Phonological grain-size and general processing speed determine literacy related differences in language mediated eye-gaze

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Background

Visual World Paradigm

Participants view a visual display and hear a spoken utterance while their eye gaze is recorded. Items within the display vary in their relationship (e.g. semantic or phonological features) to the spoken target word.

Method

Neural network model with four visible layers connected via a central resource (400 units):

- **Vision Layer**: Provides input of visual information from four locations in the visual field (80 units)
- **Semantic Layer**: Allows model to learn semantic properties (160 units)
- **Auditory Layer**: Provides time variant auditory input (60 units)
- **Eye Layer**: Unit activation represents fixation (a) associated region of visual field (4 units)

Artificial Corpus:

- 200 items each item has a unique:
  - visual representation
  - pseudoword components

Competitors & Targets embedded:

- Competitors and Target share additional properties in a single modality of representation

Granularity of Speech Processing

**Coarse**

- Representation: 1 component per word
- All components unique
- 60 features per component

**Moderate**

- Representation: 2 components per word
- All components unique
- 30 features per component

**Fine**

- Representation: 6 components per word
- Set of 20 possible components
- 10 features per component

Results:

- No difference between models in fixation of competitor

Conclusions

- Differences in the granularity of speech processing can lead to modulation of the phonological effect in language mediated visual attention
  
  The results of Huettig, Singh and Mishra (2011) are consistent with the argument that formal literacy training leads to increased granularity in speech processing.
  
  General processing speed deficits result in quantitative rather than qualitative differences in language mediated eye gaze behavior.

- The efficiency of processing may have consequences for performance on many cognitive tasks

- While sensitivity to components of a larger grain size is less effected

- Low Literates: (Alain et al., 2003)
- High literacy differences (Morais et al., 2005)
- Phonological length (Kub能把 et al., 1995)

- Exposure to written words results in more fine grained processing of spoken words.

- Efficiency of processing may have consequences for performance on many cognitive tasks.

- General processing speed deficit may effect magnitude and timing of fixation behavior.

Research Question

Can differences in the granularity of speech processing or general processing speed offer explanation for differences observed between High and Low Literates in Language Mediated Visual Attention?

Models:

- Grain size: To simulate different grain sizes of speech representation three forms of auditory input were constructed:
  
  - Models differ only in respect to the granularity of auditory representation.
  - Overall similarity between representations was controlled.

- General Processing Speed: Noise [N(μ=0, σ2=0.02)] is applied to the output of all units in the network reducing the efficiency with which information flows through the system.

Testing:

- Models were tested on scenes containing:
  
  1 x auditory competitor; 1 x semantic competitor; 2 x unrelated distractor

References


