undetectable to the sensors.
- (42) Due to the temporal resolution of PET which experimental design would provide the most accurate data?
- a. Blocked Trials
 - b. Spaced Mixed Trials
 - c. Rapid Mixed Trials
 - d. None of the above
- (43) Which of the following most accurately distinguishes between MEG and EEG?
- a. EEG is dependent on magnetic flux and the currents that emerge on the head surface are greatly distorted.
 - b. EEG is dependent on volume currents and displays excellent spatial resolution.
 - c. MEG is dependent on magnetic flux whose constituent flux lines emerge on the head surface in geometrically regular distributions.
 - d. MEG is dependent on volume currents and displays excellent temporal resolution.
- (44) The following sentence would be a very good example of a patient with which type of aphasia. *Uh... Sally... uh... eats... chicken... fries... err... mustard... all... time... Tuesday.*
- a. Conduction aphasia
 - b. Wernike's Aphasia
 - c. Broca's Aphasia
 - d. Temporal Aphasia
- (45) Which of the following is NOT true of Broca's Aphasia?
- a. it often involves a lesion in the posterior part of the left third frontal convolution
 - b. it is generally a production problem
 - c. the trace deletion hypothesis is generally accepted as an explanation for Broca's aphasic abilities and difficulties
 - d. Broca's aphasics don't have trouble with all syntax, rather, BA and the correlating area of the brain deal with specific aspects of syntax.
- (46) Phonological Dyslexia is when a patient seems to have...
- a. difficulty in remembering lists of words.
 - b. Lost the ability to use spelling-to-sound rules
 - c. An inability to read words they have never seen before
- (47) A person is heard uttering the following set of sentences- "Well, no. I mean err I haven't. But he came from there although they still voting. Now I go I eat grapes." According to this speech pattern, which of these is most likely true?

- a. The patient suffers from Broca's aphasia
 - b. The patient suffers from conduction aphasia
 - c. The patient was not exposed to language until after the critical period
 - d. The patients suffers from Wernicke's aphasia
- (48) A general inability to comprehend language, in which patients are normally unaware is which type of disability.
- a. Broca's Aphasia
 - b. Audible Aphasia
 - c. Wernicke's Aphasia
 - d. bilateral aphasia
- (49) Which one of the following does not describe an individual suffering from Broca's Aphasia (nonfluent aphasia)?
- a. omits inflectional affixes such as "ing," "ed" and omits function words "it," "is"
 - b. shows difficulty judging grammar in sentences
 - c. aware of their language deficit and frustrated with it
 - d. unaware of their language deficit
- (50) A patient with Broca's aphasia would have difficulties with what?
- a. language comprehension
 - b. language production
 - c. motor skills
 - d. bilingual abilities
- (51) Which of the following questions would be the most difficult for a Broca's aphasic to understand?
- a. The cat bit the dog
 - b. The cat who bit the dog was rabid
 - c. The dog who the cat bit was rabid
 - d. It was the cat who bit the dog
- (52) Information about language representations in the brain is gained through an investigation of the brain itself. Which type of experiment involves studying the corpus callosum?
- a. Dichotic listening studies
 - b. Split brain studies. (The corpus callosum is the bundle of fibers that connects the left and right hemispheres.)
 - c. Autopsy studies
 - d. Dyslexia studies
- (53) If you were to carry out an experiment in which you needed to have good spatial resolution and be as non-invasive as possible, which of the following neuro-imaging techniques would you use?
- a. Electro-encephalography (EEG)
 - b. Magneto-encephalography (MEG)

- c. Functional magnetic resonance imaging (fMRI)
- d. Positron emission tomography (PET)

3 Open-ended question

- (54) Does the brain process language differently when hearing it versus seeing it, and if so at what speeds?

For instance, the Mandarin language is phonetic as well as pictorial. The written part of Mandarin does not phonetically sound like its spoken words, such as in the English language, because it consists of characters. For this research question one could test native speakers of Mandarin by PET to see which areas of the brain light up. It could also be interesting to see how native speakers of the language, and non-native speakers of the language process language differently.

- (55) Through conditioning techniques would it be possible to help someone with aphasia relearn their language impairment?

I am not sure if there is any safe way to activate specific areas of the brain, but if there were you could possibly play words or phrases the person was having trouble with while activating areas of the brain. Also, because there are two hemispheres it would be interesting to see if you could make an unharmed section of the brain learn new techniques by pairing events together. For example, a person who was having trouble with the function words, could listen to a recording of function words while also watching an image that is known to activate a completely separate area of the brain and perhaps the brain will be able to teach itself these new connections and progress could be made.

- (56) If a deaf individual who used ASL his/her entire life developed a lesion in his frontal lobe, would he develop a form of Broca's aphasia? If so what does this say about the frontal lobe in language skills?

I hypothesize that since the frontal lobe is key in motor/language functioning ASL will be negatively affected.

Bonus: Though this question would be hard to ethically research (as you could not create a lesion in a deaf individual,) you could attempt to locate an individual with this circumstance or (more pragmatically) you could research the empirical literature on how and where ASL is processed in the brain and compare it to regions active in auditory language processing.

- (57) Lesion's to Wernicke's area and Broca's area produce very different types of aphasia. The part of the brain connecting these two areas is called arcuate fasciculus, and a lesion to this area results in Conduction aphasia. Develop more insights about Conduction aphasia; how do patients with this type of aphasia differ from Broca's or Wernicke aphasia patients, do they have trouble with reading/writing/ speaking? Would the symptoms of both Broca's and Wernicke's aphasia be present but at different times? Does Conduction aphasia effect memory and does this have anything to do with well known diseases? Hypothesis-This disease might be more debilitating than either Broca's or Wernicke's aphasia. I would suppose that symptoms of both the two aphasia's are present. However, since the brain may be unable to send messages and relate the motor images to the acoustic images, the results could be worse then the other types of aphasia. Using fMIRs to study the activity

in the brain on patients with Conduction aphasia would be one step. I would want to see if there is activity spreading from Wernicke's to Broca's area. I would definitely have to study patients with this aphasia to see how they were processing language; how they responded to questions, remembered facts.

- (58) Would the symptoms experienced by a patient with Broca's aphasia differ depending on the patient's native language? The studies to answer the question would be to examine cases of different language speaker patients with Broca's aphasia, specially the languages which parameters varied such as, for example, English and Japanese.
- (59) Why is it that patients with Broca's Aphasia are able to recognize that the noun which follows the word "by" is an agent in the sentence?
- (60) Many children with autism have difficulty with language production. A new technique for helping these children overcome their deficits, is teaching them language through reading. Knowing that reading and speech production primarily activate different areas of the brain, how is it that one of these actions can be used to facilitate the other. Are we strengthening a connection between the two areas? Maybe we are using reading to enable functioning of a 3rd component that is fundamental to speech production?
A good start to research this would be to do imaging studies on children with speech production deficits before and after intervention (the method of teaching through reading) and see if there are any differences in brain activation.
- (61) Does the hypothesis that Broca's area is part of the "mirror system" in our brains have anything to do with the general awareness of their language impairment among Broca's aphasics?
- (62) It seems that there is a lack of a body of research on language localization in the brains of left-handers. Where is language comprehension localized? If not Wernicke's area, or not completely, then what areas share the process?

Requirements:

- Access to an fMRI or PET machine
- Left-handed native English speakers without fluency in other languages
- Participants must also be without brain damage and with full language capabilities
- Setup: Create a gradual presentation in 3 stages:
 - Stage 1) composed of simple words and numbers; participants have 2 buttons to press after being presented each stimulus: word or non-word
 - Stage 2) composed of simple words and words not possible (grammatically, phonologically or otherwise) in English, again after each stimulus participants will either press word or non-word
 - Stage 3) composed of both English words and words that are possible (grammatically, phonologically or otherwise) in the English language, same response choices

After recording what areas of the brain are activated, we can look for a pattern to see which areas are lit up in all of the correct "word" decisions

After the experiment is conducted we should compare the lighted areas with past experiments that show localities for simple activities such as simply viewing random stimuli, resting, breathing or solely viewing words. This will serve to reduce the error of mistaken identity, or naming parts that are in charge of production that actually serve more basic functions. After this, we can attempt to identify those areas that are associated with language comprehension in left-handers.

- (63) Patients with Broca's aphasia are believed by some to employ a particular strategy when encountering syntactically complex sentences containing traces. In these sentences, the first appearing noun phrase (NP) is assigned the role of actor in a sentence. In sentences in which a second "actor" is encountered, the aphasics guess whether or not this is the actor. English grammar, however, is arranged in a "subject, verb, object" order. What strategy would be employed by speakers of a language in which the object precedes the subject, such as Fiiian or Malagasy?
- (64) Would neuro-imaging show there to be a difference in areas involved in the processing of sounds found within the speech frequency range and those that are not?
- (65) Could Transcranial Magnetic Stimulation show any positive effect on patients with minor damage to their Broca's area? To do this, one could just administer TMS to Broca's Aphasia patients and test them on their speech fluency and record the number of breaks in speech versus these traits without TMS.
- (66) Given a Broca's Aphasic presented with pictures of objects and names of the objects asked to then visualize things, what would a neuro-imaging procedure show as opposed to a 'normal' control subject?
- (67) Do simultaneous EEG and MEG scans of a single individual indicate phenomena in language processing in the brain in conjunction that were are not present when the data are taken into account separately?
- (68) Wernicke's area is implicated in language comprehension while brocas area is implicated language production or syntax. Which part of language is constructed in our minds first, do we produce the form of the sentence or do we produce the meaning of the sentence first. In looking at the activation times of both areas when a subject is trying to create a phrase should show which area is activated first. Then the same can be done with language comprehension do we decipher what is the content of the sentence first or do we decipher what type of sentence we are dealing with first.
- (69) Are right-handed individuals more susceptible to more severe cases of Broca's aphasia than left-handed individuals?
- (70) Wernike's Aphasics have a problem comprehending language both spoken and written, however is it possible that they can comprehend ideas expressed in symbols. Perhaps there is a way to ask them questions using symbols that can express ideas without using words. It seems strange that they are completely disconnected from the fact they are no longer able to comprehend language. Using symbols that stand for certain words may help them to be able to express and comprehend very basic ideas that may allow them to communicate with others.

- (71) How (if at all) do the brain correlates of Broca's and Wernicke's areas in chimpanzees inform our understanding of how these areas process language. This research would entail various mirroring and signaling tasks that attempt to activate these areas (using what activates them in humans as the starting point, both language-based and otherwise.) PET could be used.
- (72) What does Broca's aphasia tell us about how certain areas of the brain process language? Do different areas of the brain process different parts of sentences from syntax to function to memory?
- (73) If a child suffers from a stroke or undergoes severe head trauma before the critical age of language acquisition, are there ways to "re-wire" parts of the brain such that speech comprehension or production isn't lost?
- (74) Is aphasia ameliorated in left handed people compared to right handed given that their language processing isn't as localized?
- (75) Could knowledge of acquired dyslexia help us find new ways to treat developmental dyslexia?
- (76) O'Grady et al. mention an fMRI study in which "Second language processing has been shown to involve a wider variety of cortical sites" relative to primary language processing. Is there a measurable difference in activation between second-language processing in individuals who learned the language before puberty vs. after puberty?
 In order to examine this question we could look at speakers of Spanish and English, where Spanish is the speakers' L1. In order to control for years of second language spoken we would need to separate groups such that the after puberty group were about 5 years older than matched prepubescent subjects. Although this is not ideal, it is most important that subjects have equal exposure to learning English. In order to account for differing developmental rates our prepubescent group would have started learning English at 10 years of age, while the postpubescent group would have begun at 15 years. The subjects would be 20 and 25 years old at the time of our study. An fMRI paradigm would be developed incorporating listening comprehension questions in English and Spanish. Analysis would involve a subtraction using English as a baseline for individuals, and subsequent comparison of activation between groups. If a significant difference could be found, it would support the notion of a critical period for language. Follow up studies could compare the prepubescent group to subjects who were exposed to both English and Spanish at birth.
- (77) Are Broca's aphasic problems with object relatives and object clefts cross-linguistic with other languages with a different or less rigid word order than English?