Human Communication
PHY 302
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Language
● Lateralization
  ○ Left hemisphere dominance in speech production in 95% of right handed people and in 70% of left handed people
    ■ Left hemisphere- timing, sequence of events
    ■ Right hemisphere- analysis of simultaneous streams of information, emotion expression and regulation (face and voice); also involved in global perceptions (maps)
    ■ WADA test- used to determine the location of language processing areas in individuals
      ● Inject dye into the brain showing the route anesthesia will follow in the brain
      ● Anesthetize each hemisphere individually and see how speech is affected
  ○ Recall split brain patients- using words and pictures tests
  ○ Do animals have language (vocabulary, grammar)?- maybe, to some extent
    ■ Monkey language- up to 400 symbols
  ○ Is sign language lateralized?- yes (sign language is impaired with left hemisphere damage
  ○ Speech production vs speech comprehension

Speech production

Perceptions Memories

Verbal thoughts

Broca’s area (inferior frontal lobe)

● Broca’s aphasia- deficit in verbal expression of thought (slow speech), but comprehension is (mostly) intact
  ○ More precisely, deficit in function/relation words but normal in content words
    ■ Content words (object-related): chair, cookie, plate, water
  ○ Video: https://youtu.be/JWC-cVQmEmY

Language Production: Broca’s Aphasia
People with Broca’s aphasia are aware of their deficits (hear themselves)

Theory: Broca’s area controls ‘motor programs’ for word production
  ○ Control of tongue, throat muscles, jaw, lips, …
  ○ Other areas involved: insular cortex and basal ganglia

3 independent (?) components:
  ○ Articulation deficits- left insular cortex
  ○ Anomia- deficit in finding words
  ○ Agrammatism- deficit in the production/comprehension of word order
    (subject/complement) in ‘symmetric’ cases

Speech Comprehension

Wernicke’s area

Wernicke’s aphasia
  ○ Deficit in recognizing words (including their own)
  ○ Deficit in comprehending the meaning of words
  ○ Deficit in converting thoughts into words
  ○ Normal and producing speech-like sounds
  ○ Normal at using function words, produce nonsensical content words
  ○ Normal at facial expressions/tone regulation
  ○ Normal prosody
  ○ Not aware of their deficit
  ○ Video: https://youtu.be/3oef68YabD0

Theory: deficits in the memory of the sounds that make up words (pattern matching)

3 components:
  ○ Deficit in recognition of spoken words (also called pure word deafness)
    ■ Cannot recognize spoken words (as is foreign language) due to:
      ● Disconnection: auditory cortex -X-> Wernicke’s area
      ● Or damage to Wernicke’s area
    ■ Can read lips, read words, produce speech, recognize meaningful sounds
  ○ Deficit in comprehension of word meaning
    ■ Transcortical sensory aphasia: can repeat words (perception intact), but cannot understand/produce meaningful speech. Damage to posterior language area (= angular gyrus)
    ■ Direct pathway: Wernicke -> Broca via the arcuate fasciculus
  ○ Deficit in converting thoughts into words
    ■ Attributing meaning to a word involves memories
    ■ Indirect pathway: (diagram below)
Examples: metaphors, humor, or ‘moral of the story’; need more than comprehension, also need memories and meaning

From Wernicke to Broca
- 2 pathways:
  - Direct pathway - speech sounds, no meaning necessary, foreign language
  - Indirect pathway - meaning information, no sounds necessary, need to access memory info

Does Comprehension Involve ‘Internal Rehearsal’?
- Motor neurons (tongue) activated when hearing speech = mirror neurons
  - Experiment: subjects either hear, think about, or say words that would involve tongue/lips muscles (e.g. ‘p’ involves lips, ‘t’ involves tongue) -> same brain areas in all conditions active
- Theory: motor neurons feedback to brain, help with the ‘recognition’ or words
  - Mumbling = lack of inhibitory feedback control?
  - Experiment: subjects with ear plugs -> auditory cortex activated when words spoken aloud but not whispered.
    - Theory: we use auditory feedback in normal speech

Conduction Aphasia (arcuate fasciculus)
- Meaningful speech, good comprehension, repetition is normal except for nonsense/meaningless words or sentences

Other Aphasias
- Anomic aphasia
  - Fluent and well-formed speech, good comprehension
○ Difficulty in finding words- use circumlocutions
  ■ Problem in finding verbs/actions (motor cortex)
  ■ Problem in finding nouns (association cortex)
● Aphasia in deaf individuals
  ○ Sign language is a language
  ○ Mirror neurons in Broca’s area respond to perception of hand gestures. Speech production is influenced by perception of visual/hand information
  ○ Aphasia -> may also result in a deficit in the perception/production of hand gestures (left hemisphere)

Other Aspects of Speech
● Prosody- use of intonation to convey information
  ○ Grammatical information (i.e. asking a question)
  ○ Emotions information
  ○ Affected in Broca’s but not Wernicke’s
  ○ Right hemisphere specialization
● Stuttering- deficit in planning/initiation of speech
  ○ 1% of the population, 3x more men than women
  ○ Theory: faulty auditory feedback from subject’s own speech (too fast?)
  ○ Delayed auditory feedback decreases stuttering

Reading
● Disorder of reading- (pure) alexia
  ○ Inability to read (but not write) words. Can recognize spelled words said aloud
  ○ Perceptual disorder; damage to corpus callosum
  ○ Damage to the left hemisphere
  ○ Alexia is independent from visual agnosia -> reading words and perceiving objects use different brain regions

The Normal Reading Process (diagram below)
● Reading can be achieved in 2 ways: whole-word and phonetic
Surface Dyslexia
- Deficit in whole word recognition. Deficit in reading ‘exceptions’ to the pronunciation rules
- Left lateral temporal lobe damage

Phonological Dyslexia
- Deficit in reading unfamiliar words or non-words
- Damage in left frontal lobe
  - Phonetic reading is damaged

Neural Substrate of Reading
- Primary visual cortex
  - Ventral
    - Fusiform cortex (visual word Form area)
      - Whole-word reading
  - Dorsal
    - Parietal cortex
      - Broca’s area
        - Phonological reading