

Constructing neighborhood density through recognition errors

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Research Goals

- Use content of recognition errors to discover what words are being activated in the lexicon during spoken word recognition
- Test predictions made by theories of word recognition in terms of neighborhood density
- Is the traditional definition of a neighbor (1 phoneme deletion, addition or substitution) (Greenberg & Jenkins, 1964; Luce, 1986; Luce & Pisoni, 1998) sufficient to account for multisyllabic words?

Method

Materials

- 1428 English words chosen from the Hoosier Mental Lexicon (Nusbaum et al., 1984), designed to be a **representative sample of the entire English lexicon**, based on:
 1. Number of phonemes (2-11)
 2. Number of syllables (1-5)
 3. Syllable structure
 4. Initial phoneme
 5. Lexical frequency
- Recorded by a single male talker

Participants

- 95 native English-speaking undergraduates from IU (so far)

Task — Open-set word recognition in noise

- Participants heard the recorded materials over headphones and entered responses via keyboard.
- 6 talker babble was added to the stimuli at 3 different signal-to-noise ratios (S/N): 0, 5, and 10 dB
- Materials were presented at 77 dB SPL
- Each listener heard only 1/4 of the stimulus list; 1/3 of the stimuli were presented at each S/N ratio.

Analysis

- Responses were converted into phonetic transcriptions semi-automatically
- Analysis here included 8548 incorrect responses (4324 at S/N = 0, 2599 at S/N = 5, and 1625 at S/N = 10)

Results — Percent Correct

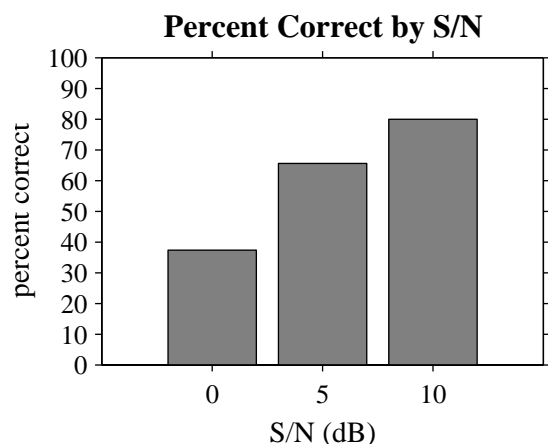


Figure 1 Percent correct for each S/N ratio used

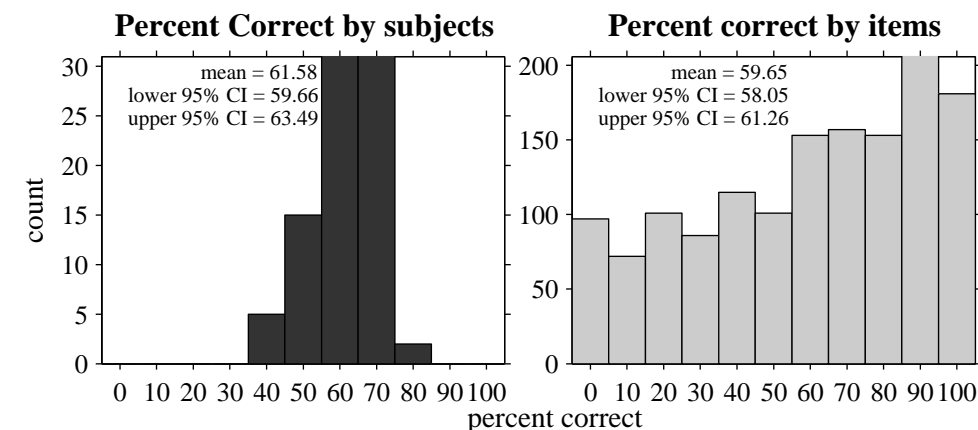


Figure 2 Distribution of percent correct by subjects and items

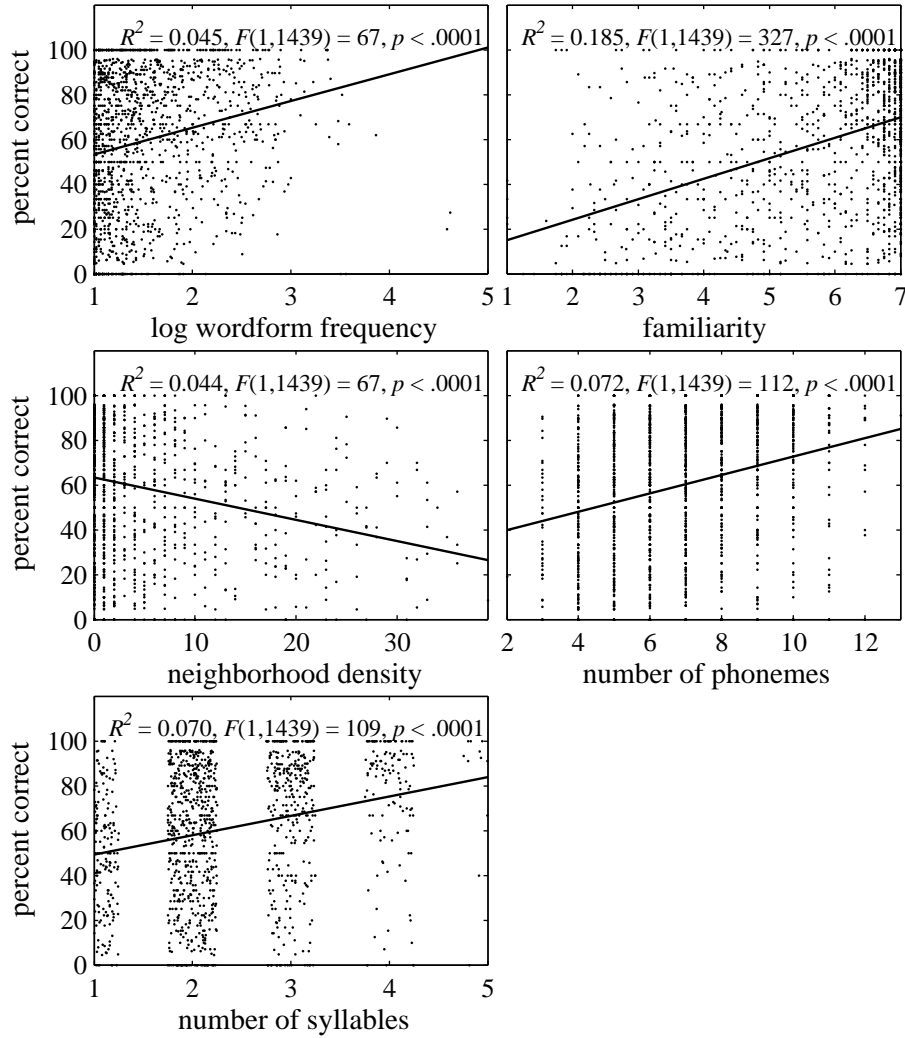


Figure 3 Percent correct as a function of different lexicostatistical properties of the target words. Points in the syllable plot have been randomly scattered along the x-axis in order to minimize point overlap

Results — Frequency

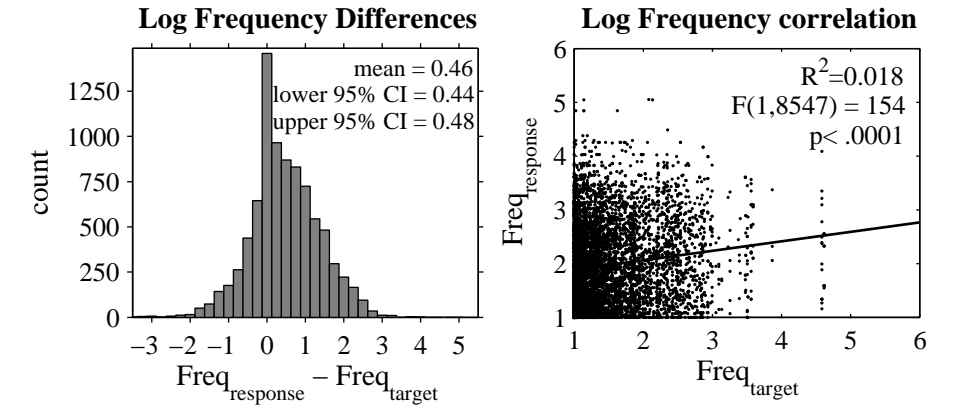


Figure 4 Frequency analyses. The left panel shows the difference in log frequency between target word and incorrect responses. The right panel shows response frequency as a function of target frequency

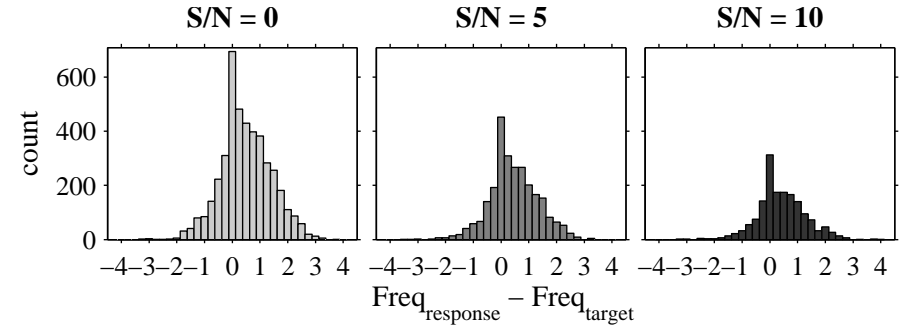


Figure 5 Difference in log frequency between target word and incorrect responses by SNR

Results — Edit Distance

- Edit distance is defined as the minimum number of additions, deletions, or substitutions to change one string into another.
- Traditionally, a neighbor is defined as a word which differs in only one phoneme (i.e. has an Edit Distance of 1)
- **Less than 22% of the responses are neighbors by this definition**

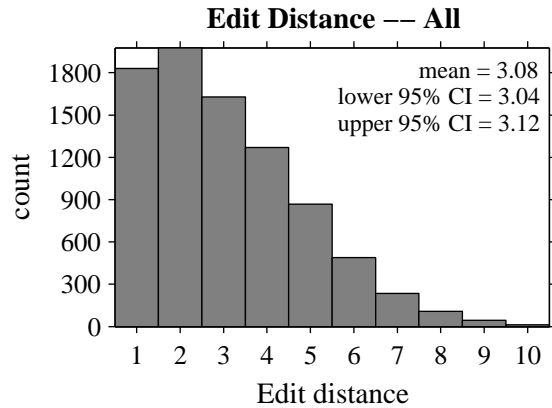


Figure 6 Edit distance between target word and incorrect responses for all words.

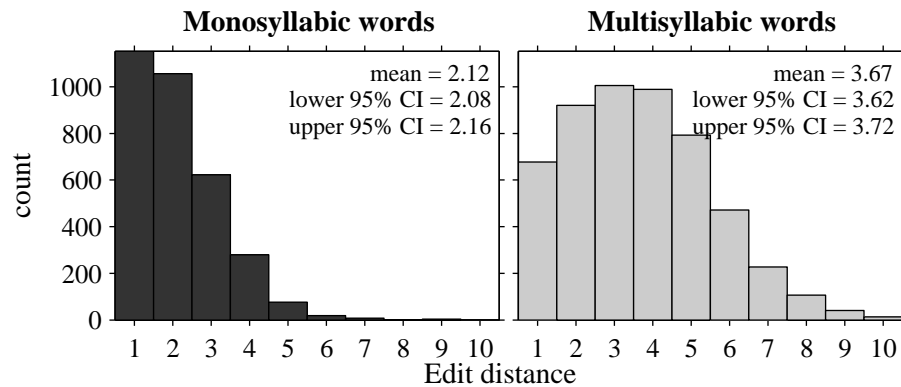


Figure 7 Edit distance between target word and incorrect responses for multisyllabic words

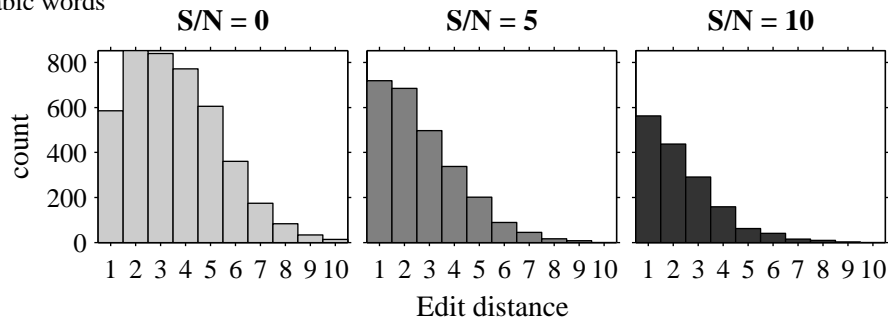


Figure 8 Edit distance between target word and incorrect responses for all words according to S/N ratio

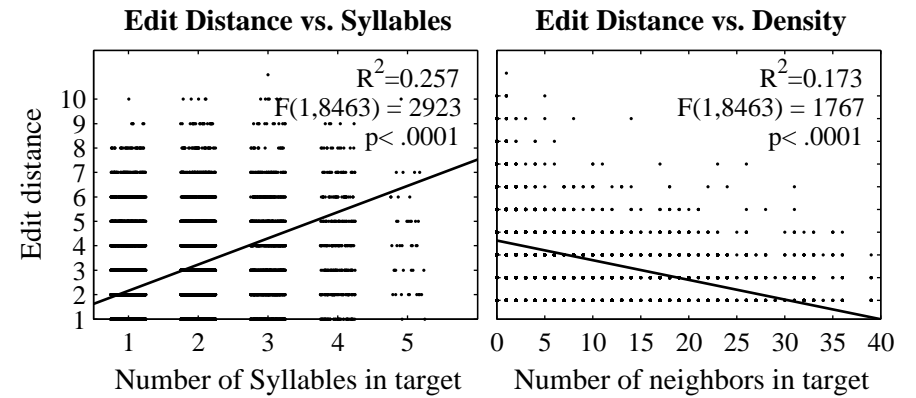


Figure 9 Edit distance as a function of the number of syllables in the target word (left panel) and the neighborhood density of the target word (right panel). Points in the left panel have been randomly scattered along the x-axis in order to minimize point overlap

Results — Phonemes

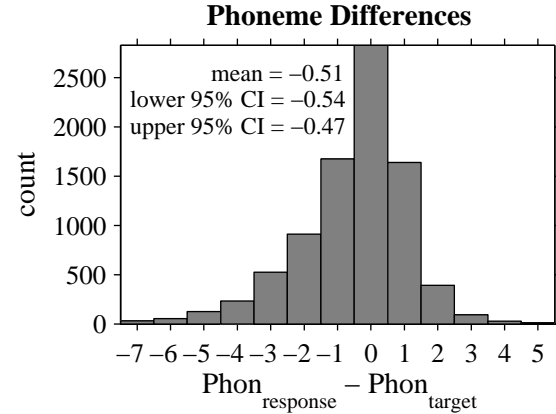


Figure 10 Difference in number of phonemes between target word and incorrect responses

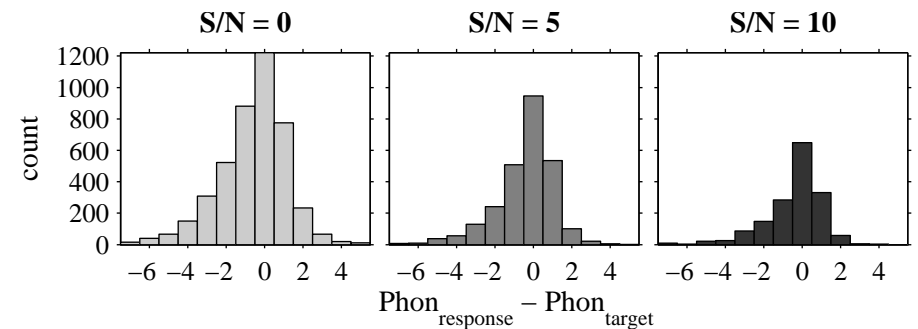


Figure 11 Difference in number of phonemes between target word and incorrect responses by SNR

Results — Syllables

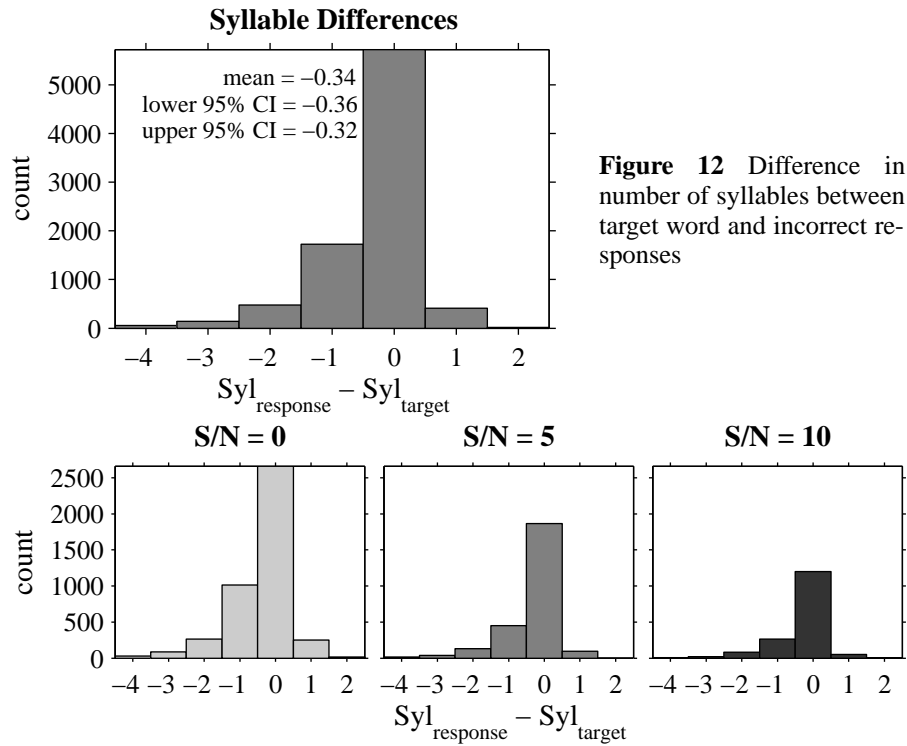


Figure 13 Difference in number of syllables between target word and incorrect responses for each S/N ratio

Discussion

- Preliminary results suggest that the traditional definition of neighborhood density (one phoneme deletion, addition, or substitution) is not sensitive enough to capture a large portion of the data.
- Patterns of results are consistent across different S/N ratios
- Contrary to Pollack et al. (1960), our results indicate a small but significant correlation between the frequency of incorrect responses and the frequency of the target word.

Future Directions

- Include a more detailed measure of similarity between target and response
- Analyze individual target-response pairs to determine whether the patterns regarding frequency, phonemes, syllables are attributable to chance
- Develop a more sensitive definition of neighborhood density

References

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Acknowledgements

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