Inner-speech slips exhibit lexical bias, but not the phonemic similarity effect

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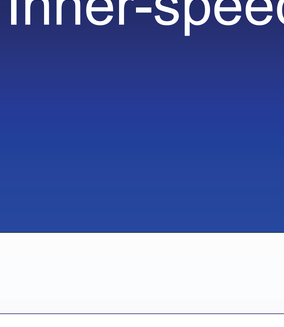
Research question:

How abstract is inner speech?

Inner speech refers to the paired phenomena of speech without articulation *and* our conscious access to this imagery. In the vernacular, inner speech is often termed, "saying something in one's head," and in some working memory theories (e.g. Baddeley), inner speech is referred to as the "articulatory loop." According to some theories of language production (e.g. Levelt, 1989), inner speech engages all parts of the speech production system except for the actual articulation of utterances (see the figure at right), and therefore can be useful for examining the speech production process.



Background

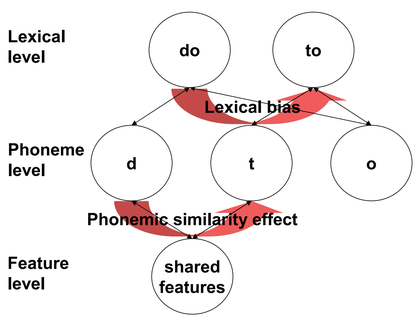
This research uses the elicitation of phonological speech errors to determine whether inner speech involves articulatory or phonological features beyond the phoneme level.

Two speech error effects are:

- ***Lexical bias:*** Errors that produce words (*e.g.* barn door → darn bore) are more likely than those that do not (*e.g.* back dip → dack bip)
- ***Phonemic similarity effect:*** Phonemes that are more similarly articulated (*e.g.* /b/ and /d/) are more likely to interact in speech errors than those that are less similarly articulated (*e.g.* /b/ and /t/)

Model

Spreading activation models of speech production (*e.g.* Dell, 1986, illustrated below) suggest that *lexical bias* is due to the interaction of lexical and phoneme levels, and that the *phonemic similarity effect* is due to the interaction of phoneme and feature levels.



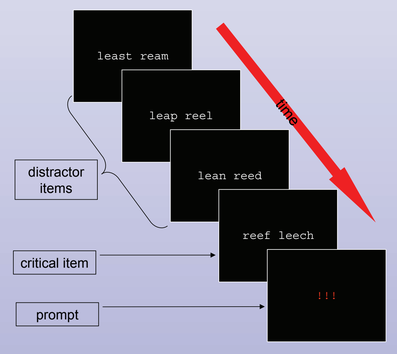
- *Lexical level is input, phoneme level is output*
- *Linear activation rule*
- *The noise in the activation of each output node is proportional to its activation*
- *Reciprocal connections between all levels*
- *The onset phoneme with the greatest activation after five time steps is selected as the output*

Experiment 1: Demonstrating lexical bias and phonemic similarity effects in overt speech errors

Procedure

48 participants
Baars and Motley (1974)-style SLIP procedure
Word pairs briefly displayed on a monitor
Participants named the last-seen word pair following irregularly-placed prompts

Presentation sequence:



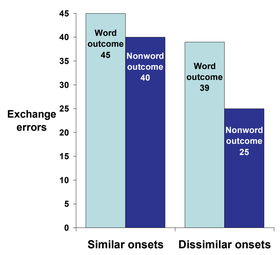
Manipulations

Orthogonal manipulation of outcome lexicality and onset phoneme similarity within matched item sets and within subjects

	Similar onsets	Dissimilar onsets
Word outcome	reef leech → *leaf reach*	reef beech → *beef reach*
Nonword outcome	wreath leech → *leath reach*	wreath beech → *beath reach*

Critical words were controlled for log frequency
Word- and nonword-outcome pairs differed by a single feature in the coda of the first word
Only onset exchanges were analyzed

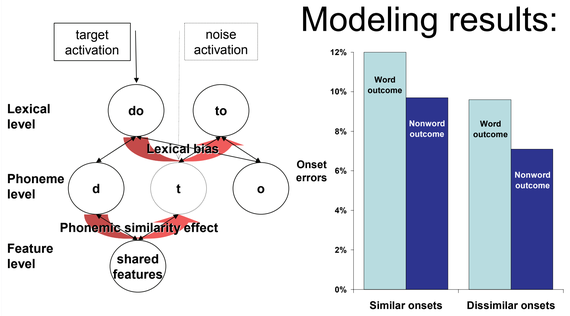
Behavioral results:



Summary of effects

- More word-outcome than nonword-outcome onset exchanges (*p=.030*)
- More similar than dissimilar onset exchanges (*p=.017*)
- No significant lexicality by similarity interaction (*p=0.423*)

Computational model:



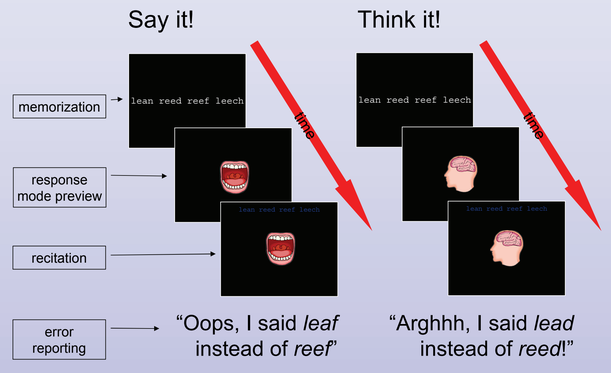
Modeling results:

Experiment 2: Comparing inner and overt speech errors

Procedure

48 participants
Serial recitation of four-word sequences, in time with a fast (120 bpm) metronome

Presentation sequences:



Manipulations

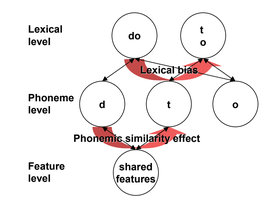
Critical word pairs from Experiment 1 were combined with priming pairs to form matched sets four-word sequences (*e.g. lean reed reef beech*), in which outcome lexicality, onset phonemic similarity, and overtness of response were orthogonally manipulated

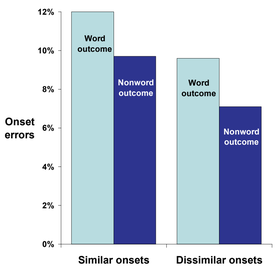
	Similar onsets	Dissimilar onsets
Word outcome	lean reed reef leech	bean reed reef beech
Nonword outcome	lean reed wreath leech	bean reed wreath beech

In each matched set, the second word was identical in all conditions, and the third word was identical within each outcome lexicality condition
Slips on the third word were analyzed for lexical bias, and slips on the second and third word were analyzed for phonemic similarity effects

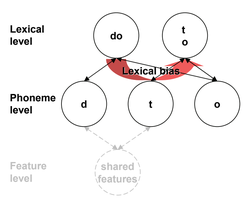
Model predictions:

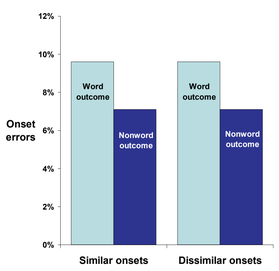
With feature-level activation





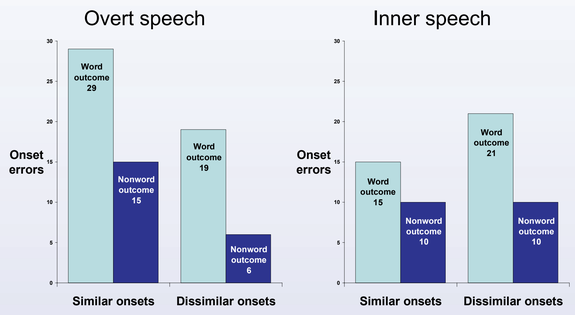
Without feature-level activation



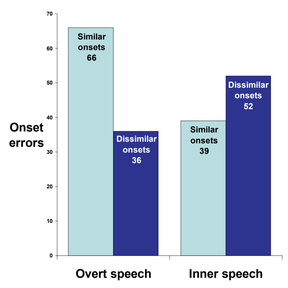


Behavioral results:

Lexical bias:



Phonemic similarity effects:

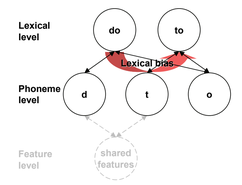


Summary of effects

- More word than nonword slips in both inner (*p=.0089*) and overt (*p=0.0089*) speech
- More slips of similar phonemes in overt speech only (*p=.035*), with no such effect in inner speech (*p=.848*)
- Significant overtness by similarity interaction (*p=.0234*)

Conclusions

- Inner speech, or our access to it, is robust at the phonemic and lexical levels, but seems to be impoverished at the featural level
- A featural level of representation is not a necessary component of inner speech
- Eliciting inner slips is an effective way to examine the properties of inner speech



Future work

- Compare effects in silently articulated (mouthed) speech with those in inner speech
- Compare effects of articulatory versus acoustic similarity
- Vary the speed of production to establish whether phonemic similarity effects in inner and overt speech may be modulated by the time allowed for feedback effects to build up

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Acknowledgements

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Overt speech, similar onsets
Overt speech, dissimilar onsets
Inner speech, similar onsets
Inner speech, dissimilar onsets