Lexical cascade to phonetic processes: Evidence from errorful and non-errorful speech

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Studies of speech errors have provided ample support for the claim that word-level processes exert an influence on phonological representations.

• Through a combination of cascading activation and feedback, phonological error outcomes are biased by word-level properties (e.g., Dell, 1986, at uq).

One concern: this influence reflects unusual processing conditions.

• Vast majority of productions are correct (Garnham et al., 1981).

• Error-inducing contexts might reflect abnormal processing.

One means of addressing this concern:

• Documenting lexical effects on phonological processing during correct productions. (e.g., picture naming; Costa et al., 2004)

**LEXICAL INFLUENCES ON PHONETIC PROCESSING**

Does activation from word-level representations continue to cascade to lower levels in the production system?

• Above research: Lexical information influences phonological processes.

• Does this influence extend to lower levels in the processing system?
  ➢ Phonetic processing: Specification of fine-grained (non-contrastive, sub-segmental) aspects of form.
  ➢ Focus: within-category variation in voice-onset time (VOT).
  ➢ To address concerns about unusual processing conditions, document effects for both errorful and non-errorful productions.

**Study I**

Does lexicality affect sub-phonemic speech errors?

• The sub-phonemic properties of speech errors reflect “traces” of the intended target.

• Are these traces influenced by lexical properties?
  ➢ Compare size of traces for errors resulting in words (e.g., kes ->”guess”) vs. nonwords (kev ->gev).

**Study II**

Does lexical competition affect the sub-phonemic properties of correctly produced words?

• Some words form minimal pairs with highly confusable words (e.g., “pad” forms a minimal pair with “bad”).

• Does this lexical competition influence sub-phonemic properties of words?
  ➢ Compare non-neutralizing productions of words that form minimal pairs (e.g., “pun”) to matched words that do not (e.g., “pup”).

**Methods**

**Study I: SPEECH ERRORS**

**Participants:** 5 male native English speakers.

**Materials:** 80 tongue twisters made up of 4 CVCC syllables each.

- Alliterating initial consonants with a constant vowel-liquidic combination (e.g., “tea dez dez tee”).
  
- Matched subset: Post-hoc selection of word and nonword error outcomes matched on forward and backward transitional probability of initial CV.
    
- Initial CV: /k, g/ paired with /s, z, /t, /d/ paired with /l, n, e/.
  
- Mean forward probability — word: 0.12; nonword: 0.16; p > .20.
  
- Mean backward probability — word: 0.78; nonword: 0.76; p > .80.

**Procedure:** Reading paced by metronome.

- **Practice:** Twister read at 1 syllable/second; errors corrected.

- **Error Elicitation:** 3 repetitions at 2.5 syllables/second.

**Analysis:** Perceptible errors resulting in voiced consonants were matched within speaker with correct productions matched to the error outcomes (e.g., “taz-o-dez” was matched with “dez-02aze”).

VOT measured from onset of release burst to onset of periodicity in acoustic waveform.

**Results:**

Sub-phonemic properties of errors are influenced by lexicality.

**Study II: CORRECT PRODUCTIONS**

**Participants:** 13 native English speakers.

**Materials:** 16 pairs, composed of:

- A neutralizing /p/-initial word that forms a minimal pair with a /b/-initial word (e.g., “pun” forms a minimal pair with “bun”);
  
- A matched non-neutralizing /p/-initial word that does not form a minimal pair (e.g., “pup” -> “bup”);

**Procedure:** Self-paced reading. Words are presented in a random order 3 times for each participant.

- No significant differences in VOTs across repetitions.

**Analysis:** VOT. All mispronunciations excluded (1.5% of all tokens).

- Primarily regularization errors. Some pattern of results found when analysis repeated with only orthographically regular words.

**Conclusions**

Activation from word-level processes cascades beyond phonological processing to influence phonetic processes.

• Lexical representations enhance the activation of (non-target) phonological representations corresponding to words (leading to lexical bias effects; Dell, 1986).

• Lexical support allows phonological representation of words to suppress any residual phonetic activation of the target.

• Nonword phonological representation receive no such support;

• Weaker suppression of target activation leads to traces.

- Correct Productions
  - Phonological selection requires suppression of non-target material (leading to competition effects in form-related priming; O’Shea, & Mars, 2003).
  - Neutralizing words: activation of /p/ at the phonological level is driven up in order to suppress non-target /b/ (activated by minimal pair competitor).
  - Increased activation leads to more extreme VOT values.

• Non-neutralizing words do not face competition; lower activation of /p/ leads to less extreme productions.

Previous Results Supporting Lexical Cascade

Studies of disrupted speech production:

- Strop interference slows not only latency but duration of productions (Kello, Plaut & MacWhinney, 2005).

• Error: Failure to replicate (Davies, 2001).

Studies of non-disrupted speech production:

- Words with many lexical neighbors are produced more acoustically distinct (Johnson, in press; Munson & Solomon, 2004; Wright, 2002, and with greater coarticulation (Kucharczyk, 2005) than those with few neighbors.

• Error: Failure to control for correlated phonotactic variables (e.g., phonotactic probability).

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