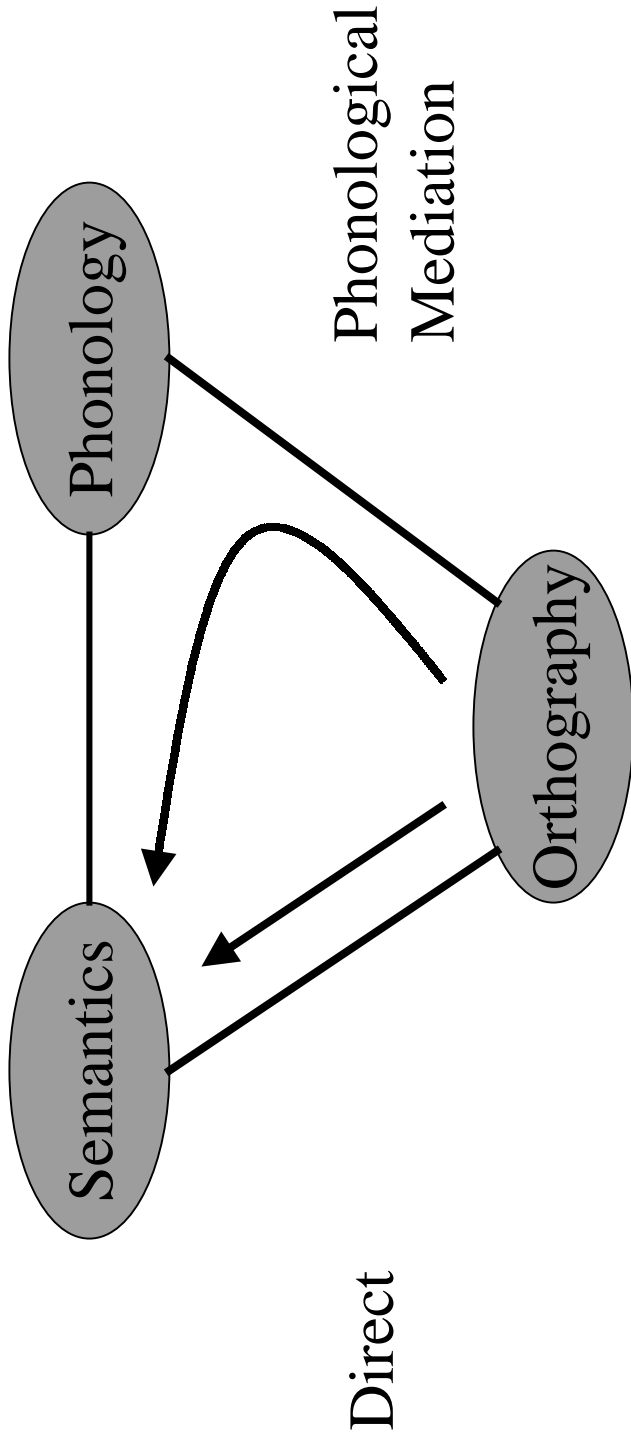


Division of Labor in a
Multicomponent Model of Visual
Word Recognition

Michael W. Harm, CMU

Mark S. Seidenberg, USC

Research Question: What is the Division of Labor in the Computation of Semantics?



Conflicting Intuitions

It's all Phonology!

- Sem \leftrightarrow Phon is already known!
- Orth \rightarrow Phon is *easier* than Orth \rightarrow Sem
- Hence, reading is phonologically mediated

It's all Direct!

- Faster: Only one translation needed
- Orth \rightarrow Phon ambiguous for many items!
- Hence, phonology is not useful in computing meaning

Another Approach

- Both pathways *cooperate* in the computation of meaning
- Activity is *graded* and *accumulates* over time
- Re-casts the research question:
 - Not “which path wins?”
 - Rather: “what factors influence the relative contributions of each path?”

Computational Principles

- *Pre-existing knowledge*
 - *Phonology, Semantics Pre-Structured*
 - *Phon <--> Sem path Pre-Trained*
- *Greed is Good*
- *The Need for Speed*
- *Error Driven Cooperation / Competition*
 - *Computation along each path is sensitive to successes and failures of other path*
- *Differential ease of mappings*

Research Strategy

- Construct large scale “triangle” model
 - Pretrain semantics, phonology, and “hearing”
part of model
- Train this system to read
 - Time pressure on targets for phonology,
semantics
- Analyze relative contributions of each path

Representations

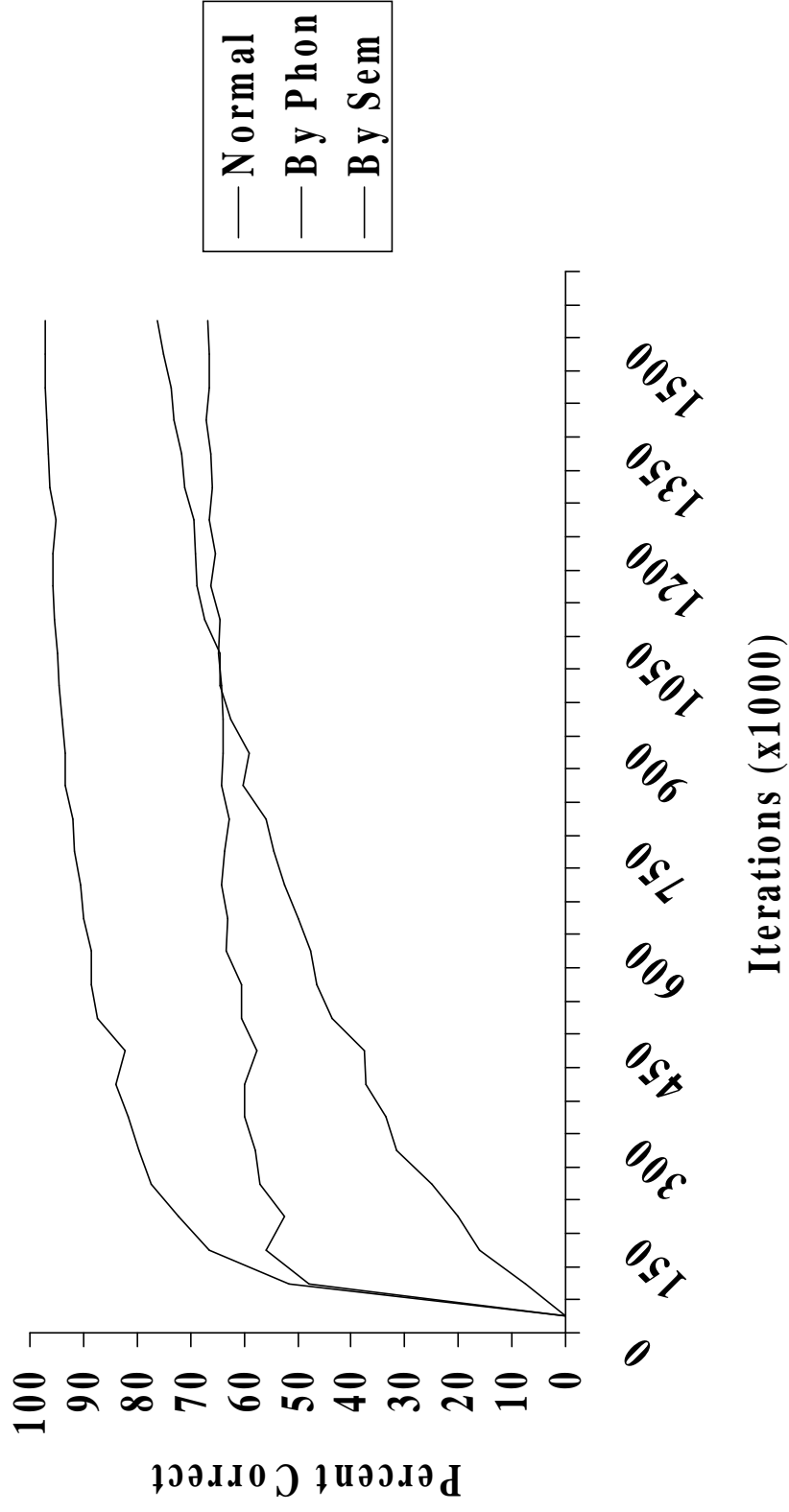
- Phonology: Distributed phonetic features derived from Chomsky and Halle (1968)
- Semantics: Distributed features derived from WordNet
 - Hierarchical feature tree
- Spelling: Pattern of atomic letter units
- Morphology: Semantic features for *plural*, *past-tense*, *3rd person*
- 6,000 Words (1800 nouns, 1000 verbs)

Analysis Method: Lesion Studies

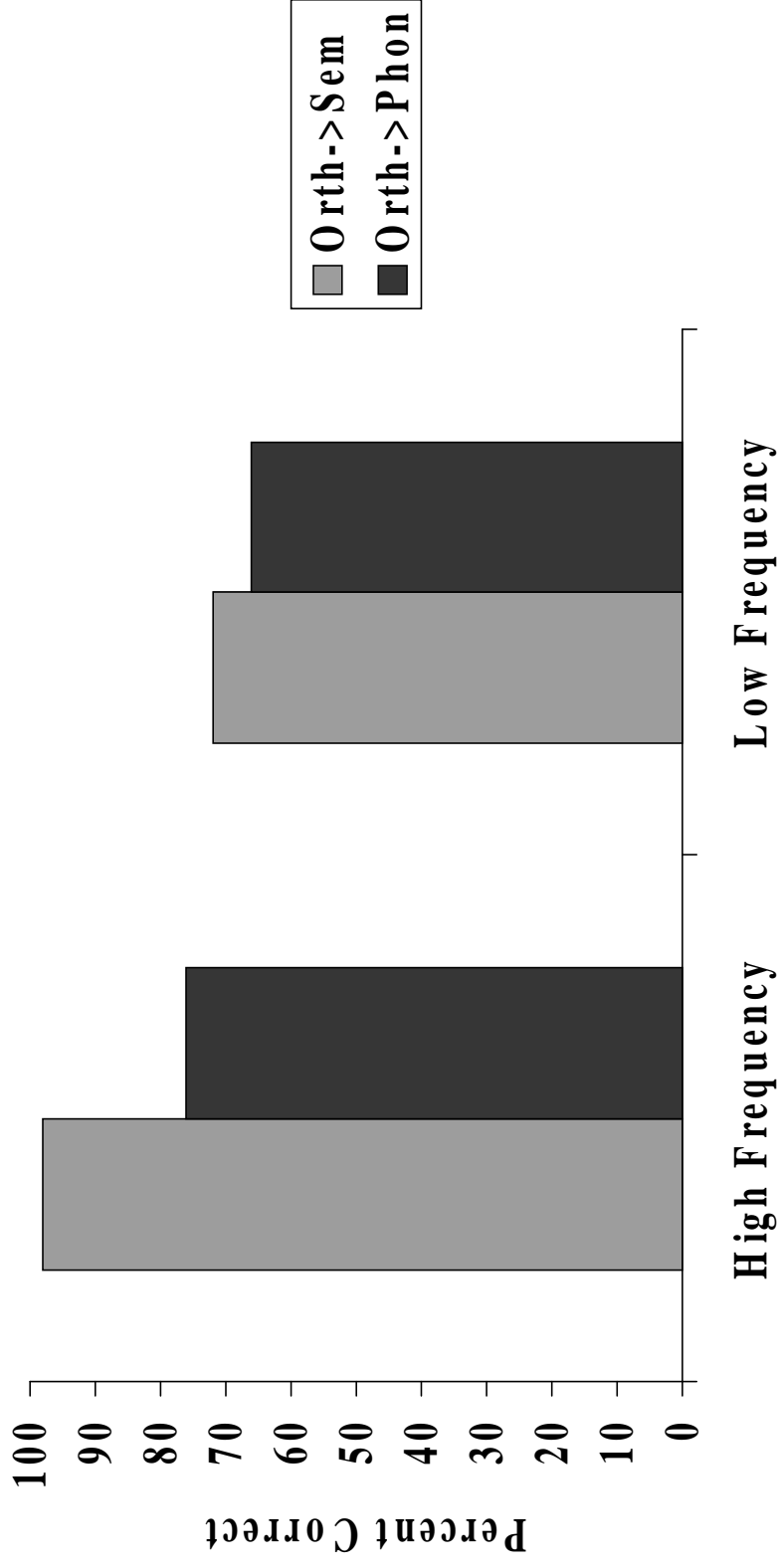
- Sever orth->phon path, observe competence of orth->sem
- Sever orth->sem, observe competence of orth->phon

... As broken out by different types of stimuli

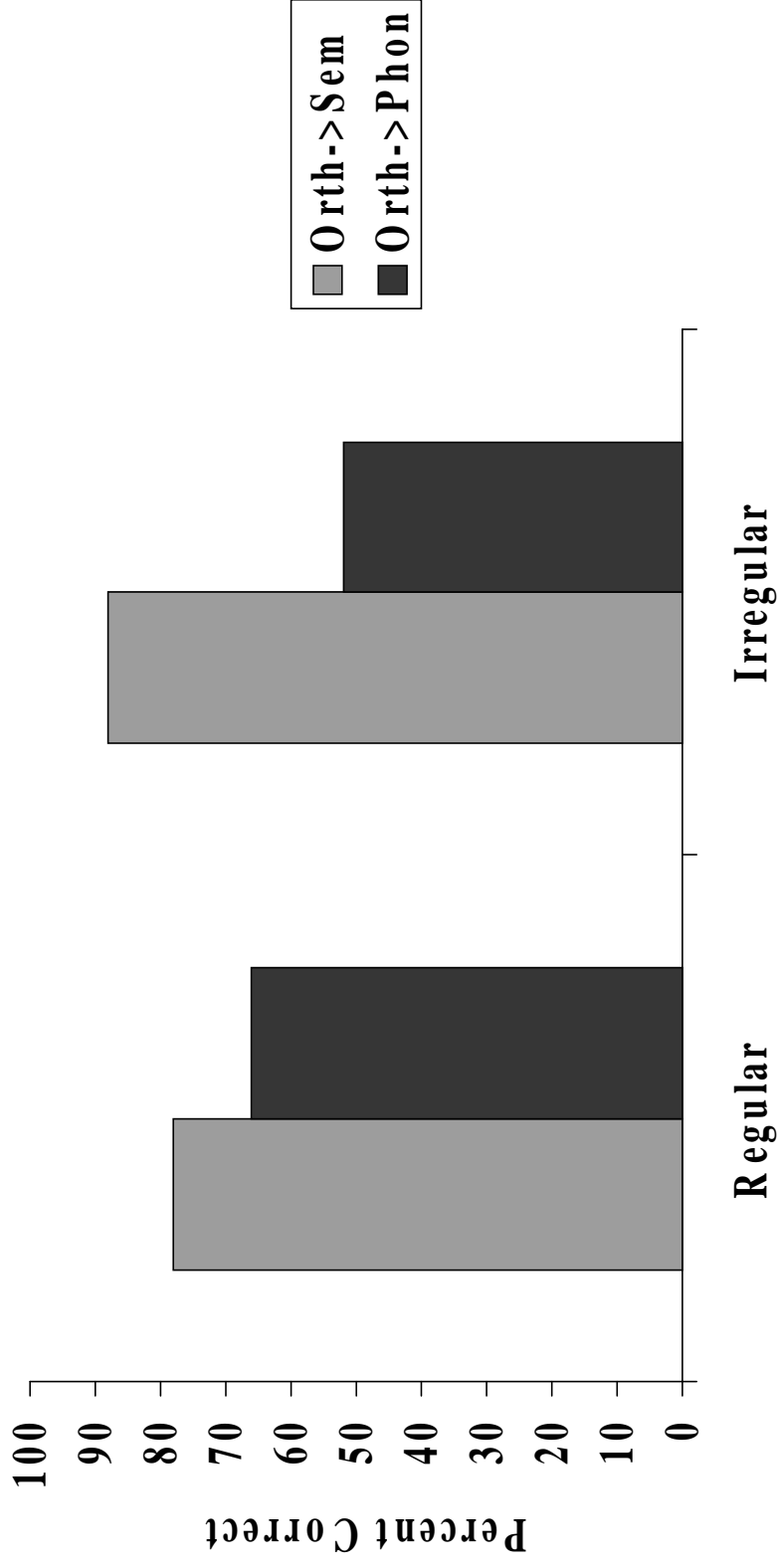
Division of Labor Over Training



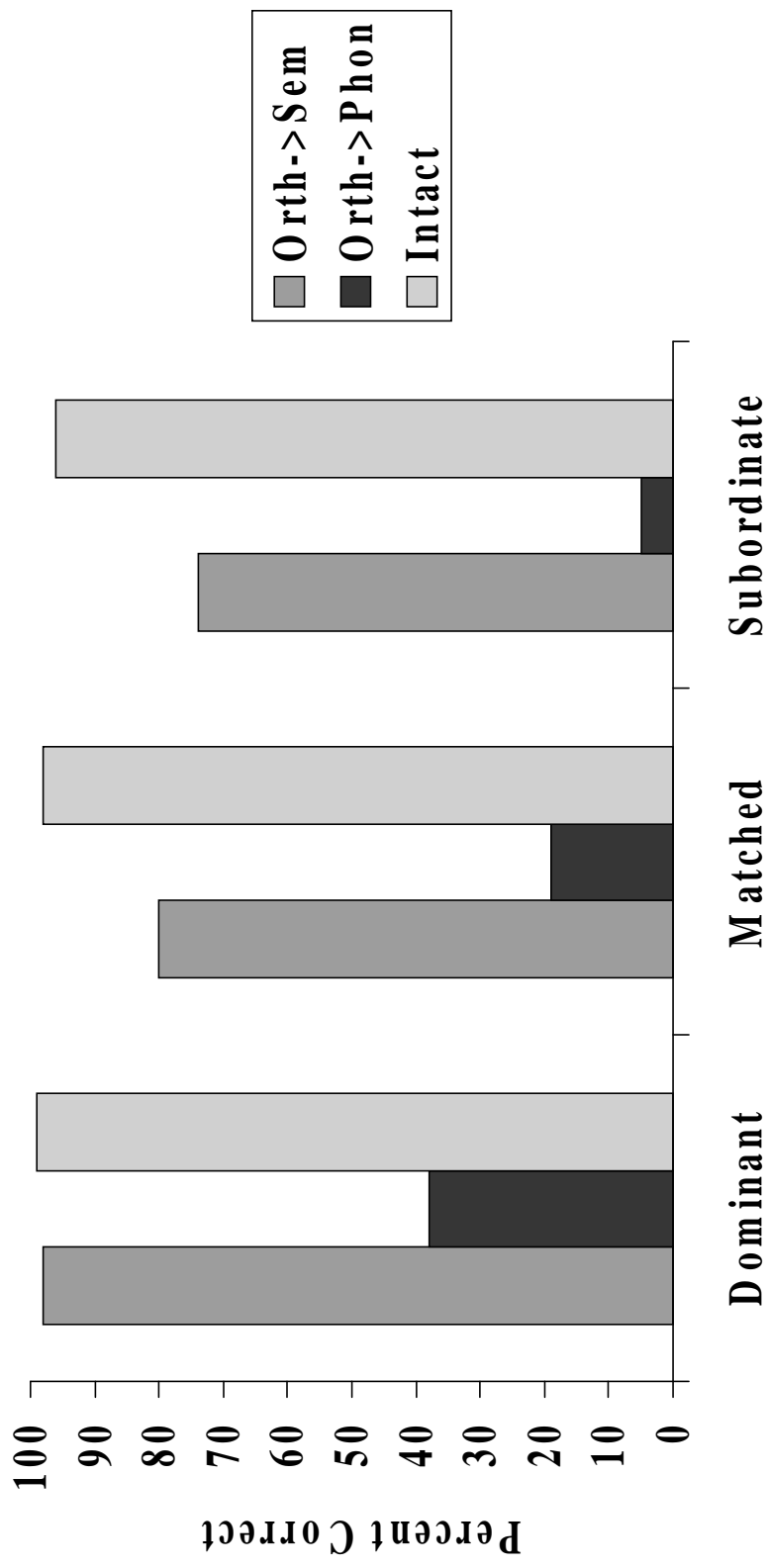
DOL by Frequency



DOL by Regularity



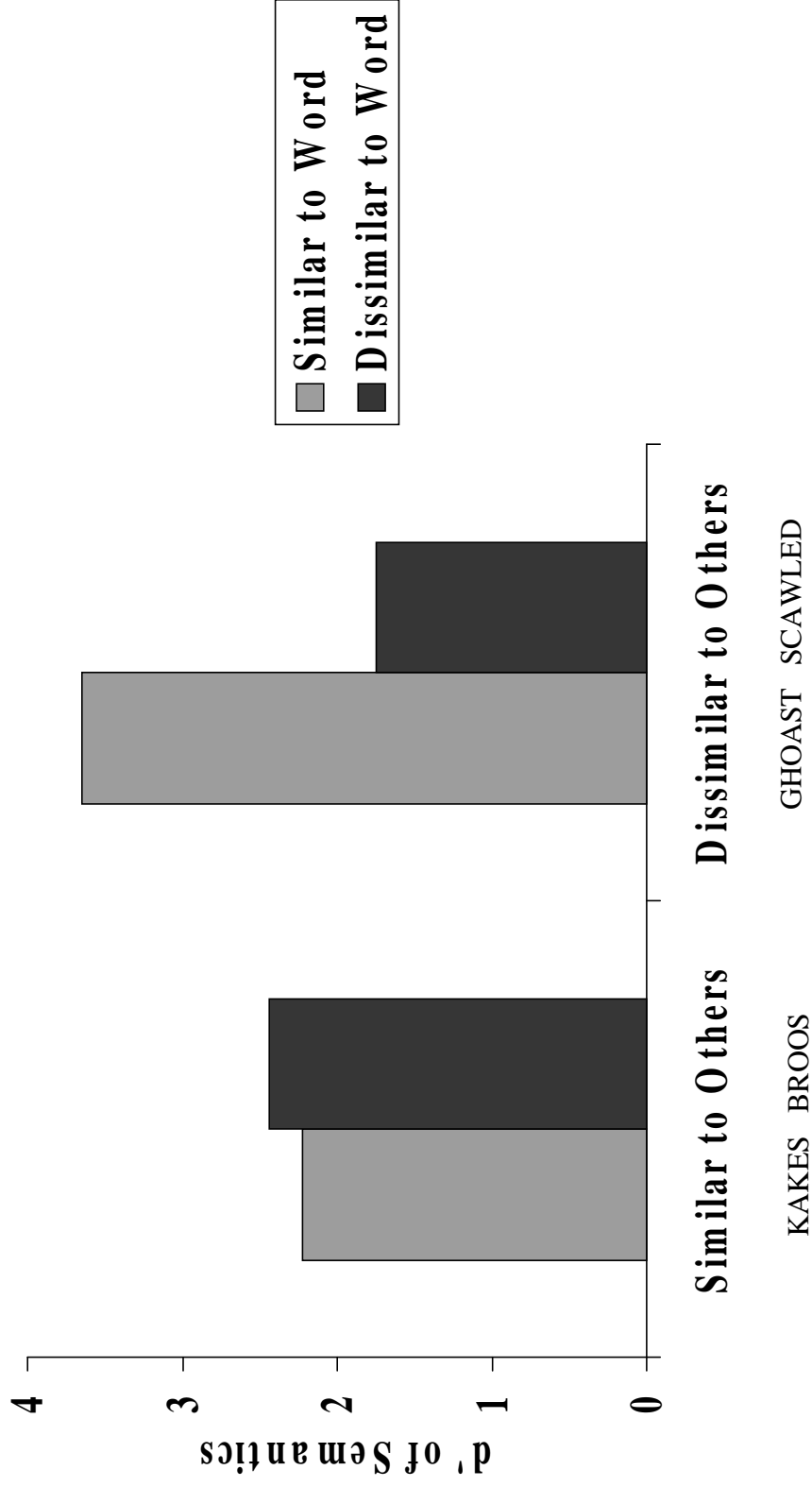
DOL for Homophones



Pseudohomophones

- Typically assumed that pseudohomophones cannot be read by direct route
- However, not all pseudohomophones are created equally:
 - Visual similarity to target word
 - “Uniqueness”, or dissimilarity to other words
- Items very similar to target word, and far from other words may still be “recognized”

Visual Similarity and Pseudohomophony

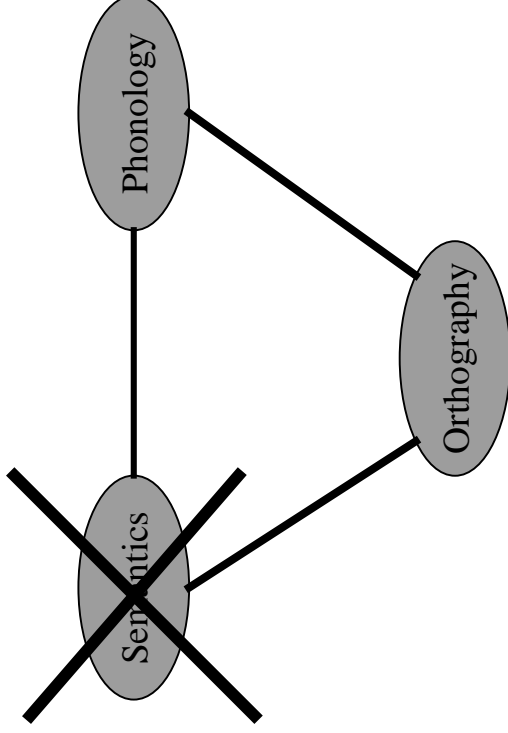


Future Work: DOL to Phonology

- Acquired Surface Dyslexia
 - Fluent
 - Dysfluent
- Acquired Phonological Dyslexia

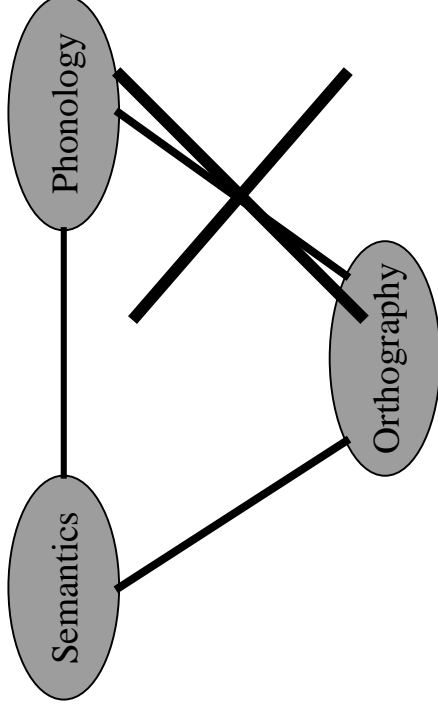
Fluent Surface Dyslexia

- Errors on exception words
- Errors mostly regularizations
- Semantics Impaired
- Latencies normal
- (Patients KT, MP)



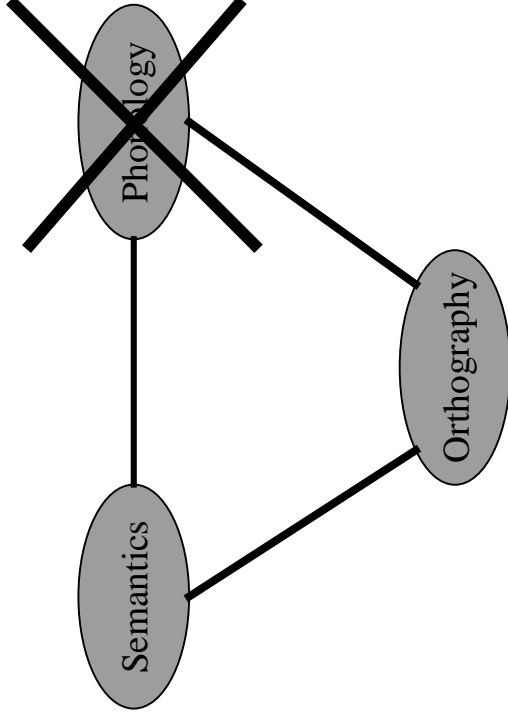
Dysfluent Surface Dyslexia

- Errors on exception words
- Many “visual” errors
- Semantics Largely Intact
- Latencies abnormally long



Phonological Dyslexia

- Errors on nonwords, some words
- Generally (always?) accompanied by phonological impairment



Specific Challenges

- Orth->Phon can't be totally perfect at reading exception words, or this account of *fluent* surface dyslexia fails
- Orth->Sem can't be totally perfect at exception words, or account of *dysfluent* surface dyslexia fails
- Two paths together must be able to read exception words at normal levels of performance