Cumulative semantic interference:
the dark side of repetition priming

Gary M. Oppenheim[1], Gary S. Dell[1], and Myrna F. Schwartz[2]

[1]Beckman Institute, University of Illinois and [2]Moss Rehabilitation Research Institute

goppenh2@illinois.edu gdell@illinois.edu mschwart@einstein.edu

Cumulative semantic interference:

Retrieving a word from meaning becomes increasingly difficult after retrieving semantically related words. Naming a picture of a dog, for instance, tends to be slower and more error-prone when it follows the naming of other mammals, compared to the naming of unrelated items.

Naming latencies increase for each related item that has previously been named

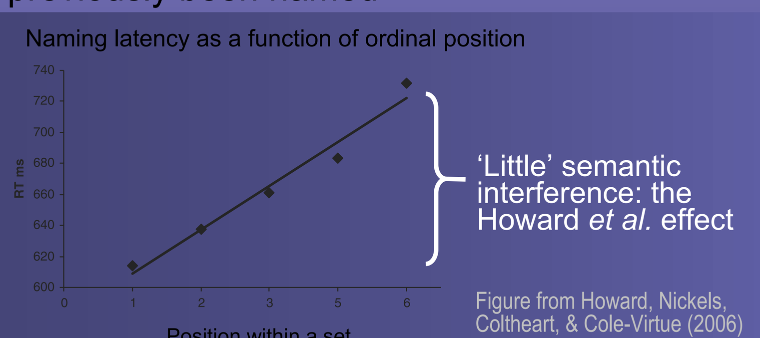


Figure from Howard, Nickels, Coltheart, & Cole-Virtue (2006)

The interference effect grows as a small set of semantically related pictures is repeatedly named

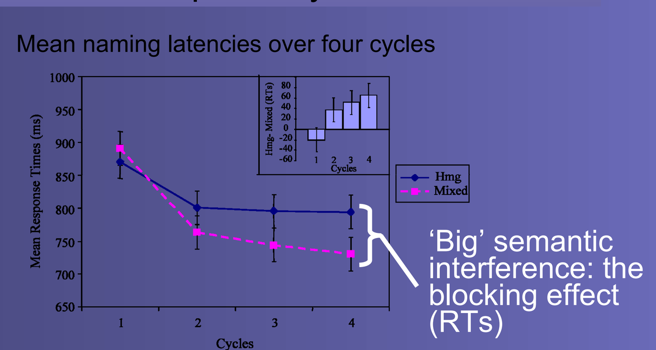


Figure from Experiment 1 of Schnur, Schwartz, Brecher & Hodgson (2006)

For individuals with aphasia, semantic interference manifests as increasing semantic error and omission rates.

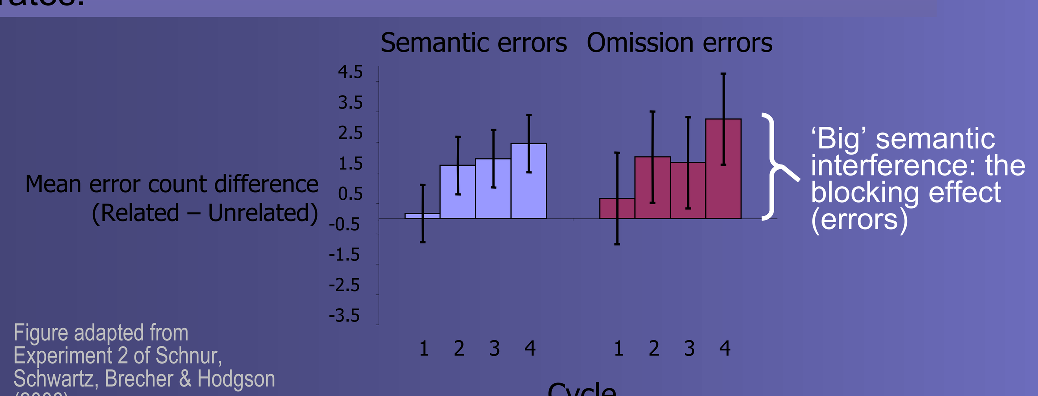


Figure adapted from Experiment 2 of Schnur, Schwartz, Brecher & Hodgson (2006)

This interference may arise during the mapping from semantic representations lexical items (Damian, Vigliocco, & Levelt, 2001).

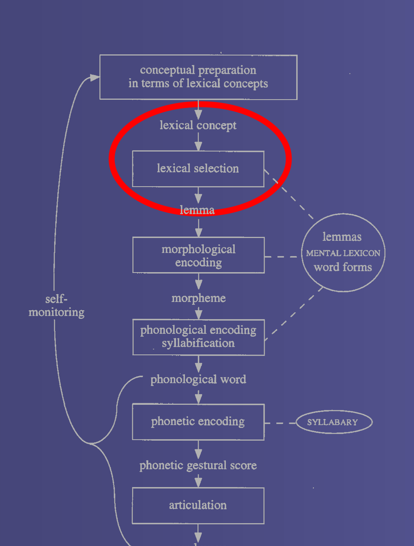


Figure from Levelt, Roelofs, & Meyer (1999)

Research question: Could cumulative semantic interference reflect incremental learning in the mapping from semantics to words?

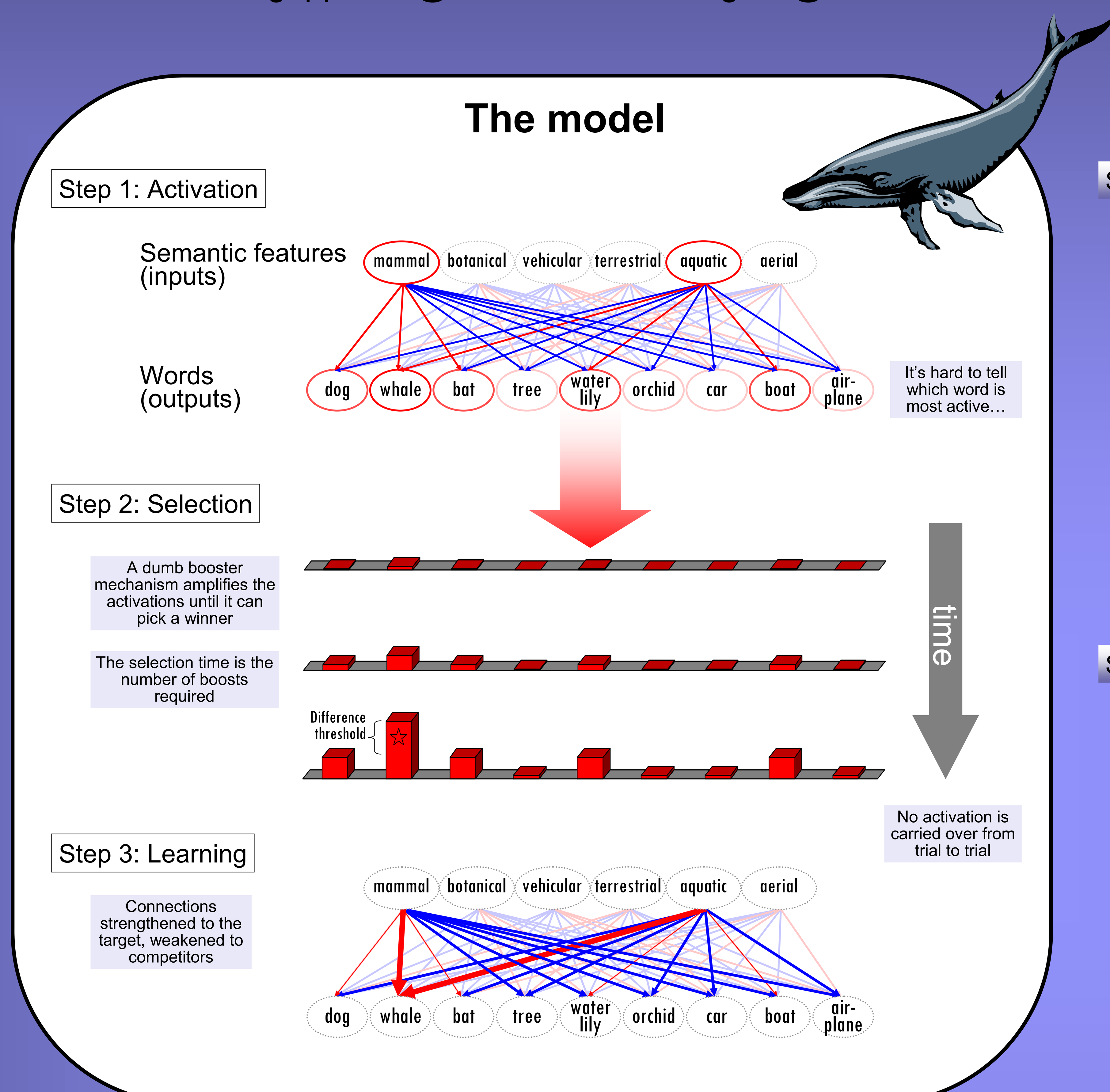
Some empirical evidence:

- Incrementality: each related picture takes longer to name than the last (Howard et al., 2006)
- Facilitating access to recent words: naming errors tend to match more recent responses (Lee, Schnur, & Schwartz, 2007)
- Persistence: interference effects aren't affected by presentation rate (Schnur, et al., 2006; Lee et al., 2007), and accessing unrelated words does not disrupt interference (Damian & Als, 2005; Howard et al., 2006)

The present model attempts to account for cumulative semantic interference by simulating lexical access as a process that learns

- Words are activated by distributed semantic features
- An external selection mechanism boosts word activations until one reaches a differential threshold
- The semantic-to-lexical mapping is then adjusted to facilitate retrieval of the target word the next time it is cued

The model



Simulation 1: Healthy subjects' blocked cyclic naming latencies

Objective: Compare simulated lexical selection time effects to naming latency effects reported by Howard et al. (2006) and Schnur et al. (2006)

Parameters

- *Learning rate* = 0.75 , *Activation noise* = 0.5, *Boosting factor* = 1.01, *Difference threshold* = 1, *Deadline* = 100

Vocabulary

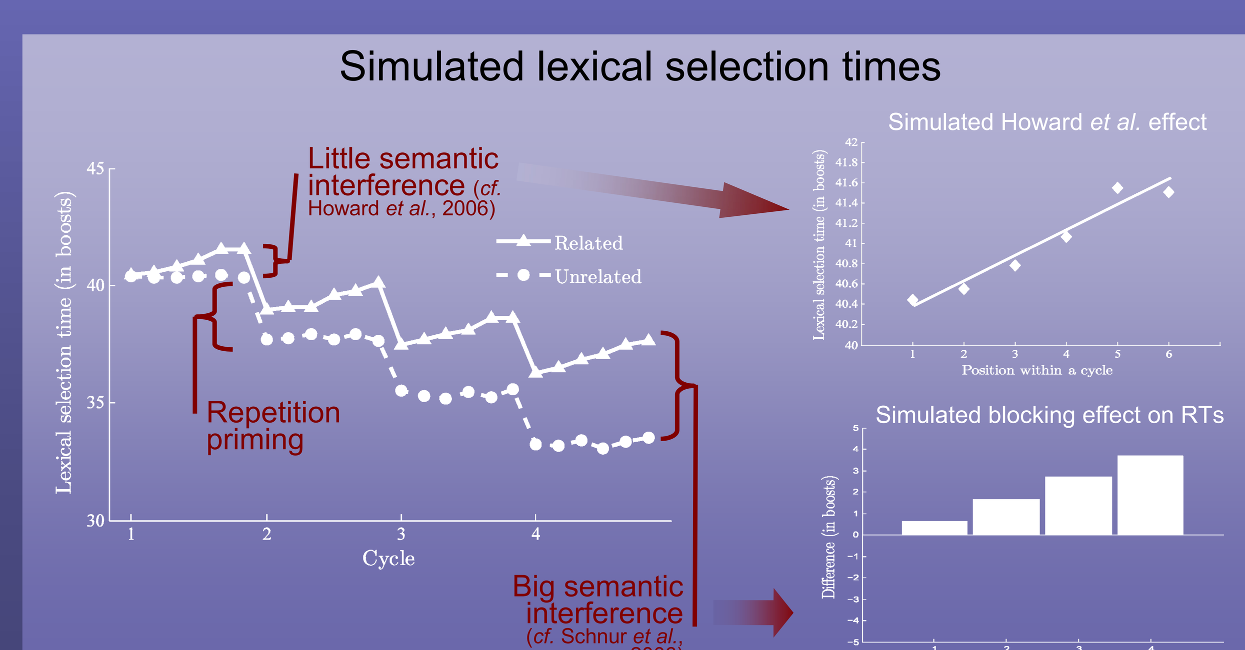
- Twelve semantic input features, 36 lexical outputs
- Related words shared one feature, unrelated shared none

Training

- One-hundred training cycles through the entire vocabulary

Testing

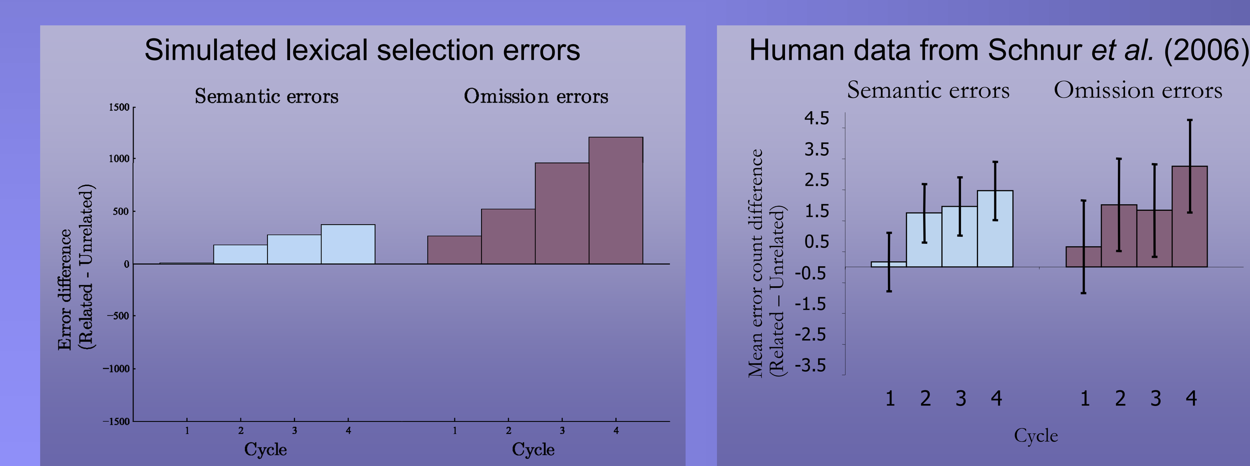
- Four cycles through a 6-item set (procedure based on Experiment 1 of Schnur *et al.*, 2006)



Simulation 2a: Aphasic blocked cyclic naming errors

Objective: Compare semantic blocking effects on simulated semantic and omission errors to those reported by Schnur *et al.* (2006) for patients with aphasia

Methods: Same as Simulation 1, but with noisier lexical activations (*Activation noise* = 1.0)

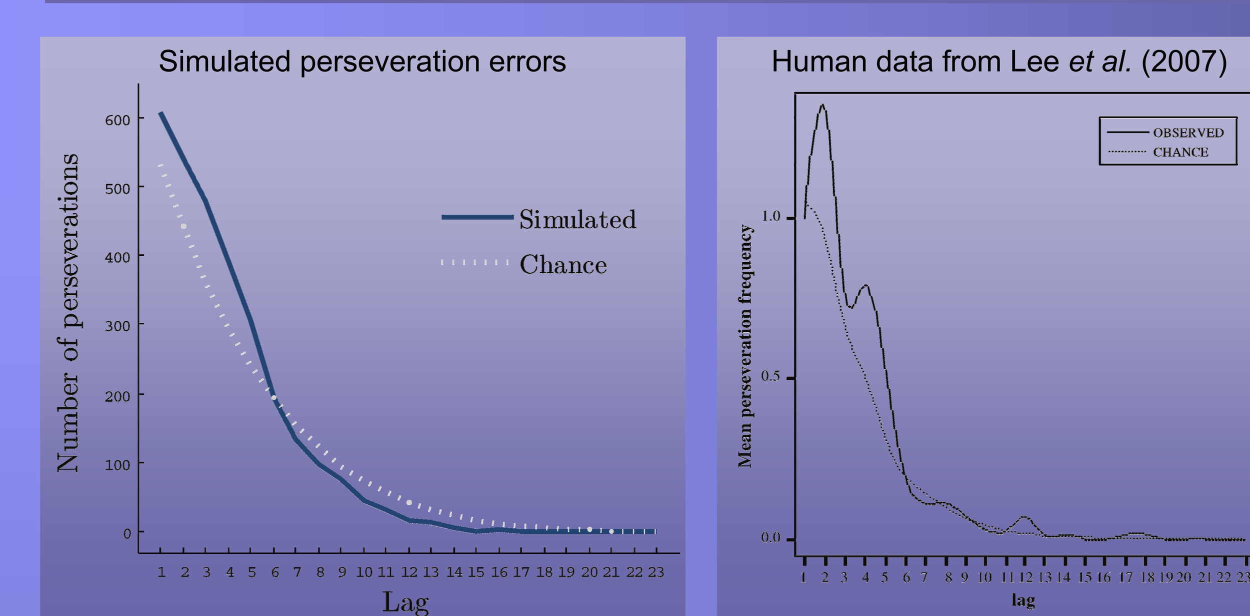


Simulation 2b: Aphasic blocked cyclic naming perseverations

Objective: Test whether more recent responses are more likely to emerge as simulated perseveration errors, as reported by Lee *et al.* (2007) for patients with aphasia

Methods:

- Identical to Simulation 2a
- Analyses followed the methods specified by Lee *et al.* (2007)



Simulation 3: Accumulated interference extends to new items

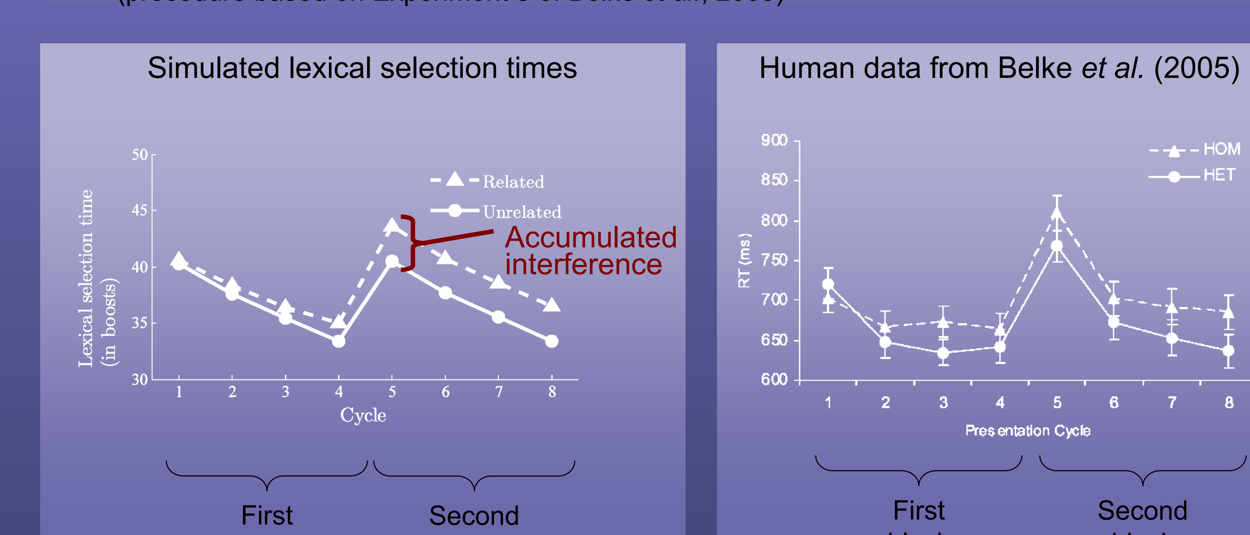
Objective: Test whether accumulated semantic interference extends to the simulated naming of new items, as demonstrated empirically by Belke, Meyer, & Damian (2005)

Methods:

- Parameters, vocabulary, and training identical to Simulation 1

Testing

- Four cycles through three items of a set, then four cycles through the other three items (procedure based on Experiment 3 of Belke *et al.*, 2005)



Model also accounts for:

- Graded semantic interference effects (e.g. Vigliocco, Vinson, Damian, & Levelt, 2002)
- Insensitivity to timing manipulations (e.g. Lee et al., 2007; Schnur et al., 2006, Experiments 1-2)
- Robustness to naming unrelated items (e.g. Damian & Als, 2005, Experiments 2-3; Howard et al. 2006) and performing unrelated tasks (Damian & Als, 2005, Experiment 1)

Conclusions

Adding an incremental learning component to a model of lexical activation and selection is sufficient to explain many phenomena associated with cumulative semantic interference.

Learning in a competitive domain, such as lexical access, facilitates more recent responses at the expense of less recent ones. Semantic interference therefore results from the incremental weight changes that underlie repetition priming. It is just the dark side of the force behind priming.

Together, semantic interference and repetition priming demonstrate that lexical learning never stops.

References:

Belke, A.S., Meyer, A.S., & Damian, M. (2005). Refractoriness in the semantic system. *Quarterly Journal of Experimental Psychology, 58,* 667-692.

Damian, M. F., & Als, L. C. (2005). Long-lasting semantic context effects in the spoken production of object names. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 31,* 1372-1384.

Damian, M. F., Vigliocco, G., & Levelt, W. J. M. (2001). Effects of semantic context in the naming of pictures and words. *Cognition, 81,* B77-B86.

Howard, D., Nickels, L., Coltheart, M., & Cole-Virtue, J. (2006). Cumulative semantic inhibition in picture naming: experimental and computational studies. *Cognition, 100,* 464-482.

Lee, E., Schnur, T.T., & Schwartz, M. (2007). The temporal analysis of semantic perseverations in blocked-cyclic naming. *Brain and Language, 103,* 173 – 174.

Levelt, W.J.M., Roelofs, A.P.A., & Meyer, A.S. (1999). A theory of lexical access in speech production. *Behavioral and Brain Sciences, 22,* 1-37.

Schnur, T.T., Schwartz, M.F., Brecher, A., & Hodgson, C. (2006). Semantic interference during blocked-cyclic naming: Evidence from aphasia. *Journal of Memory and Language, 54,* 199 - 227.

This research was supported by NIH DC000191, HD44458, and H1819990