Notes on brain, language, gesture, action

Language, gesture, action
- Cognition and action: studied as separate
- Embodied cognition, grounded cognition, dynamic cognition
- Co-speech gesture: action

Language-gesture
- is there an overlap of brain processes supporting language and action?
- Is there neural evidence?

Methods in neuroscience
- Clinical, lesion studies, neuropsychology
- Neuroimaging / experimental
  - fMRI (functional magnetic resonance imaging)
  - PET (positron emission tomography)
  - ERPs/EEG (event related potentials/electroencephalography)
  - MEG (magnetoencephalography)
  - TMS (transcranial magnetic stimulation)

Neural evidence?
1. Neural/motor representations of speech sounds during comprehension
2. Neural representations of action-related language
3. Neural correlates of sign language comprehension
4. Neural basis of comprehension of speech/gesture
1. Motor representations of speech sounds
- fMRI and TMS studies:
- Listening to speech sounds activates parts of neural motor system (premotor cortex): e.g., lips, tongue
- Representations of speech sounds in premotor cortex that are activated during speaking are also activated while listening to speech sounds
- But there is modulation by higher level processes

2. Action-related language
- Activation of premotor cortex in response to action words (e.g., kick, lick, pick)
- Imagery of action?
- Listening to action-related language activates cortical motor areas
  - Concrete actions (but not metaphorical) (?)
  - But, is the activation of the motor cortex necessary for semantic processing?

3. Sign language
- Overall SL involves similar parts of the brains of signers as spoken language does in the hearing.
- Parietal cortex (involved in action observation/understanding) is more strongly activated in signers

4. Co-speech (hand) gestures
- N400 effects
  - Congruent/incongruent gestures
- Co-speech gestures evoke semantic processing
Small voltage fluctuations in the EEG, time-locked tasks (perceptual, motor, cognitive)

Average of multiple tokens (e.g., onset of a metaphorical word): waveform

Waveform has peaks (components) labeled relative to
- Polarity (N, P)
- When they occur relative to onset of the stimulus (ms)

ERP components and linguistic processing
- N400: semantic integration processes
  - Contrasting sentences with anomalous and non-anomalous ending
    - Non-anomalous: late positive wave
    - Anomalous: negative wave peaking at 400ms (Kutas & Hillyard, 1980)

ERP components and linguistic processing
- N400: semantic integration processes whose amplitude can be modulated by
  - Predictability
  - Difficulty
  - Larger amplitude → more difficult semantic integration
In sum: Neural evidence

- Neural/motor representations of speech sounds during comprehension
- Neural representations of action-related language
- Neural correlates of sign language comprehension
- Neural basis of comprehension of speech/gesture
- BUT, … flexible, integrated, contextual, …

4. Co-speech (hand) gestures (cont’d)

- Emblems: production and comprehension of the combination of word and emblem leads to specific effects not present with these alone.
- Left inferior frontal cortex plays a crucial role in combining information from speech and emblem.

EEG/MEG studies

- N400: meaningless/meaningful emblems ≈ pseudowords/words
- But emblems activate action-observation areas (right inferior parietal & right superior temporal)