Abstract and concrete noun processing in healthy older adults using fMRI

Chaleece Sandberg & Swathi Kiran
Aphasia Research Laboratory, Speech Language and Hearing Sciences
Boston University, Sargent College
*This work was completed at the University of Texas at Austin

**Background**
- Behavioral data from both normal and brain-injured subjects suggests that abstract words and concrete words are processed differently.
- Dual Coding Theory (Paivio, 1991)
- Suggests two systems for encoding words into semantic memory
  - Verbal (linguistic): Abstract words are encoded into the semantic system with only verbal information
  - Nonverbal (sensory): Concrete words are encoded into the semantic system with both verbal and multi-modal sensory information
- Evidence from recent neuroimaging studies suggests the possibility of dissociable neural correlates for abstract and concrete word processing (Binder, 2007)
- An issue yet unaddressed in the current literature is the processing of abstract and concrete nouns in normal, healthy adult participants, although neural activation corresponding to different cognitive processes has been shown to change as a function of age (Cabeza, 2001)
- Patients with aphasia, who typically fall into the category of older adults, are hypothesized to use the right hemisphere for semantic processing instead of the damaged left hemisphere

**Methods**
- **Participants**
  - N=10, 5 male, 5 female, Age range: 50-63 (Mean: 57)
  - Right-handed, monolingual English speakers
  - No history of neurological disease, trauma, or disorders. Normal cognitive and linguistic functioning.
- **Tasks**
  - Lexical Decision ( replicated from Binder et al., 2005)
  - 50 abstract words, 50 concrete words, 100 pseudowords
  - Word Judgment
  - 50 abstract words, 50 concrete words, 50 same symbol strings, and 50 different symbol strings

**fMRI Paradigm**
- Event-related design
- Experimental stimuli for each task is combined and randomly presented
- Allows for analysis of BOLD signal for each stimulus

**Behavioral Results**
- **Lexical Decision**
- **Concrete**
- **Abstract**
- **Condition**
- **Mean Percent Accuracy (with 95% Confidence Interval)**
  - Control: 1.00
  - Concrete: 0.95
  - Abstract: 0.90

- **Word Judgment**
- **Concrete**
- **Abstract**
- **Condition**
- **Mean Percent Accuracy (with 95% Confidence Interval)**
  - Control: 1.00
  - Concrete: 0.95
  - Abstract: 0.90

**fMRI Results**
- **Abstract**
- **Concrete**
- **Lexical Decision**
- **Word Judgment**
- **Condition**
- **Mean Percent Accuracy (with 95% Confidence Interval)**
  - Control: 1.00
  - Concrete: 0.95
  - Abstract: 0.90

**Discussion**
- The areas of overlap obtained in the lexical decision task (angular gyrus bilaterally and left posterior cingulate gyrus) agree with suggested areas of general semantic processing.
- These areas did not show a preference for either abstract or concrete word processing.
- However, RT in the lexical decision task during abstract processing had a positive correlation with activation in left posterior cingulate.
- Overall, more areas of activation were found bilaterally for concrete words during the lexical decision task. This may be due to similarities in processing between abstract words and pseudowords (see behavioral data).
- The areas of overlap obtained in the word judgment task (left inferior frontal gyrus, left posterior middle temporal gyrus, and left superior frontal gyrus) also agree with suggested areas of general semantic processing.
- These areas also did not show a preference for either abstract or concrete word processing.
- Overall, more areas of activation were found for abstract words bilaterally during the word judgment task, specifically in the IFG. This may be due to task difficulty and/or effects of healthy aging.

**Conclusion**
- In general, this study agrees with previous neuroimaging studies exploring neural correlates of semantic processing.
- However, the left-lateralized processing of abstract words and bilateral processing of concrete words was not specifically supported
- This may be due to the effects of normal aging.
- Future research should focus on a larger sample, with a wider age range.

**References**
- Barry, C., & Gershkoff, S. (2003). Both consciousness and age-related memory decline are predicted by task difficulty, but only conscious effects are correlated with brain atrophy. *Brain and Language, 80, 184-194.*