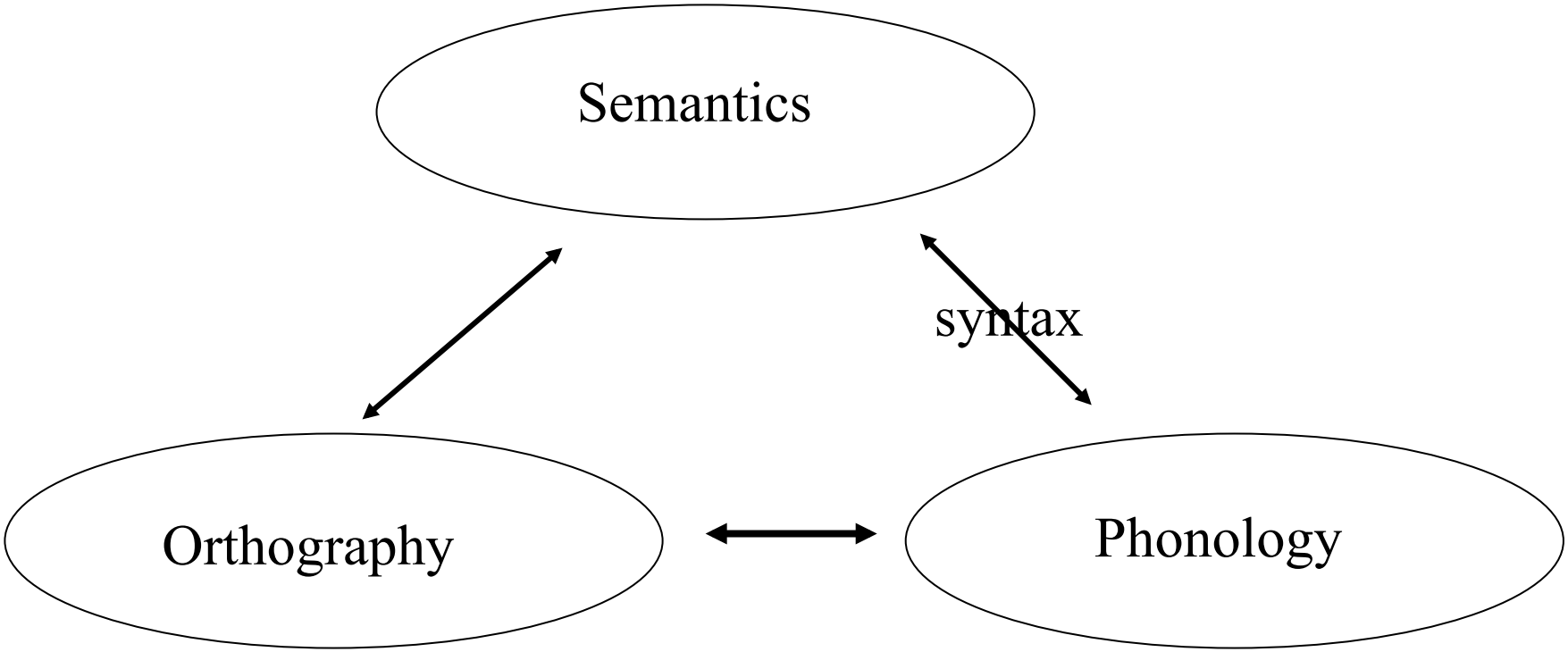
Language includes multiple sub-systems



Today: we are interested in how to go from orthography to phonology when reading single words aloud.

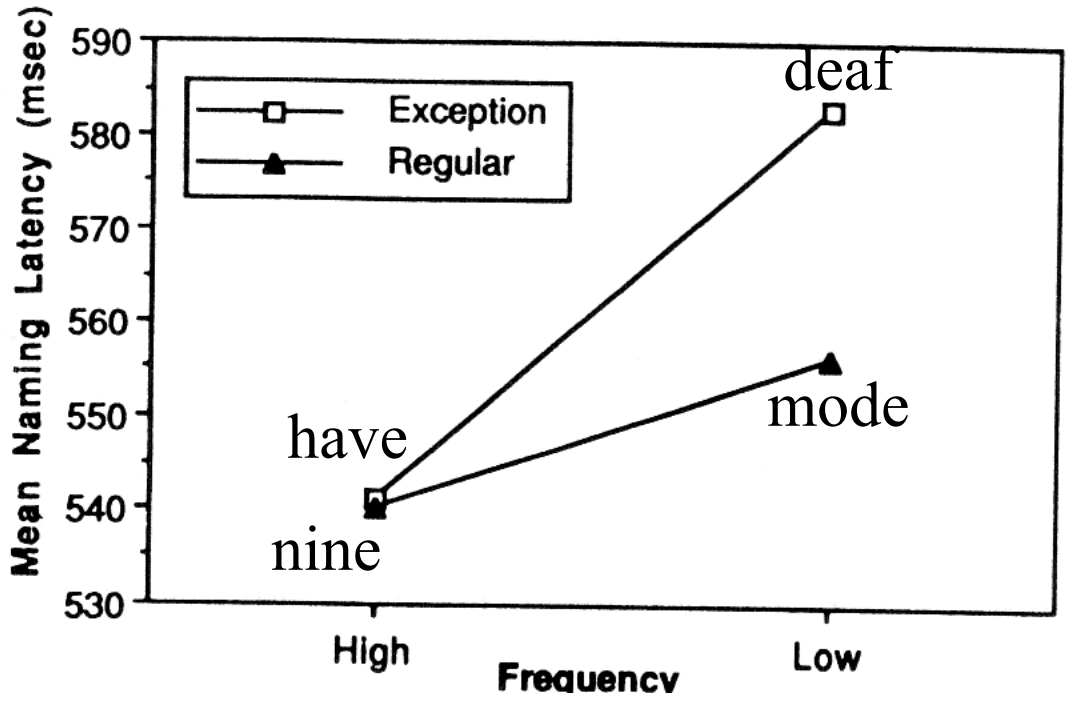
Today: Overview a classic theory of reading words aloud.

- Dual-Route Model.
  - **actually includes 3 routes-- so more appropriately called the tri-route model.

Key phenomena that need to be explained.

- Our ability to read regular (e.g., mint, hint, tint), and irregular (e.g., pint) words, as well as nonwords (e.g., blap).
- Frequency effects:
  - High frequency words read more quickly than low frequency words.
- Regularity effects:
  - Regular words read more quickly than irregular words.
- Frequency*Regularity interaction:
  - Regularity effect only found for low-frequency words.

Example of Frequency x Regularity interaction in naming



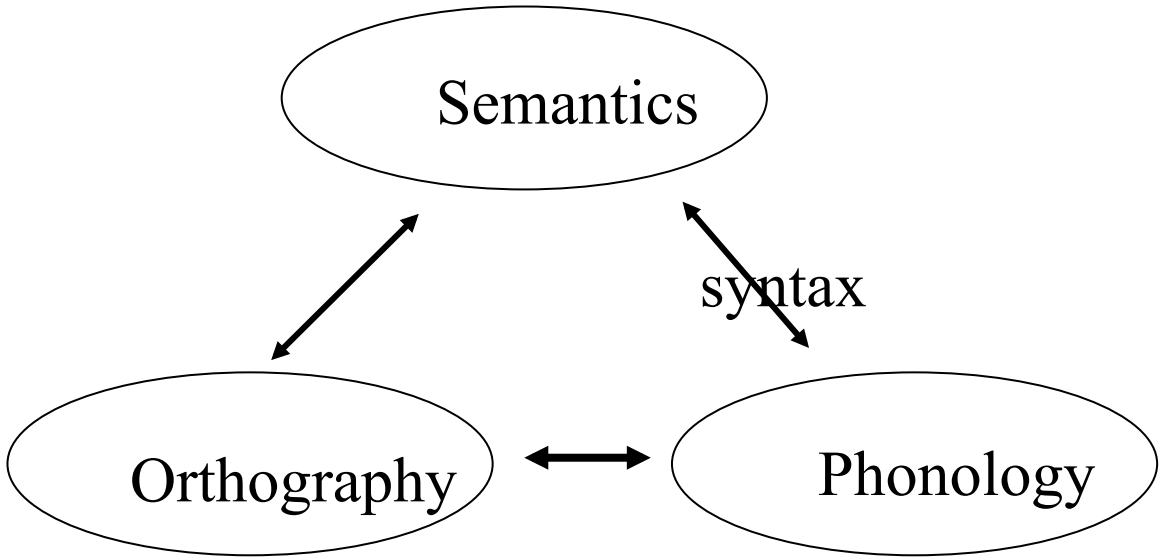
Key phenomena…

Acquired neuropsychological disorders in reading

- Surface Dyslexia: Difficulty in reading irregular words, but fine with nonwords and regular words.
- Phonological Dyslexia: Difficulty in reading nonwords, but fine at regular and irregular words.
  - Double dissociation between irregular words and nonwords!
- Deep Dyslexia: Difficulty with nonwords, irregular words, and regular words. But better with high imageable than low imageable words. Often make semantic errors. E.g., read: the word PIG as ELEPHANT.

Some basic terms:

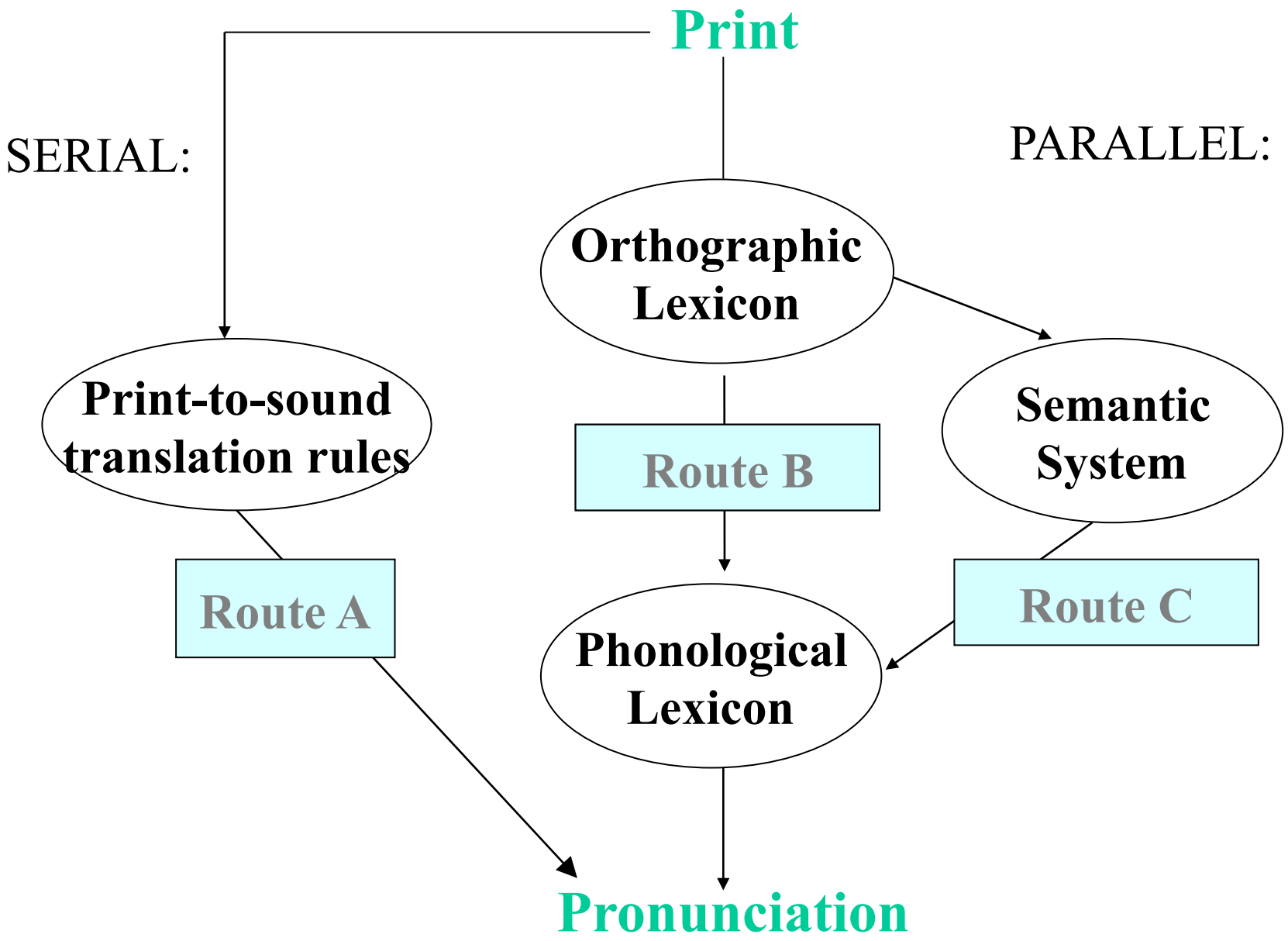
- Orthographic knowledge -- Visual knowledge of letters and words.
- Phonological knowledge -- Knowledge of how letters and words sound.
- Semantic knowledge -- Meaning of words.



More Terms!

- Lexical -- Word level-knowledge -- could be lexical-orthographic, lexical phonological, or lexical-semantic
- Sub-lexical -- sub-word information -- e.g., individual letters or phonemes. Or groups of letters or phonemes (e.g., syllable).
- Route -- connection between representations.
  - Sub-lexical route: Connects graphemes to phonemes (A)
  - Lexical-phonological route: Connects lexical orthographic to lexical phonological representations (B)
  - Lexical-Semantic route: Connects lexical orthographic to lexical semantic to lexical phonological representations (C)

Dual Route Model:



Route A is sub-lexical route, Routes B & C are lexical routes

Basic idea:

- Regular words can be read by all three routes.
- Irregular words can only be read by the lexical-routes (both of them)
- Nonwords can only be read by sub-lexical grapheme-phoneme route.
- Naming speed and pronunciation is based on the route that finishes first.

Model can account for the various acquired dyslexias

- Surface Dyslexia, damage to both lexical routes, with sub-lexical route spared.
  - Poor at reading irregular words.
- Phonological Dyslexia, selective difficulty in using sub-lexical route.
  - Poor at reading nonwords (e.g., blap).
- Deep dyslexia, patients can only read by the lexical-semantic route (and semantic route partly damaged).
  - Make semantic errors, e.g., say "table" to chair.

Horse Race account of frequency and regularity effects

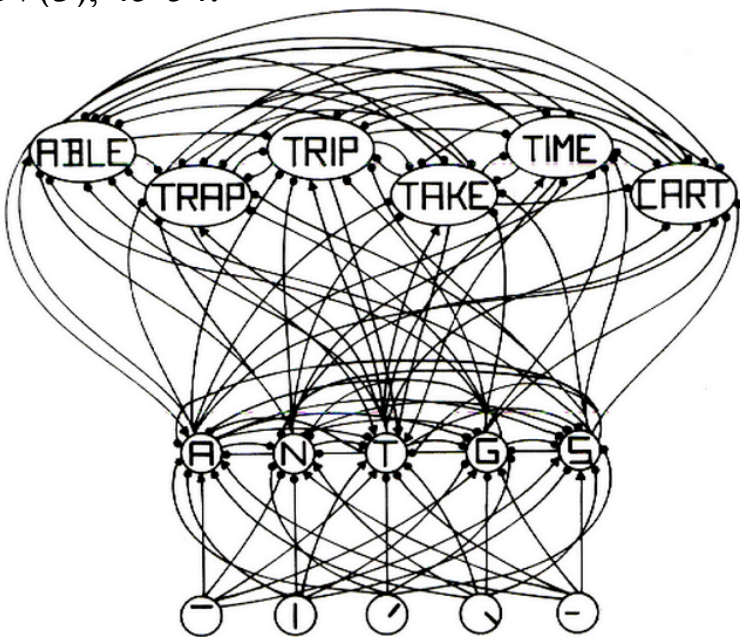
- High frequency words are processed more quickly than low frequency words (but only within the lexical routes).
- Regularity effects are due to the conflicting pronunciations of irregular words derived from lexical and sub-lexical routes.
- Conflict is avoided for high-frequency words, as lexical route finished before sub-lexical route -- producing interaction.

Many other variables need to be considered when developing models of reading.

- What is the impact of word length?
  - Short words appear to be identified more quickly than long words all else being equal.
    - Joseph, H. S., Liversedge, S. P., Blythe, H. I., White, S. J., & Rayner, K. (2009). Word length and landing position effects during reading in children and adults. *Vision research*.

- What is the impact of visual similarity on identifying words?
  - E.g., TABLE/CABLE (neighbours), CROWN/CROW (supersets/subsets), TRIAL/TRAIL (transposed letters) are all similar to one another. Does this help or hurt word identification?
- Similarity hurts:
  - » Bowers, J. S., Davis, C. J., & Hanley, D. A. (2005). Interfering neighbours: The impact of novel word learning on the identification of visually similar words. *Cognition*, *97*(3), 45-54.

Competition in orthographic lexicon:



- What is the impact of age-of-acquisition (AoA) on reading times?
  - Early acquired words read more quickly than late.
    - Stadthagen-Gonzalez, H., Bowers, J.S., & Damian, M.F. (2004) Age of Acquisition Effects in Visual Word Recognition: Evidence From Expert Vocabularies. Cognition, 93, B11-B26

- How explain developmental dyslexia?
  - Difficulty in learning to read despite normal intelligence and opportunity to learn to read.
  - Most cases developmental dyslexia are due to a mild difficulty in phonological processing.
    - Melby-Lervåg, M., Lyster, S. A. H., & Hulme, C. (2012). Phonological skills and their role in learning to read: a meta-analytic review. Psychological Bulletin, Vol 138(2), 322-352.

- Many other findings as well need to be explained.

Debate!

First detailed description of dual route model:

- Coltheart, M., Curtis, B., Atkins, P., & Haller, M. (1993). Models of reading aloud: Dual-route and parallel-distributed-processing approaches. *Psychological Review; Psychological Review*, *100*(4), 589.

Alternative approach (gets rid of different routes) called the Parallel Distributed Processing approach:

- Seidenberg, M. S., & McClelland, J. L. (1989). A distributed, developmental model of word recognition and naming. *Psychological Review; Psychological Review*, *96*(4), 523.